INVESTIGATION OF THE PRESERVICE SCIENCE TEACHERS' VIEWS ON SCIENCE TECHNOLOGY AND SOCIETY ISSUES

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ELVAN KAHYAOĞLU

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Prof.Dr. Canan Özgen
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science

Prof.Dr. Ömer Geban
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

Assoc.Prof.Dr. Ceren Tekkaya
Co-Supervisor

Assist.Prof.Dr. Jale Çakıroğlu
Supervisor

Prof. Dr. Ömer Geban	(METU,SSME)	
Assoc. Prof. Dr. Ceren Tekkaya	(METU, ELE)	
Assist.Prof.Dr. Jale Çakıroğlu	(METU, ELE)	
Assist.Prof.Dr. Semra Sungur	(METU, ELE)	
Dr. Naciye Aksoy	(GAZİ, ELE)	

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Name, Last name : Elvan KAHYAOĞLU

Signature :

ABSTRACT

INVESTIGATION OF THE PRESERVICE SCIENCE TEACHERS' VIEWS ON SCIENCE TECHNOLOGY AND SOCIETY ISSUES

Kahyaoğlu, Elvan
M.S., Department of Secondary Science and Mathematics Education
Supervisor: Assist. Prof. Dr. Jale Çakıroğlu
Co-Supervisor: Assoc. Prof. Dr. Ceren Tekkaya

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The aim of this study is to investigate the views of preservice science teachers on science-technology-society, STS, issue. A total of 176 preservice science teachers participated in the study. A 26-item "Views on Science-Technology-Society (VOSTS)" instrument, translated and adapted into Turkish, were utilized to assess participants' views on STS. The VOSTS (Aikenhead, Ryan and Fleming, 1989) is a pool of 114 empirically developed multiple-choice items with nine categories. In order to understand participants' views on STS in depth, semi-structured interviews were also conducted by 9 volunteer preservice science teachers.

The results gave a colorful picture of the views of preservice science teachers on science-technology-society issue. The analysis revealed that preservice science teachers often confuse the definitions of technology with science. Most of the participants of the study had specific views about the reasons of doing scientific researches in their country, for example, to be independent from other countries, to get financial profit. Results displayed a consensus on the possible positive effects of upbringing and the importance of education given to high school students. According to the data obtained from the present study, respondents possess varied views about the influences of society on science and technology. While preservice science teachers claiming that scientists could break the rules of science, they also claimed scientists as objective in their study. On the other hand, participants supported the view that scientists' concern on all the effects of their experiments. Preservice science teachers advocated also that technological developments can be controlled by citizens.

Keywords: Views on science-technology-society, preservice science teachers, nature of science.

ÖZ

FEN BİLGİSİ ÖĞRETMEN ADAYLARININ BİLİM-TEKNOLOJİ VE TOPLUM HAKKINDAKİ GÖRÜŞLERİNİN ARAŞTIRILMASI

Kahyaoğlu, Elvan
Yüksek Lisans, Ortaöğretim Fen ve Matematik Alanları Eğitimi Bölümü
Tez Danışmanı: Yrd. Doç. Dr. Jale Çakıroğlu
Ortak Tez Danışmanı: Doç. Dr. Ceren Tekkaya
Temmuz 2004, 134 sayfa

Bu çalışmanın amacı fen bilgisi öğretmen adaylarının bilim-teknoloji-toplum (BTT) hakkındaki görüşlerini araştırmaktır. Çalışmaya 176 fen bilgisi öğretmen adayı katılmıştır. Katılımcıların bilim-teknoloji-toplum hakkındaki görüşlerini değerlendirmek için Türkçe'ye adapte edilmiş, 26 sorudan oluşan "Bilim-Teknoloji-Toplum Hakkındaki Görüşler" anketi kullanılmıştır. Bu anket deneysel yolla geliştirilen, dokuz kategoriden oluşan, 114 çoktan seçmeli sorudan oluşmaktadır. Katılımcıların bilim-teknoloji-toplum hakkındaki görüşlerini daha detaylı incelemek amacıyla 9 fen bilgisi öğretmen adayının katıldığı görüşmeler yapılmıştır.

Sonuçlar, öğretmen adaylarının bilim-teknoloji-toplum konusundaki görüşlerini yansıtmıştır. İncelemeler sonucunda fen bilgisi öğretmen adaylarının bilim ve teknoloji tanımlarını birbirine karıştırdıkları gözlenmiştir. Ayrıca katılımcıların çoğunluğunun, bilimsel araştırma yapmanın nedenleri hakkında farklı gerekçelere sahip olduğu görüldü. Diğer ülkelerden bağımsız olmak, ekonomik kazanç elde etmek bu gerekçelerden bazılarıdır. Öte yandan, öğretmen adaylarının çoğunluğu, yetiştirme tarzının ve lise öğrencilerine verilen eğitimin bilim-teknoloji-toplum konusunun algılanmasındaki olası pozitif etkileri konusunda fikir birliğine vardı. Bu çalışmanın sonuçlarına göre fen bilgisi öğretmen adayları, toplumun bilim ve teknolojiye olan etkisi konusunda da farklı görüşlere sahiptir. Aday öğretmenler bir yandan bilim adamlarının zaman zaman bilimin kurallarını çiğneyebileceklerini

iddia ederken, bir yandan da bilim adamlarının çalışmalarında tarafsız olduklarını savunmuştur. Öte yandan katılımcılar, bilim adamlarının, yaptıkları çalışmaların tüm olası sonuçlarını değerlendirdikleri fikrini savunmuşlardır. Aday öğretmenler ayrıca teknolojik gelişmelerin vatandaşlar tarafından kontrol edilebileceği fikrini savunmuşlardır.

Anahtar kelimeler: Bilim-teknoloji-toplum hakkında görüşler, fen bilgisi öğretmen adayları, bilimin doğası.

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CHAPTER 1

INTRODUCTION

There is not a consensus among educators on how to define "science education." Good, Herron, Lawson, and Renner (1985) defined science education as the discipline devoted to discovering, developing, and evaluating improved methods and materials to teach science, i.e., the quest for knowledge, as well as the knowledge generated by that quest. According to them a central concern of science education should be developing a better understanding of how scientists and people in general learn to quest for knowledge in order to help children learn. On the other hand, Yager (1985) claimed that to limit science education to discovering, developing, and evaluating "improved methods and materials for teaching science" makes science education "administrative"-less than a discipline- an inquiry without a domain of its own. Such a limited definition identifies the task of the science educators one of transmitting what scientists know to students of varying ages. Yager (1984) defined science education as; the discipline concerned with the study of the interaction of science and society-i.e., the study of the impact of science upon society as well as the impact of society upon science. According to him their interdependence becomes a reality and the interlocking concept for the discipline. In Yager's opinion research in science education centers upon this interface.

For two centuries science and technology have increasingly shaped the character of developed societies. Throughout most of the history the interaction and significance among science, technology, and society went unrecognized. During this time, however, the interaction continually changed. Citizens became aware of the promises of science and technology. Government became involved in the support of research and development. Technology also became larger and more sophisticated. With little fanfare, science and technology slowly moved to center stage in society. A paradox has also recently emerged (Kellough, Cangelosi, Collette, Chiapetta, Souviney, Trawbridge, and Bybee, 1996). Scientific advances and technological innovation have contributed to both social progress and cultural problems. Many critical decisions related to the role of science and technology have to be made by the nation. The decision will be made relative to many local and regional issues-land use, acid rain, atmospheric conditions, carbon dioxide, toxic waste pumps, energy shortages, preservation of endangered species, and water resources to name only a few examples. Who should make decisions about problems, research development, or applications? On what basis should these decisions be made? Every society has struggled with the problem of how to prepare the next generation during the history. Today this preparation needs to be concentrated on especially decisions about socio-scientific issues. Societies generally support an education system that prepares learners for life, work, and further specialization at the next academic level; societies refine the system over time to better meet those goals (Yager, 2000). Achieving a balance between the values of science and society suggests the need for citizens to be well informed concerning social issues and the facts and values related to the cost, benefits, and consequences of decisions about science, technology, and society. Science education is thought as the way to help citizens to make such decisions.

In response to the growing importance of science and technology in contemporary society-and to the increasing recognition of that importance-the last decades have witnessed the birth and growth of a new academic field: "science, technology, and society," most often report to simply as "STS." Precisely STS refers to the study of science and technology in society-that is, the study of the ways in which technical and social phenomena interact and influence each other (McGinn, 1991). Yager and Lutz (1995) defined STS as the teaching and learning of science in the context of human experience, including the technological applications of science. According to them, central to the STS approach is a focus upon individual learners. Students are often involved in determining and developing directions for study. STS gives students an understanding of what science and technology are and the role they play in our lives. Yager (1990) defined STS as the process would give the student practice identifying potential problems, collecting data with regard to the problem, considering alternative solutions, and considering the consequences based on a particular situation.

The field of STS has taken a long way in time. As Yager stated (1993) that STS efforts were underway in several European countries before becoming a major force in the United States and other parts of the world. As a result of several studies performed in different countries, STS came into practice in educational area. Many educators thought that it could solve many problems in science education. The problems that can be resolved by STS approach in science education stated by Yager and Lutz (1995) were;

1-The textbook is relieved of responsibility of defining the course. Instead, it is relegated to what it should be: a source of information, a useful reference.

2-Information included in science courses is justified by use, and application of learned information is the focus of the lesson, instead of being presented as an afterthought.

3-Because they actually apply their knowledge in real situations, the students find science classes relevant to their daily lives.

4-The teachers' role is that of facilitator, rather than an omnipotent dispenser of truths.

5-Student success can be measured in terms of performance, including application and synthesis, as opposed to straight recall.

6-Science becomes something that is found everywhere, not just in textbooks, and science classes, and many new resources are tapped.

7-The STS approach calls upon community members to support school efforts. Teachers are quick to realize that they must continue to grow, and that the best teachers are also involved learners.

Yager (1993) defined the following general results about the students and teachers experiencing STS, by using the many other studies performed by many other researchers. He reached the following arguments: students experiencing STS are four times more effective in using basic science concepts and procedures; they develop attitudes that not only do not decline (as in traditional course) but are more positive by a factor of two; their creativity skills increase with STS, questions, ideas on causes, and predictions of consequences increase by a factor of two and quality/unique response increase by a factor of six; students ability to use science process skills, especially those used in daily operations, increase by a factor of two; student mastery of science concepts is as great as in traditional classrooms but the mastery lasts much longer, presumably because it was developed by the student first-hand and has been used; students have better perceptions of the nature of science and its role in their own daily lives with STS instruction than is the situation with traditional instruction; teachers become more confident in their ability to teach science and stimulate student involvement and learning when utilizing STS approaches; teachers and students are better able to construct meaning for themselves as a result of STS instruction; STS results in improved attitudes and confidence among female students than do their counterparts in traditional classrooms; STS approaches result in greater career awareness and accuracy about careers in science than what occurs as a result of traditional instruction.

As a summary, science education researchers showed that students that are taught STS issues can define a problem, analyze data, make choices, and take appropriate actions. These abilities are necessary for citizens to be considered scientifically literate. Science education reform brought scientific literacy into the central point of the science education goals. Laugksch and Spargo (1996) stated that scientific literacy has received much attention in the last decade, particularly in the U.S. and Britain. Widespread scientific literacy of individuals is increasingly seen as being of vital importance for a number of different reasons-scientific, economic, ideological, intellectual, and aesthetic. Bybee, Powel, Ellis, Giese, Parisi, and Singleyton (1991) explained that the features of a scientifically and technologically literate person understand those; science and technology are the products of culture within which they develop; the roles and effects of science and technology have differed in different cultures and in different groups within these cultures; technology and science are human activities that have creative, affective and ethical dimensions; and they base decisions on scientific and technological knowledge and process.

According to Lawrence, Yager, Hancock, Yalaki, and Jablon (2001), any transition to STS education is not a simple process. It requires patience, determination, time and good planning. It is important to inform students about what STS is and how the instruction will change with STS. It is clear that science teachers are the key factor to put STS into curriculum effectively. Teachers need to proceed toward STS education step by step experimenting with short STS activities and use these experiences for developing more comprehensive STS units. Teachers also need to get support from school administrations and parents. They can do so by providing information about STS education and trying to explain the advantages of STS to administrations and parents.

1.1. Significance of the Study

As McComas, Almazroa, and Clough (1998) stated, although the relationship between teachers' STS knowledge and their pedagogical decision-making is not straight-forward, complex interplay does exist. Hence it can be said that to determine the future-science teachers' views on STS has crucial importance for contemporary science education and a successful transmission. By determining the teachers' views, mistaken points can be bring into light and gives the educators the opportunity to reconstruct these mistaken or old fashioned points in science education. The results of Third International Mathematics and Science Study (TIMSS, 1999) showed some alarming results for our country in terms of science education. According to the results of this study, there is much more emphasis on scientific knowledge, basic science facts and concepts than the application of science, designing and conducting scientific investigations, and STS approach. The same study also displayed this dramatic results; the science topic in the intended curriculum is 95% for Turkey. This is about 86% in US, 71% in England, 67% in Italy, and 38% in Belgium. This means that we intended to teach but we could not. TIMSS also investigated the emphasis on several approaches and processes given in different countries. According to this study, emphasis given on to science-technology-society in Turkey evaluated as moderate. Major emphasis was given to this point in many other countries such as Canada, Finland, and Netherlands etc. It is obviously seen that our science education needs fundamental changes. STS can be one of the ways for actualization of changes in science education. As it's mentioned above, science teachers are the key factors for changes in education. For that reason, the present study aimed to determine the views of preservice science teachers' on Science-Technology-Society issue, which is the basic goal of contemporary science education. The result of this study gives the opportunity to future studies to improve science education starting from the key elements, science teachers, of the STS education procedure.

CHAPTER 2

REVIEW OF LITERATURE

This chapter is devoted to the previous studies that have produced theoretical background of this study.

2.1. Science-Technology-Society Issues in Education

Life in the industrialized countries under changes continually. According to Chisman (1984), industrialized countries have, through their control of science and technology, developed the potential to enhance the human environment, to increase production, and to improve the standard of living of their peoples. However, this potential has, in recent years, not been fully realized and has led to waste of resources, including energy, and, in consequence, has introduced serious social and environmental problems. For this reason, one of the goals of science education, societal issues, have greater importance today than it was in the past. According to Bingle and Gaskell (1994), citizens are often required to make decisions about socioscientific issues in a climate characterized by conflict within both the scientific community and the larger society. Central to the process of decision making is a critical examination of the relevant scientific knowledge involved. Individuals capable of performing this task can be considered scientifically literate in a decision making sense.

McGinn (1991) stated that in response to growing importance of science and technology in contemporary society-and to the increasing recognition of that importance- the last two decades have witnessed the birth and growth of a new academic field: “science-technology and society” most often referred to simply as “STS” (p.7). Aikenhead’s (1994) explanation of the interaction among science, technology, and society were presented in Figure 2.1. According to Aikenhead (1994) students strive to understand their everyday experiences. To do so, they make their sense out of their social environment, their artificially constructed environment, and their natural environment. This sense-making was depicted in figure 2.1.by the solid arrows between the student and the three different environments.

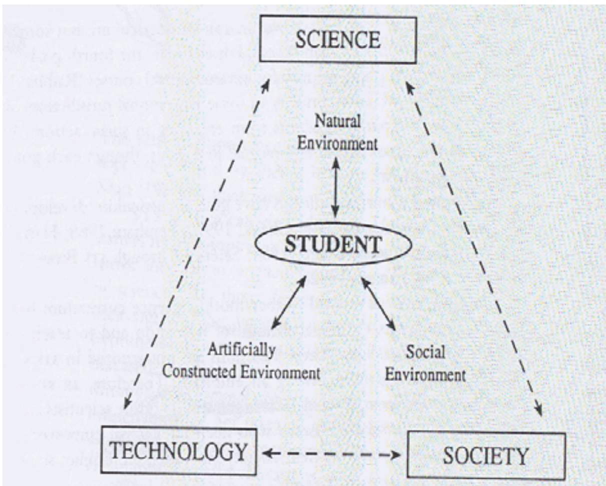

Figure2.1. The essence of STS education (Aikenhead, 1994,p.48).

This complex essence of STS education needs some additional efforts. Bybee (1985; as cited in Aikenhead, 1994) stated that an STS orientation would mean research and development of curriculum and instruction for the following:

1-Presentation of science knowledge, skills and understanding in a personal/social context.

2-Inclusion in the curriculum of knowledge, skills and understanding relative to technology.

3-Extension of the inquiry goal to include decision making.

4-Clarification of the knowledge, skills, and understanding relative to the STS theme that are appropriate to different ages and stages of development.

5-Identification of the most effective means of incorporating STS issues into existing science programs.

6-Implementation of STS programs into school systems social goals.

Bybee (1985) also stated the balance for STS science education among three general goals (see Aikenhead, 1994):

1. "Acquisition of knowledge" (concepts within, and concepts about, science and technology) for personal matters, civic concerns, or cultural perspectives.
2. "Development of learning skills" (process of scientific and technological inquiry) for information gathering, problem solving, and decision making.
3. "Development of values and ideas" (dealing with the interactions among science, technology, and society) for local issues, public policies, and global problems.

Most STS science courses harbor similar goals but give different priorities to different goals. Features characterizing an STS program defined by the National Science Teacher Association (NSTA) in the US (cited in Yager, 2001) are; preparing individuals to use science for improving their own lives and for coping with an increasingly technological world; preparing students to deal responsibility with technology/society issues; identifying a body of fundamental knowledge which students may need to master in order to deal intelligently with STS issues; and providing students an accurate picture of the requirements and opportunities involved in the multitude of careers available in the STS area (p.85).

According to Yager and Lutz (1995), the richness of STS comes from contributions of the individual students, their creative ideas, and the central role they play in planning and carrying out the STS investigations. The power of STS comes from its close approximation of how real people deal with real issues in the real world. The potential of STS is that it can help educators reconstruct the school program, creating better learners and better future citizens. He argued that the STS approach, resolves the major problems of science education. Aikenhead (1994) claimed that a societal question or problem creates the need to know certain technological knowledge but both create the need to know some science content (Figure 2.2.). This science content will help students understand the technology and societal issue. As it was shown in the figure 2.2., the sequence of instruction suggested by the arrow begins in the domain of society, moves through the domains of technology and traditional science, and then out again to technology. Finally, the arrow in figure 2.2. ends in the domain of society. As Aikenhead stated, at that point students often address the original key question or social problem and then make a decision.

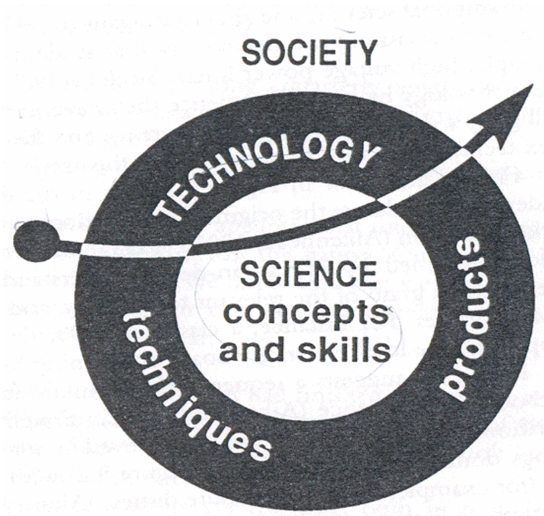

Figure 2.2. A sequence for STS science teaching (Aikenhead, 1994, p.57).

STS programs are characterized as those with many of the following characteristics (NSTA, 1990; as cited in Yager, 2000):

1. The use of local resources (human and material) to locate information that can be used in problem resolution;

2. The active involvement of students in seeking information that can be applied to solve real-life problems;

3. The extension of learning going beyond the class period-the classroom, the school;

4. A focus upon the impact of science and technology on individual students;

5. A view that science content is more than concepts which exist for students to master on tests;

6. An emphasis upon process skills which students can use in their own problem resolution;

7. An emphasis upon career awareness especially careers related to science and technology;

8. Opportunities for students to experience citizenship roles as they attempt to resolve issues they have identified;

9. Identification of ways that science and technology are likely to impact the future;

10. Some autonomy in the learning process (as individual issues are identified).

In Yager's (1993) opinion, STS teaching will require new models for pre- and inservice teacher education. One of the greatest problems of shifts to STS teaching is the failure of most teachers, even those newly certified, to have ever experienced science study and learning themselves as STS, i.e., learning in the concept of human experience.

Since the subject STS is so important, it must be studied to make room for more improvement in our country.

2.2.Instruments Developed to Assess the Understanding of STS

There are several instruments that have been developed to assess the views on science-technology and society concepts. Most of these instruments are specifically related with the epistemological part (nature of science) of the Science-Technology-Society issues (Table 2.1.).

2.2.1.Instruments Related with NOS

Scientific Literacy Research Center constructed an inventory called as Test on Understanding Science (TOUS) was developed by Cooley and Klopfer in 1961 (as cited in Lederman, Wade, and Bell, 2000). It is a four alternative, 60-item multiple-choice test. It has three subscales: understanding about the scientific enterprise; the scientist; and the methods and aims of science. Its questions are clearly more relevant to the institution of science and the profession of "scientist" than to one's understanding of the nature of science. Wheeler (1968) (as cited in Lederman, Wade, and Bell, 2000) stated that in this instrument, too many items embrace a negative viewpoint of science. He felt that items could be rewritten to minimize their reflection of current stereotypes of science and scientists and suggested the addition of more items to increase the test's comprehensiveness (Lederman, Wade, and Bell, 2000).

In 1966, Welch developed an instrument called "Science Process Inventory, (SPI)." It is a 135-item forced-choice inventory (agree/disagree), purporting to assess an understanding of the methods and processes by which scientific knowledge evolves (Lederman, Wade, and Bell, 2000). The content of the SPI is almost identical to Wisconcin Inventory of Science Process, WISP, (Scientific Literacy Research Center, 1967) and Test on Understanding Science, TOUS, subscale III. SPI has several forms. The length (135 items) is obviously too long for a single class period administration. Due to its forced response nature, students are unable to express "neutral" or uncertain answers. The SPI does not possess subscales so it's open to critiques (Lederman, Wade, and Bell, 2000).

Another instrument on this subject was developed by "Scientific Literacy Center" in 1967 and called as Wisconsin Inventory of Science Process (WISP). The WISP consists of 93 statements that the respondent evaluates as "accurate," "inaccurate," or "not understood." The instrument was developed and validated for high school students. Although it has excellent reliability and validity data, WISP's length is its primary concern. The 93 items test takes over an hour to administer in a single class period. In addition, this instrument does not possess discrete subscales which, unfortunately, means that only unitary scores can be calculated (Lederman, Wade, and Bell, 2000).

Kimbal developed a scale called Nature of Science Scale (NOSS) in 1968 (as cited in Lederman, Wade, and Bell, 2000). It is purported to measure opinions about the nature of science. It was developed to determine whether science teachers have the same view of science as scientists. A student may respond to each of the twenty-nine statements in one of three ways: by agreeing; by disagreeing; or by signifying that he is not sure, does not understand, or feels neutral about the item. The model is composed of eight assertions: curiosity in science; dynamic nature of science; comprehensiveness and simplifications using mathematics to state relationships; different scientific methods; characterization of science matters by value-type attributes; faith in the susceptibility; openness of science; and tentativeness and uncertainty of science.

Nature of Scientific Knowledge Scale, NSKS, was developed by Rubba and Andersen in 1976 (as cited in Lederman, Wade, and Bell, 2000). The test was purported to be an objective measure of secondary students' understanding of the nature of science. There were 48 items in this scale. Subscales were composed of eight items. Subscales of the NSKS were; amoral, creative, developmental, parsimonious, testable, and unified.

Beliefs About Science and School Science Questionnaire, BASSSQ, was developed by Alridge, Taylor and Chen in 1997. The BASSSQ is a Likert-scaled survey consisting of 41 items. This instrument was of particular significance due to the nature of its ability to measure teachers' and students' beliefs about the nature of science and school science. The instrument contains for sub-scales pertaining to one's beliefs about science and school science. The sub-scales are: process of scientific inquiry; certainty of scientific knowledge; process of school science inquiry; certainty of school science knowledge.

A model of Nature of Science questionnaire was developed by Moss, Abrams, and Robb (2001). The questionnaire was developed to assess the students' conceptions of the Nature of Science. The model has eight tenets which address both the nature of the scientific enterprise and the nature of the scientific knowledge. The questionnaire includes about 24 questions under these eight tenets.

Lederman, Khalick, Bell, and Schwartz (2002) developed an instrument called as The Views of Nature of Science Questionnaire (VNOS). Items of the instrument are open-ended to avoid the problems inherent in the use of standardized forced-choice instruments.

2.2.2.Instruments Related with STS

Test on Social Aspects of Science (TSAS) was developed by Korth in 1969. It deals with the interaction between science and society and those features which are related to the social nature of scientific enterprise itself. There are 52 statements to which the student response on a five point scale, from "strongly disagree" to "strongly agree." TSAS has three subscales: interaction among science, technology, and society; social nature of the scientific enterprise; social and political responsibilities of scientists. The validity is based on statement from the literature and on students' interpretations of a preliminary form of the TSAS. On the basis of content, TSAS resembles the TOUS subscale I (Aikenhead, 1973).

The VOSTS was developed to assess student' understanding of the nature of science, technology and their interactions with society. Aikenhead, Fleming, and Ryan (1987) developed the instrument over a six-year period starting from 1987. It consists of a pool of 114 multiple-choice items. There are four main parts of VOSTS: definitions, external sociology of science, internal sociology of science, and epistemology. Each main part has one or more sub-categories, for example, definition part includes science and technology; external sociology of science part includes influence of society on science/technology, influence of science/technology on society, influence of school science on society; internal sociology of science part covers the characteristics of scientists, social construction of scientific knowledge, social construction of technology; and finally epistemology part includes the nature of scientific knowledge (Aikenhead, Ryan, 1992). Several statements in this instrument refer to a specific nationality, such as Canadian scientists, so some caution or adjustments are suggested when administering this to students from other nationalities to avoid "nationalistic feelings" influencing responses (Lederman, Wade, and Bell, 2000).

A fifty-item survey was developed by Pomeroy in 1993. It consisted of agree-disagree statements on a 5 points Likert scale. These include consideration of the roles of deduction, art perception, attitude, judgment, community, and prior belief in shaping the work of scientists and their knowledge of nature. The survey also explored relevant beliefs about science education, K-12, including the statements about the role of the laboratory experience. The development of the instrument was not subjected to tests for validity and reliability for more general use and interpretation.

Nature of Science and Technology Questionnaire (NSTQ) was developed by Tairab (2001). The instrument contains 8 items (seven multiple choice and only one open-ended) measuring various aspects of the nature of science and technology. Items of the NSTQ were modified from the Views on Science-Technology-Society (VOSTS) instrument. It includes several parts: the characteristics of science and technology; the relationship between scientific research; the characteristics of scientific knowledge and scientific theories; the relationship between science and technology. The instruments for STS were summarized at Table 2.1.

Table 2.1. Instruments on Science-Technology-Society Issues

Name of the instrument	Date of development	Researcher	Main Issue of the instrument
TOUS	1961	Cooley&Klopfer	NOS
SPI	1966	Welch	NOS
WISP	1967	Scientific Literacy Research Center	NOS
NOSS	1968	Kimbal	NOS
NSKS	1976	Rubba&Andersen	NOS
BASSSQ	1997	Alridge, Taylor,&Chen	NOS
A Model of NOS Questionnaire	2001	Moss& Robb	NOS
VNOS	2002	Lederman, Khalick, Bell,&Shcwartz	NOS
TSAS	1967	Korth	STS
VOSTS	1987	Aikenhead, Ryan,&Fleming	STS
Pomeroy's Scale	1993	Pomeroy	STS
NSTQ	2001	Tairab	STS

2.3.Studies Conducted for Assessing the Views on Science-Technology-Society

Studies conducted on STS can be fallen into two categories; students' views on STS and teachers' views on STS. The majority of the studies on this subject focus on the students' views. Meanwhile the importance of the teachers' view was realized and new studies were carried out. The relationship of these two factors was also subjected to the studies done by several researchers. The views are investigated with several forms of the research design. The studies generally focused on the epistemological part of the subject. In this part, first the nature of science (NOS) studies and then the studies about the STS in general were reported.

2.3.1.Students' Views on STS

The studies conducted to assess students' views were performed in several levels of education; from primary school level to university level. One of the studies performed at the early school levels was the study of Shiang and Lederman (2002). They examined the seventh grade Taiwanian students conceptions of the Nature of Science, epistemology part of the STS. The students were engaged in a 1-week science camp with emphasis on scientific inquiry and nature of science (NOS). Results indicated that the majority of the participants had a basic understanding of the tentative, subjective, empirical, and socially and culturally embedded aspects of NOS. There were no significant changes in students' views on NOS both before and after instruction.

Most of the studies about epistemological part of the subject STS conducted with high school students. One of the study with high school students on this subject was performed by Aikenhead, Fleming, and Ryan (1987). More than 2000 students enrolled in the study. A selection of VOSTS items administered as a national survey in Canada. The study was performed to understand the high school graduates' beliefs about characteristics and limitations of the scientific knowledge. VOSTS statements were used as the instrument. Almost half of the high-school graduates (45%), claimed that scientific models are epistemological rather than ontological. They emphasized the criterion of being helpful in understanding nature and discounted the possibility of models duplicating reality. Similarly, 44% of the students assumed an epistemological view of models. They argued that like scientific theories, scientific models can be changed in time. For another question three basic reactions were observed at students, the constructionist position that scientific knowledge does change (44%), the cumulative position that it does not change but is added to (31%), and somewhere in between these two positions (11%). By using the same sample; Ryan, and Aikenhead (1992) studied on the students' preconceptions about the epistemology of science. A selection of VOSTS items administered as a national survey in Canada. Items related to the following issues: the meaning of science, scientific assumption, values in science, conceptual inventions in science, scientific method, consensus making in science, and characteristics of the knowledge produced in science. Some of the findings of the study are those; Canadian students confused science with technology. Most of the students believed that there is a scientific method used by scientists. Few students chose the contemporary view of most epistemologists-scientists use any method that might get favorable results. In another study at that level performed by Lederman and O'Malley (1990). They investigated the students' perceptions of tentativeness in science. The sample consisted of 36 males and 33 females spanned grades 9-12. Students are enrolled in physical science, biology, chemistry, and physics classes. All students were asked to complete a seven item open-ended questionnaire concerned with their beliefs about the tentative nature of science during the second week of the school year. The same questionnaire was repeated during the final month of the school year. At the end, researchers reviewed the completed questionnaires and identified 20 students to participate in videotaped "follow-up" interviews. The data gathered during the pretest seem to indicate that the students, as a group, do not uniformly adhere to either an absolute or tentative view of scientific knowledge. In contrast to the pre-test, the results of the post-test more clearly adhere to the tentative view of scientific knowledge. In the interview part, all students correctly interpreted the intent of each of the questionnaire items. In conclusion, the study displayed that more care must be taken in the assessment of students' perceptions of science. Language is often used differently by students and researchers and this mismatch has almost certainly led to misinterpretations of students' perceptions in the past.

Griffiths and Barmen (1995) interviewed a total of 96 high school students individually to understand some general terms used to classify scientific knowledge. The students were from three different countries; Australia, United States, and Canada. Answer to the question “how do scientists get information?” showed considerable differences between the three groups. Seventy-five percent of the American students were very attracted to the traditional view of the practice of science as involving a relatively set sequence of events. American students formed such sentences; scientists formulate a hypothesis, set up control groups and experimental groups etc. In complete contrast, the Australian students, although making frequent reference to experiments, virtually never spoke in terms of the traditional scientific method mentioned above. Collectively, the responses of the Canadian students were intermediate between these extremes, with 30% of them being attracted to the traditional view. In answer to the question “does science change?” About 75% of the total sample expressed a belief that it does. As a result of this international study, some major differences and many commonalties were observed between the three groups of students involved in terms of beliefs in the underlying status of scientific knowledge.

Solomon, Scott, and Duveen (1996) reported a study of British pupils’ understanding of several aspects of the nature of science. The prime sample was nearly 800 pupils aged 14-15 years. Interviews with teachers and a questionnaire were used for the study. It was seen that a strikingly relation between the class in which the pupils were taught and how they answered most of the questions. This study showed what may be both the effect of the teacher on the pupils’ views and also an indication of the relative effect of in-school and out-of-school knowledge. Previous studies (Brickhouse, 1989; Lederman and Zeidler, 1987 as cited in Solomon, Scott, and Duveen, 1996) have also pointed to the overriding influence of the teachers’ views of the nature of science on what their pupils come to believe, whether or not it is explicitly taught.

Zeidler, Walker, Ackett, and Simmons (2001) examined the relationships between students’ conceptions of the nature of science and their reactions to evidence that challenged their beliefs about socioscientific issues. This study involved 41 pairs of students. These 82 students were identified from a larger sample of 248 students from 9^{th} and 10^{th} grade general science classes, 11^{th} and 12^{th} grades honor biology, honors science, and physics classes, and upper level collage preservice science education classes. During the first phase of the study, students were asked to respond to open-ended questions in order to assess their conceptions relating to the nature of science. During the second phase, students were presented with a socioscientific scenario that required decisions based on their moral reasoning or ethical beliefs. In the third phase, pairs were constructed from different levels of variation about the subject. Then, they were allowed to freely interact, challenge, and question each other during the interview process. Findings showed that students' conceptions of nature of science ranged from theories as static and fixed to the idea that they change in quick response to social utility and technological advances. Status of scientific knowledge versus opinion, students' responses distinguished between the "subjectiveness" of opinion and the "objectivity" of scientific knowledge. In general, subjectiveness was equated with personal opinions whereas scientific knowledge was associated with proven, tested, or constructed knowledge. Students generally perceived connections between art and science in terms of the creativity. However, a distinction seems to be made between the "spirit" of art that is more directly linked to emotion "activity" and of science.

A study performed with higher levels of students was conducted by Moss, Abrams, and Robb (2001). They examined the pre-collage students' understanding of the nature of science and track those beliefs over the course of an academic year-is one of the many studies performed to assess the student conception of the nature of science. This study was also done to assess the epistemological part of the subject STS. Students' conceptions of the nature of science were examined using a model of the nature of science developed for use in this study. Findings indicated participant hold fully formed conceptions of the nature of science consistent with approximately one-half of the premises set out in the model. Students hold more complete understandings of the nature of scientific knowledge than the nature of the scientific enterprise. Their conceptions remained mostly unchanged over the year despite their participation in the project-based, hands-on science course.

Brickhouse, Dagher, Letts, and Shipman (2000) studied on the growth in students' understanding about the nature of astronomy in a one-semester college course. In addition to student work collected for 340 students in the course, they also interviewed students three times during the course. The study showed that students in the class came with the misconception "the view that facts and laws are absolute, whereas theories and hypotheses are tentative." Brickhouse et al. (2000) suggested that studying students' views about the nature of science is best done in a context where it is possible to talk about particular theories or particular pieces of evidence.

Ryder, Leach, and Driver (1999) studied to describe the views about the nature of science held by science students in their final year at the university. Eleven students were interviewed about the nature of science during the time they were involved a project work. Five stimulus questions were asked without reference to any particular scientific context. Many of the students showed significant development in their understanding of how lines of scientific enquiry are influenced by theoretical developments within a discipline, over the 5-8 months period of their project work. Study indicated that only a few students made statements relating to the social dimension of science despite the fact that they had the opportunity to do so in response to many of the five stimulus questions. Findings of the study also indicated that students in the sample tended to view knowledge claims in science as provable beyond doubt using empirical data alone.

Besides the studies especially related with nature of science (NOS), several studies were performed with a broader perspective, concentrating on STS. One of them was performed by Fleming (1987). He investigated the views about STS, the interaction among science, technology, and society. A sample of 10,800 students, who were in their graduating year of high school, was drawn in a stratified manner from across Canada as part of the International Association for the Evaluation of Educational Assessment study (IEA). Students were asked to respond statement concerning an STS topic in agree-disagree-do not understand format. Then they were asked to write their reasons for the choice. Statements were taken from VOSTS Form CDN-2. One of the results of the study was that unless specifically asked to do so, students do not differentiate between science and technology. Another finding is about the cause of the specific social problems. About 22% of student responses, suggests that science and technology both cause and aggravate the specific social problems but 19% of the respondents presented the view that the proper use of science and technology rests with the people.

Similarly, Aikenhead (1987) investigated to monitor the high school graduates' beliefs about STS topics, and to reexamine current assessment practices with an eye to their improvement. The sample was the same with the study of Fleming (1987) which was drawn in a stratified manner from across Canada as part of the International Association for the Evaluation of Educational Assessment Study. The results reported that Canadian students' responses to the question from the instrument called VOSTS. The questions dealt with the characteristics and limitations of scientific knowledge. Results showed the followings: a majority of Canadian high school graduates viewed scientific classification schemes as being more epistemological than ontological and almost all of the respondents believed that scientific knowledge tentative, but their reasons varied widely. A large proportion of students believed that social instructions within the scientific community can affect the knowledge that scientists discover. On the other hand almost half of the students believed there was no influence from the outside and thus the facts basically spoke for themselves. Again using the data coming from the same subjects from the IEA study, Ryan (1987) investigated the high school graduates' beliefs about the characteristics of scientists with 10,800 high school students using VOSTS. Some of the responses indicated that an overwhelming majority of students felt that scientists should be concerned with the potential effects especially the harmful effects of their discoveries. They said that scientists are being responsible in their actions. On the other hand, students were able to make a distinction between a characteristic which would be required in carrying out science and the characteristics of scientists as human beings. Some students felt that honesty and objectivity, being necessary for the performance of science, might rub off on scientists who need not necessarily be inherently honest or objective. Others felt that scientists would leave these characteristics at work and would be much like other people in daily life. Another result was related with the gender distribution of Canadian students. Many respondents (30%), especially females, gave sociological reasons for the situation. Another group (15%) felt that there were genetic differences that made science less attractive to females. The third group (25%) felt that men and women were equally capable of being good scientists. The study showed the followings; unless asked specifically to do so, students generally didn't distinguish between science (the process of understanding natural phenomena) and technology (the process of designing techniques and implements to respond to human needs). Additionally, students tended to assume that scientific research meant medical research, and to a lesser extent, environmental and agricultural research.

The views about science-technology-society interactions held by collage students in general education physics and STS courses was studied by Bradford, Rubba, and Harkness (1995). Two samples took part in the study, one consisting of 138 collage students enrolled in a general education STS course, and the other 122 collage students enrolled in a general education physics course in a university. Pretest and posttest data were collected using 16-multiple choice items selected from the VOSTS item pool. The findings were treated descriptively. Additionally, a special scoring procedure was devised for the VOSTS items to allow the use of inferential statistics. The findings supported the value of general education STS courses. The result of the study indicated that, the STS students moved toward more "realistic" views of STS but physics course had almost no impact on students' views of STS interactions. The realistic view indicates an appropriate view of STS relative to the item stems of this study.

The study of Solbes and Vilches (1997) proposed the introduction of STS interactions in physics and chemistry classes in conjunction with the teaching-learning model of science as research, in Spain. There were two groups of students only one of which were involved in different activities, from technical applications and the influence of technological development on scientific advancement to the mutual implications of science and technology on society and the environment, from the different social, economic, cultural, and philosophical point of view. A total of 212 students of 16-18 years of age in the last three years of secondary education were surveyed, and the results obtained were analyzed. These results confirmed that dealing with STS interactions in the classroom established science as something alive, more complete and integrated in the students' environment. Students subsequently developed an improved comprehension and a more real image of these sciences, which allowed them to understand better the role of scientists and how they work. All of these generated attitudes toward the study of physics and chemistry increased the students' interest in their study. Thus the results of this research make it clear that it is possible to transform the learning of physics and chemistry with the inclusion of STS activities, so that the students can build scientific knowledge.

The study done by Tsai (1999) viewed STS instruction as promising means to help students progress toward constructivist oriented epistemological views of science. One hundred and one Taiwanese female 10th graders (16 years old) were assigned to either a traditional instruction group or an STS treatment group. Chinese version of Pomeroy's questionnaire was used to asses students' scientific epistemological views. After that an interview was performed with twelve students. Through an eight month research treatment it was found that STS group students, at the final stage of the study, tended to have scientific epistemological views more oriented to constructivist views of science than traditional group subjects. Further analyses revealed that, among STS group students, those originally having empiricist-aligned views of science tended to progress most in their epistemological views. Similarly, Tsai (2000) performed another study with Taiwanese female tenth graders. He investigated the effects of STS instruction on a group of Taiwanese female tenth graders' cognitive structure outcomes. The study further examined the role of student scientific epistemological beliefs on such effects. One hundred and one female tenth graders were assigned to either a STS-oriented instruction group or a traditional teaching group and then this study conducted a eight-month research treatment. Students' interview details, analyzed through a "flow map" method, indicated that STS group students performed better in terms of the extent, richness and connection of cognitive structure outcomes than did traditional group students. Further analysis of the study suggested that STS instruction was especially beneficial to students having epistemological views more oriented to constructivist views of science.

Mbajiorgu and Ali (2001) examined the relationship between STS approach, scientific literacy (SL), and achievement in biology. A quasi-experimental design of the nonequivalent group was employed. Four secondary schools, eight teachers, and 246 students from Nigeria were involved in the study. Two instruments were used to collect data: an Achievement Test on Reproduction and Family Planning and a SL scale. Results showed that there is no relationship between SL and achievement in biology. The split-wise posttest regression showed a weak positive relationship between SL and achievement in biology for experimental group and a no relationship for the control group. However, STS approach mediated between SL and achievement to affect a slightly stronger significant positive relationship. Mbjiorgue and Ali (2001) concluded that STS approach might be affecting other variables in the science classroom that in turn affect achievement in the sciences.

2.3.2.Teachers' Views on STS

It is generally accepted that teachers' views affect their students' views on subject of the instruction so several studies were performed on the teachers' views on STS. Akindehin (1988) has done a research on the effect of an instructional package on preservice science teachers' understanding of the nature of science and acquisition of science-related attitudes. The study was carried out in three steps. Firstly, the pretests were administered to students in two of the four groups. In the second step, students in the two treatment (experimental) groups attended a one-hour lecture in the Introductory Science Teacher Education (ISTE) –instructional package designed for the study which was expected that it would foster an understanding of the nature of science as well as the development of favorable science related attitudes in preservice science teachers- once a week throughout the first semester of the academic session. Finally, the post-test were administered. The NOSS was used as pre-test and the Teacher Science-Related Attitude Scale (TESRA) was used as post-tests. TESRA was adapted by the investigator from two other instruments-The test of Science-Related Attitudes (TOSRA) and the Inquiry Science Teaching Strategies (ISTS). According to the ISTE, the course had nine units; forms and fields of scientific knowledge; nature of science; ways of scientists; class discussion; history of science; class experiment; a class discussion on science and superstition; a class discussion on the new light; a class discussion on the scientists at work. The results showed that preservice science teachers exposed to the ISTE acquired better understanding of the nature of science and more favorable science-related attitudes than those who were not exposed to the ISTE. In terms of science-related attitudes, preservice science teachers exposed to the ISTE were found to have acquired a more favorable attitude to scientific inquiry, enjoyment of science lessons and science for leisure.

In the study of Cobern (1989), American preservice science teachers' responses to the Kimbal's Nature of Science Survey (NOSS) were used as a basis for analyzing the sense of the nature of science held by a group of Nigerian preservice science teachers. Between 1980 and 1983, the researcher routinely had his senior-level preservice science teachers at the University of Sokota, Nigeria, take NOSS as a way of introducing the subject of science philosophy and its relevance to the science classroom. Two apparent differences were noted from the study. The primary difference was that the Nigerian students were much more inclined to see science as a way of producing useful technology. Given the national interest of a developing nation this is an understandable perception and one common among government policy makers. The second distinctive of the Nigerian students' sense of nature of science had to do with the openness of science. These students perceived scientists as nationalistic and secretive about their work.

Pomeroy (1993) investigated how scientists and teachers view the nature of science, scientific method, and related aspects of science education. The samples consisted of volunteers who filled out the survey in response to a written appeal. The mailing went to a group of Alaskan research scientists and secondary science and elementary teachers in Alaskan cities. A fifty-item survey was prepared in agree-disagree statements. The results showed that men in the samples fell into traditional patterns more than women. Surprisingly, the results also displayed that traditional views were expressed most strongly by scientists, next by secondary science teachers, and least by elementary teachers in this study.

In another study, Pedretti (1996) investigated to explore the genesis of an issue-based model for STS education and curriculum development created by the teachers and facilitator of the action research group and highlight applications of this model in a classroom context. It also aimed the action research. It describes the experiences of six science teachers and a facilitator involved in an action research group in science, technology, and society education, STSE. Three fundamental implications emerged from the STSE model. First, it provided a structure for issues of immediate interest and relevance to students. Second, the model could be used in conjunction with existing science curriculum to explore issues that are socially relevant and personally compelling. Finally, the most significant implication of the model was its use as a reflective tool. Teacher, who were already committed to an STSE approach, can examine their own classroom practices and theoretical understanding of science education

Khalick and BouJaoude (1997) described the knowledge base of a group of science teachers in terms of their knowledge of the structure, function, and development of their disciplines, and their understanding of the nature of science. The study also aimed to relate teachers' knowledge base to their level of education, years of teaching experience, and the class level(s) that they teach. Twenty inservice science teachers were selected to respond to a modified version of the VOSTS questionnaire to assess their understanding of the nature of science. The teachers constructed concept maps and were interviewed. The concept maps were scored and interviews analyzed to assess teachers' knowledge of the structure, function, and development of their disciplines. At the end of the study it was found that teachers held several naïve views about the nature of science and did not demonstrate adequate knowledge and understanding of the structure, function, and development of their disciplines. Moreover, the teachers' knowledge base did not relate to their years of teaching experience, the class level(s) that they teach, and their level of education.

Botton and Brown (1997) carried out a study with a selection of Views on Science-Technology-Society (VOSTS) items. They wanted to ascertain the responses from a group of preservice postgraduate certificate of education students on a test-retest process. They also aimed to test the reliability of part of the instrument and analyze the responses and discuss further some aspects of the nature of science with respect to the items and responses. It was administered to a group of 29 postgraduate trainee science teachers. Two sections of the VOSTS were addressed: defining science and technology; and epistemology. According to the test-retest criterion, only 3 items from defining science and 17 from epistemology were seemed as reliable. Results have similarities with some other studies in some parts. For example, defining technology produced a variety of responses. The majority of the respondents defined technology as the application of science. Most appreciated the tentativeness of scientific knowledge but the difference between hypotheses, laws, and theories was not appreciated.

A socio-cultural analysis was performed by McGinnis and Simmons (1999). They investigated the teachers' perspectives of teaching science-technology-society in local cultures. The case study was performed with five science teachers. Data analysis of the case study was conducted within and across two levels. The first level focused on documenting the level of selective beliefs the participants held toward science and teaching of STS. The second level analysis was performed during the academic year following the STS experiences. A variety of the data collection method were used. Throughout the first summer STS workshop one of the authors took field notes in the daily STS sessions conducted at the university. Upon completion of the STS experiences (workshop and academic class) the participants completed a 17-item-five-point Likert opinionaire. Additionally, they gave responses to four open-ended survey questions. Site visits was made to each of the participants classrooms and conducted a semi structured, audio taped interview in which the participants reflected on the workshop and on their subsequent STS teaching practices over the school year. Results indicated such things; from the teachers' perspective, their job security requires that their STS curricular decisions be informed by their construction of the local school cultures. Teachers' perceptions of themselves as outsiders to the local community increases their conformity to the school's local culture and decreases their teaching of controversial STS topics.

Akerson, Khalick, and Lederman (2000) assessed the influence of a reflective, explicit, activity-based approach to nature of science instruction undertaken in the context of an elementary science methods course on preservice teachers' views of some aspects of NOS. These aspects included the empirical, tentative, subjective (theory-laden), imaginative and creative, and social and cultural NOS. Participants were 25 undergraduate and 25 graduate preservice elementary teachers enrolled in two sections of the investigated course. An open-ended questionnaire coupled with individual interviews was used to assess participants' NOS views before and at the conclusion of the course. The majority of the participants held naïve views of the target NOS aspects. Post instruction assessments indicated that participants made substantial gains in their views of some of the target NOS aspects. Less substantial gains were evident in the case of the subjective and social and cultural NOS. The results of the present study supported the effectiveness of explicit, reflective NOS instruction.

Tairab (2001) investigated to explore the views held by pre-service and in-service science teachers regarding the nature of science and technology. It was a part of a large-scaled project. The study was particularly on the characteristics of science and technology; the aim of science and scientific research; the characteristics of scientific knowledge; and the relationship between science and technology. The sample of the study consisted of 95 respondents (41 preservice science teachers and 54 inservice science teachers) drawn from two groups of science teachers by convenience sampling. The data were collected using the Nature of Science and Technology Questionnaire (NSTQ). Results indicated that generally pre-service and in-service science teachers have comparable views in relation to the nature of science and technology. The participants displayed mix views regarding science as content oriented or process oriented. Respondents viewed technology as an application of science. Most of the participants regarded science as explanatory and interpretative of nature.

The work of Craven, Hand, and Prain (2002) stated the processes and outcomes of practices in a preservice, elementary science method course. The course was designed to fathom existing student perceptions of the nature of science and move students from holding individually constructed, typically limited views on the nature of science towards more rich, publicly negotiated views. In the course of 15 weeks, 27 preservice elementary students engaged in a series of individual collaborative exercises that required them to explore their tacit and explicit knowledge about the nature of science. The data were analyzed using the interpretative-descriptive approach. Analyses revealed notable, positive changes in the language students used to describe both the nature and structure of the scientific enterprise.

Cho (2002) looked at the effects of a science-technology-society in-service program, designed to change teachers' awareness and practice of STS/constructivist approaches, while also focusing on students' understandings and changes of perceptions of the constructivist learning environments. The STS in-service program was developed to achieve the following features: teacher-oriented, teaching in a social context, emphasis on a "constructivist" approach, developing STS units and their use in classrooms. A total of 20 middle and high school science teachers participated in the in-service program in 1998; and three of the middle school teachers were selected to gain information from their implementation of a "Reactions of Acids and Bases" unit in their respective classrooms. The Science Education Reform Inventory was administered to all the teachers at both the opening and the end of the program. One hundred twenty-five students of the three teachers experienced about 16 class hours of lessons comprising the new STS unit. At the beginning and the end of the unit, they completed the Constructivist Learning Environment Survey. In order to assess student understanding, teachers administered the creativity test after the unit. At the end, it was found that the STS program improved the teachers' awareness and practices of the science education reforms characterized by STS and constructivism. Students obtained at average 48% of the 35 key concepts and 6.6 additional non-key concepts after the unit was finished. Students made more relevant and creative responses on unfamiliar situations on the post-test than on the pre-test.

Besides studies performed with preservice and inservice teachers, there are some other studies relating the teachers' views and students' views. One of them was performed by Yager (1966; cited in Lederman, 1992). Yager selected eight experienced teachers to use a given inquiry-oriented curriculum. All of them utilized the same number of days of discussion, laboratories, examinations, and instructional materials. At the end, it was concluded that there were significant differences in students' ability to understand the nature of science when they were taught by different teachers. Another study about the influence of teachers upon students' conception was performed by Brickhouse (1990; as cited in Yakmacı, 1998). He studied on the relationship between the three secondary science teachers' beliefs about the nature of science and classroom practice. The study took 4-month period. At least four hours of interviews and about 35 hours classroom observation were done for each of the teachers. Two teachers exhibited classroom practices that were consistent with their personal views but the beginning teacher's classroom practices were not related with his beliefs.

Yager and Pennick (1984) studied on that, whether students have attitudes, perceptions, and feelings in and about science classes. A total of 2500 students from aged 13 and 17 participated the study-the third assessment in science by the Natural Assessment of Educational Progress (NAEP)- were selected randomly from the US. Some of the results of this study listed the followings: students perceived that as 13-years-olds they have more opportunity than 17 years-olds to choose the way they want to learn science, select the order they wish to learn the topic, work at their own pace, and decide when assignments or tests are to be done. Thirteen-year-olds were even more optimistic about the ultimate utility of the science knowledge they were gaining.

Lederman and Zeidler (1987) performed a study to test the validity of the prevalent assumption that a teacher's conception of the nature of science directly influences his/her classroom behavior. The subject of the study consisted of 18 senior-high school biology teachers and one randomly selected tenth grade biology class of each teacher. The NSKS was administered to the teachers as pre- and post-test. They conducted intensive qualitative observations in each of the 18 classrooms following the NSKS pretest but prior to the posttest. However, the data of this investigation did not support the prevalent assumption that teacher's classroom behavior is directly influenced by his/her conception of the nature of science.

Khalick, Bell, and Lederman (1998) studied to delineate the factors that mediate the translation of preservice teachers' conceptions of the nature of science into instructional planning and classroom practice. Fourteen preservice secondary science teachers participated in the study. Prior to the their student teaching, participants responded to an open-ended questionnaire designed to assess their conceptions of the nature of science (NOS). Observation notes were collected. Following students teaching, participants were individually interviewed to validate their responses to the open-ended questionnaire and to identify the factors or constraints that mediate the translation of their conceptions of the NOS into their classroom teaching. Participants were found to possess adequate understandings of several aspects of the NOS including the empirical and tentative nature of science, the distinction between observation and inference, and the role of subjectivity and creativity in science. Many claimed to have taught the NOS through science-based activities. However data analysis revealed that explicit references to the NOS were rare in their planning and instruction.

Similarly, the study performed by Lederman (1999) investigated the relationship of teachers' understanding of the nature of science and classroom practice and to delineate factors that facilitate or impede a relationship. Five high school biology teachers, ranging in experience from 2 to 15 years, comprised the sample for this investigation. During one full academic year, multiple data sources were collected and included classroom observations, open-ended questionnaires, semistructured and structured interviews, and instructional plans and materials. In addition, students in each of the teachers' conceptions of science do not necessarily influence classroom practice. Of critical importance were teachers' level of experience, intentions, and perceptions of students.

Although many studies were performed about the subject STS in several parts of the world, only few studies conducted in Turkey. One of them was about the epistemology part of STS issue. Yakmacı (1998) investigated the Turkish prospective and inservice science teachers' views on nature of science. She used 18 selected items from VOSTS item pool. The results of the study showed that on some points such as the tentativeness of scientific knowledge, the scientific approach in the investigations science teachers held contemporary views. On the other hand they have unrealistic views on many points; definition of science, the nature of observation, the nature of scientific models etc. Another study from Turkey was performed by Yalvaç and Crawford (2002). They aimed to explore the graduate and undergraduate science education students' conceptions of the nature of science, in Middle East Technical University (METU). The participants of the study include 25 undergraduate and graduate science education students enrolled in the Science Education Program in METU, Ankara. For this study a questionnaire, which had been adapted from previous studies was used. Findings of the study suggested that the majority of the participants hold views of nature of science aligned with logical positivism-a content oriented image of science. More than half of the Turkish students (71%) thought theories are subject to change but laws do not change.

The results of the studies discussed in this chapter revealed that students and teachers did not possess adequate conceptions of STS.

Some of the studies (Brickhouse, 1990; Yager, 1966; cited in Lederman, 1992) related the teachers' views with their students' views on STS showed that there was a relationship between teachers' conceptions on STS and classroom practices and students' conceptions on STS, but some others didn't support these relations (Lederman ,1999; Lederman and Zeidler, 1987).

The underlying idea in all of these studies is that students' views on STS can be influenced, at least in part, by what is taught in the classrooms. This idea gives higher importance to the teachers' views on the same subject. Therefore, in this study, the views of preservice science teachers on science-technology-society issues were investigated to have detailed information about their views and to make room for the future studies to fill their missing points if exist on this issue.

The studies (Yakmacı, 1998; Yalvac and Crawford, 2002) conducted in Turkey related with the epistemology part of STS so there is a big area to study on to get the whole picture of STS. The present study aimed to obtain the views of preservice science teachers on science-technology-society issues.

CHAPTER 3

METHOD

In this chapter, the main problem, research question, information about the subjects of the study, the data collection procedure, and the data analysis procedure to conduct this study were presented.

3.1. Main Problem

The purpose of this study was to investigate the views of Turkish preservice science teachers' on science-technology and society concepts.

3.2. Research Question

What kind of views do the preservice science teachers possess on the Science-Technology-Society concepts?

3.3. Population and Sample Selection

The target population of the present study was the preservice science teachers in Turkey. Since data collection from all the preservice science teachers in Turkey had some difficulties in terms of financial and time limitation issues, the accessible population was defined as "the preservice science teachers in Ankara." For the selection of the sample, the researcher limited herself only to one city, Ankara. Since

Ankara is a cosmopolitan city of Turkey, it was assumed that it would accommodate many different groups of people. Therefore, the sample is considered to bear sufficient heterogeneity in terms of the preservice science teacher profile in Turkey.

There are three universities that had the department of elementary education in this city. These universities thought as the sample of this study.

The present study included a qualitative and a quantitative part and both were conducted with preservice science teachers from three universities in Ankara, Turkey (Table 3.1.).

In quantitative part of this study, a total of 176 preservice science teachers (116 females and 60 males) answered the 26 questions from VOSTS (Table 3.1). According to the information obtained from the guide book of the University Entrance Examination of year 2000, the total number of preservice science teachers from these three universities is about 390. The capacity of these three universities hold as the base for the number. The total number of the participants of the study includes almost 45% of them.

In qualitative part of this study, nine preservice science teachers, three female and six male, were interviewed to obtain information about students' views on science-technology-society concepts. They were selected from only one university by convenient sampling. They were interviewed by using a semi-structured interview procedure.

Table 3.1 The sample of the study

Universities	Number of participants
Gazi	121
Hacettepe	27
ODTÜ	28
Total	176

3.4. Data Collection Instruments

3.4.1. Views on Science Technology and Society Questionnaire

Views on the science-technology-society (VOSTS) are thoughts or opinions of preservice science teachers about the characteristics of science-technology-society. The VOSTS (Aikenhead, Fleming and Ryan, 1989) is a pool of 114 empirically developed multiple-choice items with nine categories. These categories are; science and technology, influence of society on science/technology, future category, influence of science/technology on society, influence of school science on society, characteristics of scientists, social construction of scientific knowledge, social construction of technology, and the nature of scientific knowledge. The VOSTS was developed (1989) in a six-year period of time. Each VOSTS item comprises a statement and several student positions. The domain of student positions for any one statement is constituted by the participation of students during the development process, not by theoretical or researcher-based perception of what the domain should be. The multiple choices were developed from written responses and from interviews with Canadian high school students. This is the major difference between the VOSTS and other instruments. The instruments other than the VOSTS are composed by a researcher working under the assumption that respondents will perceive and interpret the language in the items in the same way as the researcher does (Aikenhead & Ryan, 1992). According to Aikenhead and Ryan (1992), it is not appropriate to speak about the validity of an empirically developed instrument, such as VOSTS, in the traditional sense since the validity of empirically developed instruments arises from a qualitative research paradigm. These researchers claimed that, seek to uncover the perspective of the respondent and reveal the legitimacy of that perspective from the respondent's point of view, not the imposed viewpoint of the researcher. As in qualitative research, it is assumed with empirically developed instruments that the respondents understand the complex interactions being studied and account for the influence of values on the interactions better than the investigators. Aikenhead and Ryan (1992) also argued that the validity of an empirically developed instrument is established by the trustworthiness of the method used to develop the items, as the validity of the process and of the final instrument lies in the trust which subsequent researchers place in the development process which has been described. Thus, it was assumed that the VOSTS items possessed an inherent validity that originated from the process used to develop them.

Similarly, the concept of reliability as it applies to empirically developed instruments such as the VOSTS follows from the qualitative research paradigm, where in the dependability of the results is of major concern; that is, the validity and reliability of qualitative data depend to a great extent on the methodological skill, sensitivity, and integrity of the researcher. Rather than demanding that others get the same results, one wants others to occur that, given the data collected, the results make sense that the results are dependable. In addition, VOSTS items were assumed to be reliable and based upon agreement that the data presented by Aikenhead and Ryan (1992). They argued that empirically developed items yield non-parametric data that does not fulfill the continuity and equal intervals of measures assumption that underlies parametric analysis procedures. They said that, traditional procedures such as Coefficient Alpha that are used to assess the reliability of instruments that yield parametric scores and are based on assumptions that are not tenable in the case of empirically developed instruments, are not appropriate for instruments such as the VOSTS. Although developers of the instrument thought reliability studies were meaningless, some researchers (Botton and Brown, 1998) studied on the reliability of some VOSTS items. Their results also showed that they were highly reliable.

For the present study, items were chosen from the seven subtitles of the instrument (Table 3.2.). Only 26 items were used from the pool of VOSTS. During the selection procedure of the items, a collective study was performed by the researcher, a graduate student, and two professionals in the field of science education. The questions were chosen by these people depending on their representative ability of the scale, and appropriateness of the Turkish culture. The 26 items were adapted to Turkish with a collective study of the researcher, a science teacher, and two professionals in this field, and two language experts from the Academic Writing Center at METU. The pilot study was performed with 15 second year students from the science education department of Middle East Technical University. Results showed that 26 of the 27 items were appropriate for the final study. The aim of this pilot study was to check the quality of the translations before the actual administration. Another reason for the pilot study was that this questionnaire was developed with and for the high school students and Aikenhead (1988) suggested a pilot before the use of this inventory with the collage students, teachers, and any other samples. If none of the choices fit their opinion, respondents may select the last choice presented under each multiple choice item which enables them to suggest their own responses. This pilot study also showed that the time given to answer the questions was enough for the participants. At the end, the adapted form of VOSTS was formed after necessary changes on the pilot study.

Table 3.2. Subscales of the items used in the questionnaire

Item Number	Item	Subscales
1	Defining science is difficult because science is complex and does many things. But mainly science is:	Science and Technology
2	Defining what technology is, can cause difficulties because technology does many things in Turkey. But mainly technology is	
3	Science and technology are closely related to each other:	
4	The Turkish government should give scientists research money to explore the curious unknowns of nature and the universe.	Influence of society on science/ technology
5	Some cultures have a particular viewpoint on nature and man. Scientists and scientific research are affected by the religious or ethical views of the culture where work is done.	
6	The success of science and technology in Turkey depends on how much support the public gives to scientists, engineers and technicians. This support depends on high school students'- the future public- learning how science and technology are used in Turkey.	
7	Some communities produce more scientists than other communities. This happens as a result of the upbringing which children receive from their family, schools and community.	
8	Most Turkish scientists are concerned with the potential effects (both helpful and harmful) that might result from their discoveries.	Influence of science/ technology on society
9	Scientists and engineers should be the ones to decide whether or not to build a nuclear reactor and where it should be built, because scientists and engineers are the people who know the facts best.	
10	Scientists can solve any practical everyday problem best (for example, getting a car out of a ditch, cooking, or caring for a pet) because scientists know more science.	
11	The more Turkey's science and technology develop, the wealthier Turkey will become	

12	The most powerful countries of the world have military strength because of the country's superior science and technology.	
13	The best scientists are always very open-minded, logical, unbiased and objective in their work. These personal characteristics are needed for doing the best science.	Characteristics of scientists
14	There are many more women scientists today than there used to be. This will make a difference to the scientific discoveries which are made. Scientific discoveries made by women will tend to be different than those made by men.	

Table 3.2. (continued)

15	Scientists publish their discoveries in scientific journals. They do this mainly to achieve credibility in the eyes of other scientists and funding agencies; thus, helping their own careers to advance.	Social construction of scientific knowledge
16	Scientists compete for research funds and for who will be the first to make a discovery. Sometimes fierce competition causes scientists to act in a secrecy, lift ideas from other scientists, and lobby for money. In other words, sometimes scientists break the rules of science (rules such as sharing results, honesty, independence, etc.).	
17	A scientists may play tennis, go to parties, or attend conferences with other people. Because these social contacts can influence the scientist's work, these social contacts can influence the content of the scientific knowledge he or she discovers.	
18	Scientists trained in different countries have different ways of looking at a scientific problem. This means that a country's education system or culture can influence the conclusions which scientists reach.	
19	When a new technology is developed (for example, a new computer), it may or may not be put into practice. The decision to use a new technology depends mainly on how well it works.	Social construction of technology
20	Technological developments can be controlled by citizens.	
21	Scientific observations made by competent scientists will usually be different if the scientists believe different theories.	Nature of scientific knowledge
22	Even when scientific investigations are done correctly, the knowledge that scientists discover from those investigations may change in the future.	
23	Scientific ideas develop from hypotheses to theories, and finally, If they are good enough to being scientific laws.	
24	When scientists investigate, it is said that they follow the scientific method.	
25	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.	

26	Scientists in different fields look at the same thing from very different points of view)for example, H+ causes chemists to think of acidity and physicists to think of protons). This means that one scientific idea has different meanings, depending on the field a scientist work in.	

3.4.2. Interview with Preservice Science Teachers

The interviews were conducted to get detailed information about the views of preservice science teachers on science-technology-society concepts. Interview questions (Appendix B) were developed by the researcher by taken the VOSTS items into consideration. During the interviews, a semi-structured interview schedule was used. The schedule was left flexible to allow preservice science teachers to express themselves in freedom and lets the interviewer to ask thought-provoking questions. Interview questions covered main points of the issue: the definition of science and technology (2 items), influence of society and science on science/technology (1 item), influence of science/technology on society (1 item), characteristics of scientists (1 item), social construction of scientific knowledge (1 items), social construction of technology (1 item), epistemology of knowledge (2 items). Nine individual interviews were held, each lasted approximately 30 minutes duration. All of the interviews were audio taped and transcribed.

During the interview, ten questions were asked to find the answers of the following questions.

1-How do preservice science teachers define science and technology?

2-How do preservice science teachers express the influence of society and science on science/technology?

3-How do preservice science teachers express the influence of science/technology on society?

4-How do preservice science teachers state the influence of school science on society?

5-How do preservice science teachers explain the characteristics of scientists?
6-How do preservice science teachers explain the social construction of scientific knowledge?
7-How do preservice science teachers explain the social construction of technology?
8-How do preservice science teachers express the epistemology of nature of scientific knowledge?

The following excerpt from the interviews is an example to show how thought-provoking questions help to diagnose preservice science teachers' views.

Researcher: How is society affected by the results of science and technology?
Preservice science teacher: It depends on the structure of the society. Societies with bad education and low cultural development, will have to obey the things that technology present them. On the other hand, well educated societies with developed cultures takes what they need and rejects the others.
Researcher: Do you think the societies has this power?
Preservice science teacher: If the society is conscious, yes. But if not, technology can control everything. It can present everything as good.
Researcher: Can you give some examples?
Preservice science teacher: Mobile phones. Advertisements and desires can be more effective than their negative properties in a society. But if society is well educated one, in this case people will investigate their positive and negative effects and decide to use or not to use them.
Researcher: In this point, what do you think about Turkish society?
Preservice science teacher: Not very conscious. The companies that produce technology make people to obey their wishes.

3.5. Data Collection Procedure

For the collection of data from the preservice science teachers, permission was taken from the instructors that offer several courses to them in three different universities in Ankara. In the spring term of 2002/2003 academic year, data were collected by using VOSTS. The data were collected preservice science teachers of Gazi University and Middle East Technical University during the class hours by the researcher herself. On the other hand, data were collected from Hacettepe University again during the class hours but by their research assistants. The administration of the instruments could not be done in the same way as the researcher did. The researcher gave the instrument and then necessary explanation was given by her when asked by preservice science teachers such as asbestos is a chemical etc.

For the qualitative part, nine preservice science teachers from Middle East Technical University interviewed during May 2003. They were chosen according to their willingness to participate such kind of study. Face-to-face interviews were performed during out of the school time. There were not a time limitation for the completion of the interviews. For this reason, they took different lengths of time depending on the respondents' willingness to demonstrate their thoughts.

3.6. Analysis of Data

In this study, descriptive analysis was performed. For these analyses responses to the VOSTS items were applied. Frequency and percentage distribution of each alternative under each one of the items were calculated and they were analyzed. For the interview part, the audio-taped interviews were transcribed and analyzed. In order to produce verbatim transcriptions of the interviewees' responses, the cassettes were replayed to check whether any missing point was present in the text. After the transcriptions were completed, the responses were categorized for each question according to the covered points of the issue in interview part to analyze them.

3.7. Assumptions and Limitations

During the study, assumptions and limitations encountered are given as below:

3.7.1. Assumptions

1.All students' responses to the survey were sincere.
2.The survey was administered under standard conditions.
3.Students answered interview questions voluntarily.

3.7.2. Limitations

1.The subjects in the interview were limited to nine students from the last year students at one university.
2.The subjects of the questionnaire were limited to 176 students.
3. The subjects of the study were selected from only the universities in Ankara so the generalization can be applied for the preservice elementary science teachers' only from the one city.
4.The nature of the instrument is not appropriate for inferential statistics since it evolved from the qualitative research paradigm.
5.Translated instruments may have the defects that are indispensable**.**
6.Completion time of the instrument VOSTS which took about more than half an hour and this may have caused boredom and tiredness for some participants.
7.Because of some outside factors administration of the instrument could not be held constant, this might have affected the results of the study.

CHAPTER 4

RESULTS AND CONCLUSION

Analysis of Data

In this chapter, findings of the study were presented under two headings. These headings were; descriptive analyses of VOSTS items and interview analyses.

4.1.Descriptive Analyses

In this part, preservice science teachers' views on the concepts of science-technology-society were investigated, item by item. Each of the 26 items was consisted of a stem and different number of alternatives. The last three alternatives were the same for every item and these alternatives were "I don't understand", "I don't know enough about this subject to make a choice", and "None of this choices fits my basic viewpoints", respectively. Percentage information about respondents selecting these three alternatives were not given in the explanations of tables, because number of people marked these alternatives negligible. Tables were generated in order to see clearly percentages of preservice science teachers selecting each of the alternatives for the items.

Each item itself examined respondents' views on different topics about the science-technology-society concepts. These topics were:

1. Science and Technology

1.1.Defining science (item 1: e.g., instrumentalism, curiosity satisfaction, social enterprise).

1.2.Defining technology (item 2: e.g., social and human purposes; hardware, socioeconomic and cultural components).

1.3.Interdependence of science and technology (item 3: e.g., rejection that technology is simply applied science).

2.Influence of society on science/technology

2.1. Government (item 4: e.g., control over funding, policy and science activities; influence of politics).

2.2. Ethics (item 5: e.g., influence of research program).

2.3. Education institutions (item 6: e.g., mandatory science education).

2.4. Public influence on scientists (item 7: e.g., upbringing, social interactions).

3.Influence of science/technology on society

3.1. Social responsibility of scientists/technologists (item 8: e.g., communicating with public, concern and accountability for risks and pollution, "whistle blowing").

3.2. Contribution to social decisions (item 9: e.g., technocratic vs. democratic decision making, moral and legal decisions, expert testimony, lobbying for funds).

3.3. Resolution of social and practical problems (item 10: e.g., technological fix; everyday type of problems).

3.4. Contribution to economic well-being (item 11: e.g., wealth and jobs).

3.5. Contribution to military power (item 12)

4. Characteristics of scientists

4.1.Standards/values that guides scientists at work and home (item 13: e.g., open-mindedness, logicality, honesty, objectivity, skepticism, suspension of belief; as well as the opposite values: closed-mindedness, subjectivity, etc.).

4.2.Gender effect on the process and product of science (item 14)

5.Social construction of scientific knowledge

5.1 . Professional communication among scientists (item15: e.g., peer review, journals, press conferences).

5.2 . Professional interaction in the face of competition (item16: e.g., politics, secrecy, plagiarism).

5.3 . Social interactions (item 17)

5.4 . National influence on scientific knowledge and technique (item 18)

6.Social construction of technology

6.1. Technological decisions (item 19)

6.2. Autonomous technology (item 20: e.g., technological imperative).

7.Nature of scientific knowledge

7.1. Nature of observations (item 21: e.g., theory laden ness, perception bound).

7.2. Tentativeness of scientific knowledge (item 22).

7.3. Hypothesis, theories and laws (item 23: e.g., definition, role of assumptions, criteria for belief).

7.4. Scientific approach to investigations (item 24: e.g., nonlinearity, rejection of a stepwise procedure, "the scientific method" as a writing style).

7.5. Logical reasoning (item 25: e.g., cause/effect problems, epidemology and etiology).

7.6. Paradigms vs. coherence of concepts across disciplines (item 26)

The items asked according to the topics given above were answered by the participants and the following results were obtained.

Defining Science (Item 1)

The first item of the study refers to the science definition. Table 4.1. indicates how preservice science teachers' responses varied. There is no consensus on the definition of science among preservice science teachers, the most common view was that exploring the unknown (37%) and the least common view was that indefinable. Other views on the subject were; improving the world (31%), a body of knowledge (23%), social institution (2%), a field of study (2%), and indefinable (1%).

Table 4.1. Percentage distribution of preservice science teachers' responses to item 1

Defining science is difficult because science is complex and does many things. But mainly science is:		
%		Your position, basically:
2	A.	a study of fields such as biology, chemistry and physics.
23	B.	a body of knowledge, such as principles, laws and theories, which explain the world around us (matter, energy and life).
37	C.	exploring the unknown and discovering new things about our world and universe and how they work.
1	D.	carrying out experiments to solve problems of interest about the world around us.
0	E.	inventing or designing things (for example, artificial hearts, computer, space vehicles).
31	F.	finding and using knowledge to make this world a better place to live in (for example, curing diseases, solving pollution and improving agriculture).
2	G.	an organization of people (called scientists) who have ideas and techniques for discovering new knowledge.
1	H.	No one can define science

Defining Technology (Item 2)

Preservice science teachers' understandings of definition of technology was assessed by item 2 (Table 4.2.). Most of the participants thought technology as the application of science (39%). About 21% of the participants thought technology as new process, instruments, tools, machinery etc. or practical devices. According to 18

% of the preservice science teachers, technology means ideas and techniques that help the progress of the society. Almost 11% thought that, technology is technique for doing things or solving practical problems. Only the 5% of the participants defined it as inventing, designing and testing things and just 1% defined technology as very similar to science.

Table 4.2. Percentage distribution of preservice science teachers' responses to item 2

Defining what technology is, can cause difficulties because technology does many things in Turkey. But mainly technology is	
%	Your position, basically:
1	A. very similar to science
39	B. the application to science
21	C. new processes, instruments, tools, machinery, appliances, gadgets, computers, or practical devices for everyday use
3	D. robotics, electronics, computers, communication systems, automation, etc.
11	E. a technique for doing things, or a way of solving practical problems
5	F. inventing, designing and testing things (for example, artificial hearts, computers, space vehicles)
18	G. ideas and techniques for designing and manufacturing things, for organizing workers, business people and consumers, for the progress of society

Interdependence of Science and Technology (Item 3)

There is an agreement on the close relations between the science and technology. About 75% of the respondents thought science and technology closely related because scientific research leads to practical applications in technology, and technological developments increase the ability to do scientific research. Another popular answer was that thought they are closely related since science is the basis for all technological advances (17%); though it is hard to see how technology could aid science. Only 4% thought that; although they are different they are linked so closely that is hard to tell them apart. About 3% stated that they are closely related to each other because technology is the basis of all scientific advances; although its hard to see how science could aid technology (Table 4.3).

Table 4.3. Percentage distribution of preservice science teachers' responses to item 3

Science and technology are closely related to each other:	
%	Your position, basically:
	They are closely related to each other because
17	A. science is the basis of all technological advances; though it is hard to see how technology could aid science.
75	B. scientific research leads to practical applications in technology, and technological developments increase the ability to do scientific research.
4	C. although they are different, they are linked so closely that it is hard to tell them apart.
3	D. technology is the basis of all scientific advances; though it is hard to see how science could aid technology.
0	E. Science and technology are more or less the same thing.

Influence of society on science/technology: Government (Item 4)

An interesting finding emerged from the item 4 (Table 4.4.). About 42% of the participants reported that there is a need for their country to finance science in order to make their world a better place to live in. They also agreed upon that the government should financially support scientific research not less than the other countries do (27%). About one tenth of the respondents (14%) agreed upon that money should be spent on scientific research although it includes an investment risk. Only 7% of the respondents thought the necessity to give money on scientific research to satisfy scientific curiosity. A small portion of the participants (2%) wants to spend money to the research directly related to our health, our environment or to agriculture. Few of the respondents (1%) preferred spending money on to the things such as helping Turkey's unemployed and needy, or helping less fortune countries instead of spending money on to the scientific and technological researches. Almost one tenth of the respondents (9%) could not find the choices that fit their basic viewpoint.

Table 4.4. Percentage distribution of preservice science teachers' responses to item 4

The Turkish government should give scientists research money to explore the curious unknowns of nature and the universe.	
%	Your position, basically:
	Money should be spent on scientific research:
27	A. so Turkey doesn't fall behind other countries and become dependent upon them.
7	B. in order to satisfy the human urge to know the unknown: that is, to satisfy scientific curiosity.
14	C. even though it is often impossible to tell ahead of the time whether the research will be beneficial or not. It is an investment risk, but we should take it.
42	D. because by understanding our world better, scientists can make it a better place to live in (for example, using nature's environment and resources to our best advantage, and by investing helpful technology).
2	E. only when the research is directly related to our health (especially finding cures for diseases), to our environment or to agriculture.
1	F. Little or no money should be spent on scientific research because the money could be spent on other things, such as helping Turkey's unemployed and needy, or helping less fortunate countries.

Influence of society on science/technology: Ethics (Item 5)

The analysis of this item revealed that there is not a consensus among the preservice science teachers with respect to the effects of religious and/or ethical views of the culture on scientists and scientific research (Table 4.5.). Approximately one forth of the participants (%23) thought the religious and cultural views are influential on scientific practice. According to them, certain beliefs support certain scientific researches. About one fifth of the respondents (%19) thought the research topic has an impact on what is studied in scientific research. They didn't mention that ethical and religious views would be influential. Almost one fifth of the participants (%16) thought the ethical and religious views are effective on how and what scientists think. According to them scientists unconsciously choose research topics that support their cultural views. Totally 61% of the participants believed that religious or ethical views do influence scientific research. On the other hand, 33% of them advocated that religious or ethical views do not influence these researches. Almost 14% of this class was claimed that researchers continue in spite of clashes between scientists and certain religious or cultural groups.

Table 4.5. Percentage distribution of preservice science teachers' responses to item 5

Some cultures have a particular viewpoint on nature and man. Scientists and scientific research are affected by the religious or ethical views of the culture where work is done.	
%	Your position, basically:
	Religious or ethical views do influence scientific research:
2	A. because some cultures want specific research done for the benefit of that culture.
16	B. because scientists may unconsciously choose research that would support their culture's views.
7	C. because most scientists will not do research which goes against their upbringing or their beliefs.
13	D. because everyone is different in the way they react to their culture. It is these individual differences in scientists that influence the type of research done.
23	E. because powerful groups representing certain religious, political or cultural beliefs will support certain research projects, or will give money to prevent certain research from occurring.
	Religious or ethical views don't influence scientific research:
14	F. because research continues in spite of clashes between scientists

		and certain religious or cultural groups (for example, clashes over evolution and creation).
19	G.	because scientists will research topics which are importance to science and scientists, regardless of cultural or ethical views.

Influence of society on science/technology: Education Institutions (Item 6)

Almost all of the students agreed upon the answer “yes” on the statement about influence of society on science and technology (Table 4.6.). About half of the respondents claimed that the more students learn about science and technology; the more the informed the future public will be. The reason of this answer was stated as; they will be able to form better opinions and make better contributions to how science and technology are used.

Another popular answer (30%) was reasoned as; the public will better understand the views of experts and will provided the needed support for science and technology. About one tenth of the respondents stated that the more students learn about science and technology, the better they will keep the country running. According to this ten percent, high school students are the future. Only a small portion (2%) didn’t agree on this item. According to these respondents support doesn’t depend on students learning more about science and technology. They believed that some high school students are not interested in science subjects.

Table 4.6. Percentage distribution of preservice science teachers' responses to item 6

The success of science and technology in Turkey depends on how much support the public gives to scientists, engineers and technicians. This support depends on high school students'- the future public- learning how science and technology are used in Turkey.	
%	Your position, basically:
	Yes, the more students learn about science and technology:
10	A. the better they will keep the country running. High school students are the future.
5	B. the more students will become scientists, engineers and technicians, and so Turkey will prosper.
49	C. the more informed the future public will be. They will be able to form better opinions and make better contributions to how science and technology are used.
30	D. the more the public will see that science and technology are important. The public will better understand the views of experts and will provided the needed support for science and technology.
2	E. No, support does not depend on students learning more about science and technology. Some high school students aren't interested in science subjects.

Influence of society on science/technology: Public influence on scientists (Item 7)

More than half of the respondents thought the upbringing is the main reason of that some communities produce more scientists than other communities (Table 4.7.). They argued on different reasons of these effects. About 32% of the respondents claimed that the encouragement and opportunity to become a scientist is given by schools, family, and community. About 17% of the responses claims the family as the most effective factor in this decision. Another 5% thought the schools and teachers as the most effective factor. Only 2% evaluated community as the most effective factor to this situation. On the other hand, 32% found that it is difficult to relate them. They gave the equal priority to the upbringing and to the individual effects. Approximately 13% gave the priority to the intelligence, ability, and natural interest in science. Except the one percent, these respondents believed the partial effect of upbringing.

Table 4.7. Percentage distribution of preservice science teachers' responses to item 7

Some communities produce more scientists than other communities. This happens as a result of the upbringing which children receive from their family, schools and community.	
%	Your position, basically:
	Upbringing is mostly responsible:
2	A. because some communities (for example, industrial towns such as Adapazarı) place greater emphasis on science than other communities.
17	B. because some families encourage to question and wonder. Families teach values that stick with you for the rest of your life.
5	C. because some teachers or schools offer better science courses or encourage students to learn more than other teachers or schools.
32	D. because the family, schools and community all give children with an ability in science the encouragement and opportunity to become scientists.
32	E. It is difficult to tell. Upbringing has a definite effect, but so does the individual (for example, intelligence, ability and natural interest in science). It is about half and half.
	Intelligence, ability and natural interest in science are mostly responsible:
12	F. in determining who becomes a scientist. However, upbringing has an effect.
1	G. because people are born with these traits.

Social responsibility of scientists/technologists (Item 8)

More than half of the respondents (%62) believed that 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. Respondents mentioned that this concern is a responsibility of a scientist. One tenth of the respondents (%10) argued that scientists are concerned but they have little control over how their discoveries are used for harm. Again, almost one tenth of the participants (%9) claimed that scientists concern about the undesired impact of their practices but they cannot know about all the possibilities. Some other respondents (%9) stated that scientists test their discoveries in order to prevent harmful effects from occurring. The frequency of the statement "Scientists only look for beneficial effects when they discover things or when they apply their discoveries" was zero. None of the respondents gave that any chance. Almost 4% related scientists' concern about the potential effects with the field of study that they work. Another 4% of the respondents indicated the ineffectiveness of the scientists on the results of their discoveries (Table 4.8.).

Table 4.8. Percentage distribution of preservice science teachers' responses to item 8

Most Turkish scientists are concerned with the potential effects (both helpful and harmful) that might result from their discoveries.	
%	Your position, basically:
0	A. Scientists only look for beneficial effects when they discover things or when they apply their discoveries.
9	B. Scientists are most concerned with the possible harmful effects of their discoveries, because the goal of science is to make our world a better place to live in. therefore, scientists test their discoveries in order to prevent harmful effects from occurring.
62	C. 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. Being concerned is a natural part of doing science because it helps scientists understand their discoveries.
9	D. Scientists are concerned but they can't possibly know all the-long term effects of their discoveries.

10	E.	Scientists are concerned but they have little control over how their discoveries are used for harm.
4	F.	It depends upon the field of science. For instance, in medicine Turkish scientists are highly concerned. However, in nuclear power or in military research, Turkish scientists are least concerned.
4	G.	Scientists may be concerned, but that doesn't stop them from making discoveries for their own fame, fortune, or pure joy of discovery.

Contribution to social decisions (Item 9)

About one third of the respondents claimed that the decision about whether or not to build a nuclear reactor and where it must be built should be made equally both by the specialists and the public (Table 4.9). More than half of the respondents claimed that scientists and engineers should decide. According to 35 % of the respondents, scientists and engineers should decide because they have the trainings and facts but the public should be involved-either informed or consulted. Another 11 % of the respondents agreed upon the scientists and engineers as decision making agencies but they thought the reason that they have the knowledge and can make better decision than government, bureaucrats or private companies. About 7% of the respondents gave the reason as just scientists and engineers have the training and facts which give them a better understanding of the issue. Another 5% thought scientists and engineers as the people giving advices. According to these participants the public should decide this. Almost 2% of the respondents argued that the public should decide since the public serves as a check on the scientists and engineers. Only 1% of the respondents thought that the government should decide but scientists and engineers should give advice because the issue is political.

Table 4.9. Percentage distribution of preservice science teachers' responses to item 9

Scientists and engineers should be the ones to decide whether or not to build a nuclear reactor and where it should be built, because scientists and engineers are the people who know the facts best.	
%	Your position, basically:
	Scientists and engineers should decide:
7	A. because they have the training and facts which give them a better understanding of the issue.
11	B. because they have the knowledge and can make better decisions than government, bureaucrats or private companies, both of whom have vested interest.
35	C. because they have the trainings and facts which give them a better understanding. But the public should be involved- either informed or consulted.
36	D. 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.
1	E. The government should decide because the issue is basically a political one; but scientists and engineers should give advice.
5	F. The public should decide because the decisions affects everyone; but scientists and engineers should give advice.
2	G. The public should decide because the public serves a a check on the scientists and engineers. Scientists and engineers have idealistic and narrow views on the issue and thus pay little attention to consequences.

Resolution of social and practical problems (Item 10)

Almost half of the respondents (45%) claimed that scientists are better at solving any practical problem (Table 4.10.). According to them, their logical problem solving minds or specialized knowledge give them an advantage. About one third of them suggested that scientists are no better than the others, because in everyday life scientists are like everyone else and experience and common sense will solve everyday practical problems. Another 5% suggested the same assertion that scientists are no better than the others since a scientist's education doesn't necessarily help with practical things. Just 4% of the respondents gave the reason for the same claim as; science classes help everybody learn enough problem-solving skills and knowledge to solve practical problems. Another 4% said that scientists are probably worse at solving any practical problem because they work in a complex abstract world far away from everyday life.

Table 4.10. Percentage distribution of preservice science teachers' responses to item 10

Scientists can solve any practical everyday problem best (for example, getting a car out of a ditch, cooking, or caring for a pet) because scientists know more science.	
%	Your position, basically:
45	A. Scientists are better at solving any practical problem. Their logical problem-solving minds or specialized knowledge give them an advantage.
	Scientists are no better than the others:
4	B. because science classes help everybody learn enough problem-solving skills and knowledge to solve practical problems.
5	C. because a scientist's education doesn't necessarily help with practical things.
34	D. because in everyday life scientists are like everyone else. Experience and common sense will solve everyday practical problems.
4	E. Scientists are probably worse at solving any practical problem because they work in a complex abstract world far removed from everyday life.

Contribution to economic well-being (Item 11)

Similar to the results of item 4, participants favored on the same opinion about the relation of scientific and technological researches in Turkey and dependency to the other countries. More than half of the respondents (%54) thought that scientific and technological developments make Turkey less dependent to other countries and consequently increase its annual income (Table 4.11.). Only one third of the participants (%28) mentioned about the efficiency, the productivity, and the progress gained through science and scientific research. About 7% of the respondents claimed that it depends on which science and technologies we invest in. About 6% of the participants believed that science and technology will increase Turkey's wealth since Turkey could sell new ideas and technology to other countries for profit. Only 2 % claimed that science and technology decrease Turkey's wealth since it costs a great deal of money to develop science and technology.

Table 4.11. Percentage distribution of preservice science teachers' responses to item 11

The more Turkey's science and technology develop, the wealthier Turkey will become	
%	Your position, basically:
	Science and technology will increase Turkey's wealth:
28	A. because science and technology bring greater efficiency, productivity and progress.
54	B. because more science and technology would make Turkey less dependent on other countries. We could produce things for ourselves.
6	C. because Turkey could sell new ideas and technology to other countries for profit.

7	D.	It depends on which science and technologies we invest in. Some outcomes are risky. There may be other ways besides science and technology that create wealth for Turley.
2	E.	Science and technology decrease Turkey's wealth because it costs a great deal of money to develop science and technology.

Contribution to military power (Item 12)

In this item, most of the respondents (70%) viewed the military strength of a country depends upon the science and the technology (Table 4.12.). Nearly one third of the participants (35%) responded as science and technology develop in a country, more modern, accurate, and destructive weapons are built. About one fifth of the participants (19%) claimed that the more advanced the country's science and technology, the richer that country will be. According to them, the income of a country can be spent on developing new weapons and strengthening the military. Only one eight of the participants (16%) agreed that the military usually has a strong voice in government, and the military can insist on using science and technology to build its strength. A small portion of the respondents (7%) related the power of the military forces with the size of armed forces of a country. Another 4% of the participants reported that the military strength depends partly on science and technology, and partly on governmental decision to develop weapons.

Table 4.12. Percentage distribution of preservice science teachers' responses to item 12

The most powerful countries of the world have military strength because of the country's superior science and technology.	
%	Your position, basically:
	Military strength depends a great deal on science and technology:
35	A. because the greater the development in science and technology, the more modern, accurate and destructive the weapons.
16	B. because the military usually has a strong voice in government, and the military will insist on using science and technology to build its strength.
19	C. because the more advanced the country's science and technology, the richer the country. Its money can be spent on making the military stronger.
7	D. Military strength depends not only on science and technology for powerful weapons, but also on the size of its armed forces.
4	E. Military strength depends partly on science and technology and partly on a government's decision to develop weapons to increase its power.
12	F. Military strength does not depend on science and technology, but on the government. Some countries which are strong in science and technology have weak militaries (for example, Japan). Some countries which have a strong military are weak in science and technology (for example, China).

Standards/values that guides scientists at work and home (Item 13)

Almost 39% of the respondents thought the traits of a person such as an open-mind, logical thinking ability, an unbiased thoughts and objectiveness in their work as inadequate for being a scientist (Table 4.13.). According to these participants, the best scientists also need other personal traits such as imagination, intelligence and honesty. According to the 23% of the participants, the best scientists display these characteristics since they improve the ability in science. Almost 13% of the respondents claimed that the best scientists do not necessarily display these characteristics because it depends on the individual scientists. About 12% of the respondents argued these characteristics as necessary, otherwise science will suffer. About 9% of the respondent believed that these traits are not necessary because best scientists sometimes become so deeply involved, interested or trained in their field, that they can be closed-minded, biased, subjective and not always logical in their work. Only 1% of the respondents thought that the best scientists do not display these personal characteristics any more than the average scientists. According to these subjects these characteristics are not necessary for doing good science.

Table 4.13. Percentage distribution of preservice science teachers' responses to item 13

The best scientists are always very open-minded, logical, unbiased and objective in their work. These personal characteristics are needed for doing the best science.	
%	Your position, basically:
12	A. The best scientists display these characteristics otherwise science will suffer.
23	B. The best scientists display these characteristics because the more of these characteristics you have, the better you will do at science.
39	C. These characteristics are not enough. The best scientists also need other personal traits such as imagination, intelligence and honesty.
	The best scientists do not necessarily display these personal characteristics:
9	D. because the best scientists sometimes become so deeply involved,

		interested or trained in their field, that they can be closed-minded, biased, subjective and not always logical in their work.
13	E.	because it depends on the individual scientist. Some are always open-minded, objective, etc. in their work; while others can be come closed-minded, subjective, etc. in their work.
1	F.	The best scientists do not display these personal characteristics any more than the average scientists. These characteristics are not necessary for doing good science.

Gender effect on the process and product of science (Item 14)

Another item was about the gender and its effects to the process and product of science. About 73% of the total preservice science teachers cannot see any difference depending on the sex with respect to the process and product of science (Table 4.14.). On the other hand, 23% said that there is a difference due to the difference in the sex. In the first part, most of the participants thought the source of the differences in the discoveries as the differences between individuals. Only 16% of the participants determined the source of differences as the different nature and upbringing of the female scientists. In regard to the gender equity in scientific research and technological workforce, three fourth of the participants (73%) responded that they do not believe existence of difference due to the gender effect. About one third (35%) of the respondents explained the source of the differences as the personal differences. Only a small portion of the participants (16%) claimed that there is an inequality of gender in scientific research and technological workforce. According to these students, women would make somewhat different discoveries because, by nature or upbringing, females have different values, viewpoints, perspectives, or characteristics.

Table 4.14. Percentage distribution of preservice science teachers' responses to item 14

%	Your position, basically:
	There are many more women scientists today than there used to be. This will make a difference to the scientific discoveries which are made. Scientific discoveries made by women will tend to be different than those made by men.
	There is no difference between female and male scientists in the discoveries they make:
9	A. because any good scientist will eventually make the same discovery as another good scientist.
7	B. because female and male scientists experience the same training.
3	C. because overall women and men are equally intelligent.
7	D. because women and men are the same in terms of what they want to discover in science.
11	E. because research goals are set by demands or desires from others besides scientists.
2	F. because everyone is equal, no matter what they do.
34	G. because any differences in their discoveries are due to differences between individuals. Such differences have nothing to do with being male or female.
16	H. Women would make somewhat different discoveries because, by nature or by upbringing, females have different values, viewpoints, perspectives, or characteristics (such as sensitivity toward consequences).
5	I. Men would make somewhat different discoveries because, men are better at science than women.
2	J. Women would likely make somewhat better discoveries than men because women are generally better than men at some things such as instinct and memory.

Professional communication among scientists (Item15)

According the results of the item about scientific publications, almost half of the respondents (42%) reasoned this publications as both to benefit personally from any credit, fame or fortune that a discovery may bring; and to advance science and technology by sharing ideas publicly, and thus building upon each other's work. About one fifth of the respondents thought the reason as to advance science and technology. Almost one tenth of the participants reasoned it as to help the other scientists in all parts of the world. According to them, good communication prevents wasteful duplication of effort and consequently speeds the advance of science. According to 7% claimed the reason as to advance science and technology through open communication, and to inform the general public about the latest discoveries. About 6% of the respondents said that scientists publish to get criticism and checking ensure that science will advance on the basis of true results. According to the results 5% of the participants thought the reason as to get personal profits. Only 4% of the participants gave the reason as to share ideas publicly, and to have the discovery evaluated by other scientists (Table 4.15.).

Table 4.15. Percentage distribution of preservice science teachers' responses to item 15

Scientists publish their discoveries in scientific journals. They do this mainly to achieve credibility in the eyes of other scientists and funding agencies; thus, helping their own careers to advance.	
%	Your position, basically:
	Scientists publish their discoveries:
5	A. mainly to get credit for their achievements, to become better known, or to profit from any financial success. If scientists were denied these personal benefits, science would come to a standstill.
42	B. both to benefit personally from any credit, fame or fortune that a discovery may bring; and to advance science and technology by sharing ideas, and thus building upon each other's work.
23	C. mainly to advance science and technology. by sharing their ideas publicly, scientists build upon each other's work. Without this

		open communication, science would come to a standstill.
6	D.	mainly for other scientists to evaluate the discovery. This criticism and checking ensure that science will advance on the basis of true results.
4	E.	to share ideas publicly, and to have the discovery evaluated by other scientists.
9	F.	mainly to help the other scientists in all parts of the world. Good communication prevents wasteful duplication of effort and consequently speeds the advance of science.
7	G.	to advance science and technology through open communication, and to inform the general public about the latest discoveries.

Professional interaction in the face of competition (Item16)

Analysis of responses to this item showed that most of the participants believed that sometimes scientists break the rules of science (Table 4.16.). Almost one fourth of the respondents gave the reason as to achieve personal and financial rewards. About one tenth (13%) thought the reason as to find the answer, the way is not important for the scientists. Another one tenth (11%) explained it with the competition. According to them competition pushes scientists to work harder. On the other hand almost one fifth (18%) of the respondents claimed that science is no different from other professions in terms of the rule breaking. Another one fifth (18%) advocated that most scientists do not compete.

Table 4.16. Percentage distribution of preservice science teachers' responses to item 16

Scientists compete for research funds and for who will be the first to make a discovery. Sometimes fierce competition causes scientists to act in a secrecy, lift ideas from other scientists, and lobby for money. In other words, sometimes scientists break the rules of science (rules such as sharing results, honesty, independence, etc.).		
%		Your position, basically:
		Sometimes scientists break the rules of science:
11	A.	because this is the way they achieve success in a competitive situation. Competition pushes scientists to work harder.
25	B.	in order to achieve personal and financial rewards. When scientists compete for something they really want, they'll do

		whatever they can do to get it.
13	C.	in order to find the answer. As long as their answer works in the end, it doesn't matter how they got there.
18	D.	It depends. Science is no different from other professions. Some will break the rules of science to get ahead and others will not.
18	E.	Most scientists do not compete. The way they really work, and the best way to succeed, is through cooperation and by following the rules of science.

Social interactions (Item 17)

Most of the respondents believed that social contacts has an influence on the discoveries done by the scientists (Table 4.17.). One fifth of the respondents (23%) gave this reason such kinds of contacts allow scientists to observe human behavior and other scientific phenomena. Another one fifth (22%) said that social contacts influence the content of what is discovered because scientists can be encouraged by people to apply or change their research to a new area relevant to the needs of society. About 21% believed that scientists can be helped by the ideas, experiences, or enthusiasm of people with whom they socialize. Just one tenth of the respondents advocated that social contacts can serve as a refreshing or relaxing break from work. On the other hand one fifth of the respondents argued that social contacts do not influence the content of what is discovered because a scientist's work is unrelated to socializing.

Table 4.17. Percentage distribution of preservice science teachers' responses to item 17

A scientist may play tennis, go to parties, or attend conferences with other people. Because these social contacts can influence the scientist's work, these social contacts can influence the content of the scientific knowledge he or she discovers.

%		Your position, basically:
		Social contacts influence the content of what is discovered:
21	A.	because scientists can be helped by the ideas, experiences, or

		enthusiasm of the people with whom they socialize.
10	B.	because social contacts can serve as a refreshing or relaxing break from work; thus revitalizing a scientist.
22	C.	because scientists can be encouraged by people to apply or change their research to a new area relevant to the needs of society.
23	D.	because social contacts allow scientists to observe human behavior and other scientific phenomena.
20	E.	Social contacts do not influence the content of what is discovered because a scientist's work is unrelated to socializing.

National influence on scientific knowledge and technique (Item 18)

Unsurprisingly, respondents agreed upon the impact of different countries' view points of science on scientific knowledge and technique developed in them (Table 4.18.). They have positively responded to the statement about national influence on scientific knowledge and technique. This indicates an agreement upon opinion that a country's education system and/or culture affect the conclusions scientists reach. Most of the participants believed that country makes a difference in the scientific research. Some of the advocates of this idea (%28) explored the reason as the education and the culture. Another one third of the participants (%28) thought the reasons as a need corresponds to a country's governmental and industrial management. Only 14% claimed the reason as the way that the scientists are taught to solve problems makes a difference to the conclusions scientists reach. Almost one fifth (17%) of the respondents claimed that it depends. The other one tenth of the participants believed that country does not make a difference. Half of them reasoned it as scientists' personality. And the other half claimed that there is no difference since scientists all over the world use the same scientific method which leads to similar conclusions.

Table 4.18. Percentage distribution of preservice science teachers' responses to item 18

Scientists trained in different countries have different ways of looking at a scientific problem. This means that a country's education system or culture can influence the conclusions which scientists reach.	
%	**Your position, basically:**
	The country does make a difference:
28	A. because education and culture affect all aspects of life, including the training think about a scientific problem.
14	B. because each country has a different system for teaching science. The way scientists are taught to solve problems makes a difference to the conclusions scientists reach.
28	C. because country's government and industry will only fund science project that meet their needs. This affects what a scientist will study.
17	D. It depends. The way a country trains its scientists might make a difference to some scientists. But other scientists look at problems in their own individual way based on personal views.
	The country does not make a difference:
5	E. because scientists look at problems in their own individual way regardless of what country they were trained in.
5	F. because scientists all over the world use the same scientific method which leads to similar conclusions.

Technological decisions (Item 19)

More than half of the respondents related the decision to use a new technology with several things such as its cost, efficiency, usefulness to society, and effect on employment (Table 4.19.). About one tenth (11%) gave the priority to the cost effectiveness of the new technology. Another one tenth (11%) gave this priority to that whether it has a negative effect or not. The rest of the alternatives almost have equal importance in terms of frequencies. For example, about 3% said that the most important point is how well it works and another 3% claimed that the decision primarily depends on the governments' view. Equal frequency of the respondents advocated that the decision does not depend necessarily on how well it works since they can be improved later. About 2% claimed that the decision depends whether it will make a profit for a company. Finally, only 1% of the participants thought the cost effectiveness primarily for this decision mechanism.

Table 4.19. Percentage distribution of preservice science teachers' responses to item 19

When a new technology is developed (for example, a new computer), it may or may not be put into practice. The decision to use a new technology depends mainly on how well it works.

%	Your position, basically:
3	A. The decision to use a new technology depends mainly on how well it works. You don't use something unless it works well.
60	B. The decision depends on several things, such as its cost, its efficiency, its usefulness to society, and its effect on employment.
	The decision does not depend necessarily on how well it works:
1	C. but on how cost effective it is.
11	D. but on what society wants or needs.
11	E. but on whether it helps the world and has no negative effects. New technologies are not used if they are harmful.
3	F. but on whether the government in power supports it.
2	G. but on whether it will make a profit for a company.
3	H. because some technologies are put into practice before they work well. They are improved later.

Autonomous technology (Item 20)

The majority of the respondents (81%) believed the statement that "technological developments can be controlled by citizens". About 28% of the participants claimed that citizens can control them only when put into use not the original development itself. One fourth of the people gave the reason as the needs of consumers. It is the results of the relation between demands and profits. Almost 12% of the respondents explained their answer "yes" as the way that from the citizen population comes each generation of the scientists and technologists who will developed the technology. About one tenth of them claimed the way as the electing the government who are sponsored the scientific and technological advances. Another one tenth of the participants believed that the citizens does not have effect since technology advances so rapidly that the average citizen is left ignorant of the development. Only 3% explained their answer with this reason; the citizens are prevented from doing so by those with the power to develop the technology (Table 4.20.).

Table 4.20. Percentage distribution of preservice science teachers' responses to item 20

Technological developments can be controlled by citizens.	
%	Your position, basically:

12	A.	Yes, because from the citizen population comes each generation of the scientists and technologists who will develop the technology. Thus citizens slowly control the advances in technology through time.
9	B.	Yes, because technological advances are sponsored by the government. By electing the government, citizens can control what is sponsored.
25	C.	Yes, because technology serves the needs of consumers. Technological developments will occur in areas of high demand and where profits can be made in the market place.
28	D.	Yes, but only when it comes to putting new development into use. Citizens can not control the original development itself.
7	E.	Yes, but only when citizens get together and speak out, either for or against a new development. Organized people can change just about anything.
		No, citizens are not involved in controlling technological developments:
10	F.	because technology advances so rapidly that the average citizen is left ignorant of the development.
3	G.	because citizens are prevented from doing so by those with the power to develop the technology.

Nature of observations (Item 21)

More than half of the preservice science teacher supported the effects of the different theories on the observation done by the scientists (Table 4.21.). About one third (32%) of the respondents claimed that scientists' thinking way affects their observations. One fifth of them said that scientists will experiment in different ways and will notice different things. About one third (33%) advocated that scientific observations will not differ very much even though scientists believe different theories. They related this with the competent feature of the scientist. Only 6% rejected this effects. About 4% claimed that observations display the absolute facts. Only 2% said that observations are as exact as possible.

Table 4.21. Percentage distribution of preservice science teachers' responses to item 21

Scientific observations made by competent scientists will usually be different if the scientists believe different theories.	
%	Your position, basically:
23	A. Yes, because scientists will experiment in different ways and will notice different things.
32	B. Yes, because scientists will think differently and this will alter their observations.
33	C. Scientific observations will not differ very much even though scientists believe different theories. If the scientists are indeed competent their observations will be similar.
2	D. No, because observations are as exact as possible. This is how science has been able to advance.
4	E. No, observations are exactly what we see and nothing more; they are the facts.

Tentativeness of scientific knowledge (Item 22)

Most of the respondents showed the belief that scientific knowledge may change in the future when the investigations are done correctly (Table 4.22.). Almost half of the participants (46%) claimed that by using new techniques or improved instruments, new scientists disprove the old theories or discoveries. About one third (30%) of the respondents claimed that old knowledge is reinterpreted in the light of new discoveries. According to these participants scientific facts can change. About one tenth (12%) of the participants supposed that scientific knowledge appear to change due to interpretation or application but scientific experiments results with unchangeable facts. Another one tenth (9%) rejected these kinds of changes.

Table 4.22. Percentage distribution of preservice science teachers' responses to item 22

Even when scientific investigations are done correctly, the knowledge that scientists discover from those investigations may change in the future.		
%		Your Position, Basically:
		Scientific knowledge changes:
46	A.	because new scientists disprove the theories or discoveries of old scientists. Scientists do this by using new techniques or improved instruments, by finding new factors overlooked before, or by detecting errors in the original "correct" investigations.
30	B.	because the old knowledge is reinterpreted in the light of new discoveries. Scientific facts can change.
		Scientific knowledge appears to change
12	C.	because the interpretation or the application of the old facts can change. Correctly done experiments yield unchangeable facts.
9	D.	because new knowledge is added on to old knowledge, the old knowledge doesn't change.

Hypothesis, theories and laws (Item 23)

In order to see whether preservice science teachers regarded hypotheses, theories and laws as a sequential set of statements or regarded them as different types of ideas and statements, they were asked the relationships among theory and hypotheses (Table 4.23.). Most of the respondents advocated such kind of sequential advancement. More than half of the respondents (54%) selected the statement stating an hypotheses tested by experiments, if it proves correct, it becomes a theory and after a theory has been proven true many times by different people and has been around for a long time, it becomes a law. About one third believed that an hypotheses is tested by experiments if there is supporting evidence, it is a theory. After a theory has been proven to true tested many times and seems to be essentially correct, it's good enough to become a law. About 12% thought this sequence as logical for scientific ideas to develop. Only 3% became against this view. About 2% of them said that laws can be proven but theories can not. Only one percent claimed that theories can not become laws since they both are different types of ideas. The study clearly showed that preservice science teachers have the misconception about that there is a chain relation between hypotheses, theories, and laws.

Table 4.23. Percentage distribution of preservice science teachers' responses to item 23

Scientific ideas develop from hypotheses to theories, and finally, if they are good enough to being scientific laws.		
%		Your Position, basically:
		Hypotheses can lead to theories which can lead to laws:
54	A.	because an hypothesis is tested by experiments, if it proves correct, it becomes a theory. After a theory has been proven true many times by different people and has been around for a long time, it becomes a law.
27	B.	because an hypothesis is tested by experiments if there is supporting evidence, it is a theory. After a theory has been tested many times and seems to be essentially correct, it's good enough to become a law.
12	C.	because it is logical way for scientific ideas to develop.
		Theories can't become laws because they both are different types of ideas.
2	D.	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.
1	E.	Laws describe things in general. Theories explain these laws. However, with supporting evidence, hypotheses may become theories (explanations) or laws (descriptions).

Scientific approach to investigations (Item 24)

About one third of the respondents defined the scientific method as questioning, hypothesizing, collecting data and concluding (Table 4.24.). Only 14% of the participants stated it as controlling experimental variables and leaving no room for interpretation. About one tenth of the participants said that the scientific method is getting facts, theories and hypotheses efficiently. On the other hand equal amount of the respondents claimed that the scientific method is testing and retesting-providing something true or false in a valid way. Almost one tenth of the respondents said that it is a logical and accepted approach to problem solving. About 8% of the participants the scientific method is the lab procedures or techniques; often written in a book or journal, and usually by a scientists. About 5% explained the scientific method as an attitude that guides scientists in their work. Only a few respondents (3%) defined this method as postulating a theory than creating an experiment to prove it. Only 2% thought it as the recording the results carefully. Just one percent said that considering what scientists actually do, there really is no such things as the scientific method.

Table 4.24. Percentage distribution of preservice science teachers' responses to item 24

When scientists investigate, it is said that they follow the scientific method.	
%	Your position, basically:
	The scientific method is :
8	A. the lab procedures or techniques; often written in a book or journal, and usually by a scientists.
2	B. recording your results carefully.
14	C. controlling experimental variables carefully, leaving no room for interpretation.
11	D. getting facts, theories or hypotheses efficiently.
11	E. The scientific method is : testing and retesting- providing something true pr false in a valid way.
3	F. postulating a theory then creating an experiment to prove it.
32	G. questioning, hypothesizing, collecting data and concluding.
9	H. a logical and accepted approach to problem solving.
5	I. an attitude that guides scientists in their work.
1	J. Considering what scientists actually do, there really is no such thing as the scientific method.

Logical reasoning (Item 25)

Only the 6% of the participants claimed that obviously the asbestos causes lung cancer (Table 4.25.). On the other hand, most of the respondents said that the facts do not necessarily mean that asbestos causes cancer. The most popular view on the subject that asbestos might work in combination with other things, or may work indirectly. The other popular view was that more research is needed to find out whether it is asbestos or some other substance that causes the lung cancer. About one tenth of the respondents claimed that the asbestos can not causes the lung cancer because if it did, all asbestos workers would have developed lung cancer. Only 1% of the students said that asbestos can not be cause of the lung cancer because many people who do not work with asbestos also get lung cancer.

Table 4.25. Percentage distribution of preservice science teachers' responses to item 25

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.	
%	Your position, basically:
6	A. The facts obviously prove that asbestos causes lung cancer. If asbestos workers have a greater chance of getting lung cancer, then asbestos is the cause.
	The facts do not necessarily mean that asbestos causes lung cancer:
35	B. because more research is needed to find out whether it is asbestos or some other substance that causes the lung cancer.
37	C. because asbestos might work in combination with other things, or may work indirectly (for example, weakening your resistance to other things which cause you to get lung cancer).
11	D. because if it did, all asbestos workers would have developed lung cancer.
1	E. Asbestos can not be the cause of lung cancer because many people who don't work with asbestos also get lung cancer.
	.

Paradigms vs. coherence of concepts across disciplines (Item 26)

Four tenth of the respondents believed that one scientific idea can be interpreted differently, because they thought that the interpretation depends on the individual scientist's point of view or on what the scientist already know (Table 4.26.). About one tenth (12%) said that scientific ideas can be interpreted differently in one field that in another. On the other hand, about one fifth of the participants claimed that a scientific idea will have the same meaning in all fields. Because the idea still refers to the same real thing. One tenth of the respondents advocated the similarity and reasoned it as all sciences are closely related to each other. Another one tenth (11%) reasoned as that in order to allow people in different fields to communicate with each other. According to these people, scientists must agree to use the same meanings.

Table 4.26. Percentage distribution of preservice science teachers' responses to item 26

Scientists in different fields look at the same thing from very different points of view (for example, H+ causes chemists to think of acidity and physicists to think of protons). This means that one scientific idea has different meanings, depending on the field a scientist work in.	
%	Your position, basically:
12	A. because scientific ideas can be interpreted differently in one field than in another.
40	B. because scientific ideas can be interpreted differently, depending on the individual scientist's point of view or on what the scientist already knows.
	A scientific idea will have the same meaning in all fields:
21	C. because the idea still refers to the same real thing in nature, no matter what point of view the scientist takes.
10	D. because all sciences are closely related to each other.
11	E. in order to allow people in different fields to communicate with each other. Scientists must agree to use the same meanings.

4.2.Interview Analyses

To identify the preservice science teachers' views on STS details, nine individual interviews were conducted with the preservice science teachers (3 females and 6 males) from METU. The selection of the participants depended on the willingness of the preservice science teachers to take part in the present study.

The questions and the answers given by the participants for these questions were given below.

Definition of science and technology

Question: What is science?

When asked definition of science no consensus about the definition of science was observed. Answers were quiet different. Every respondent gave his/her own definition. They defined science as: life; understanding truths and putting them in an order; an area seeking answers and unknowns; investigations, improvements, making laws and method sequence; putting the information into an order; knowledge; provable truths; application of technology; and reflections from the observations of nature. Results displayed a range of views on science definition starting from knowledge or truths to the process of ordering the knowledge, truths or observations. One of the respondents defining science stated that;

> "…Every kind of knowledge can be thought as science. This knowledge may come from our daily lives or from our past experiences (Participant 5, Male)…"

Question: What is technology?

When asked definition of technology, there was a broad consensus. More than half of the respondents (55 %) defined it as the application of science which is the most preferred definition given at schools. One participant said that;

> "…Technology is technique or it can be defined as devices such as tables, chairs (P3, Male)…"

Another popular answer which emphasizes the technology's social role was that technology is something that process science to make people's life easier (44%). One of the respondents advocating this view said that;

"…People can not solve some problems due to their nature. Technology is something to solve these problems. People develop some devices and use them. The development of these devices and use of them can be defined as technology (P5, Male)…"

Influence of society on science/technology

Question: Are science and /or technology affected by the society in which it constructs and its culture?

Interestingly, all preservice science teachers were agreeing on the answer of this question. All of them claimed that science and /or technology are affected by the society in which it constructs and its culture. Although they accepted the effects of society and its culture on to the science and/or technology, they explained that with three different reasons. For example most of the preservice science teachers (77.7%) stated that science and/or technology shaped by the needs and cultural differences of the society in which they develop. One of them gave the example of the azan reciting clocks used by the Muslims. Only one of the respondents mentioned about the importance of the freedom that is given to the citizens of the society. According to this preservice science teacher, science and/or technology can be affected by the citizens if the society gives freedom to its citizens to do that. The participant stated that

> "Freedom and creativity are very important to make science. If a society supports the creativity of its individuals, it will be better in science. For example European countries support investigations and curiosity. On the other hand rich Arabic societies don't need to do such studies. Instead they use their natural resources to survive. For example they send one of their natural resource, oil, to developed countries to process it properly. They just sell the nature itself without doing anything else because their society didn't give them such a tendency (P3, Male)…"

Finally, only one of the respondents talked about the consciousness level of the citizens. He stated that;

"…If they are conscious enough they can affect the science and/or technology (P1, Male)…"

About one third of the participants differentiated the science and technology in this item. They stated that science was independent from the society and culture but technology had a very strong relation with them. Other preservice science teachers did not talk about their differences.

Influence of science/technology on society

Question: How can science/technology affect the society?

Participants gave several responses to this question. About one fifth of them related the effects of science/society with the structure of the society. These participants claimed that conscious societies can either reject or accept the development. On the other hand, equal number of the respondents advocated that science and technology have both positive and negative effects on society. Medical developments were given as the example for the positive effects but production of destructive weapons were thought as the example of the negative effects of science and technology by those participants. According to one tenth of the participants, societies cannot reject the scientific development but can reject the technological developments. Another one tenth, supporting this view also pointed out that the importance of political decisions on science/technology to affect the society. Another one tenth of the respondents claimed that developments were adapted to the societies' life. One of the participant emphasized the direct relation between the science/technology and the society. According to this participant, science and technology exist for the society. They were born from the needs of the society and as a result they return to the society. The respondent stated that:

> "…We can't do without electricity or computers. They are the returned form of the science and technology to the society (P5, Male)…"

On the other hand one tenth of the respondents claimed that there was not a direct relation. Science and technology develop with society whether society accept them or not. The participant stated that:

> "…Today everybody use televisions even the religious people that rejected the TV technology in the past (P4, Male)…"

Influence of school science on society

Question: You have taken science courses since primary school. Do you think it has an effect on your daily life, whether positive or negative?

More than half of the respondents advocated the positive effect of school science. Another respondents (33%) implied the necessity of the positive effects of school science but they also stated the abstractness of the school science that prevents its positive effects and separated it from the real life. About one tenth of the participants related the effects of school science with the students and teachers. According to this view school science can affect positively or negatively depending on the people educated and the instructor who will give this education. They claimed that if science classes uses properly the curiosity naturally exist in the students may lead to several discoveries. One of the respondents claiming this view by stating:

> "…Most of the students are unaware about the need to be taught to many science subjects, they do not know where to use them in daily life. If the learner is logical enough, he observes the nature, he can understand that most of the science subjects are related with our daily life. Teachers' teaching methods also have same effects . If they teach by using examples from students' daily lives, students could easily relate science courses with their lives (P6, Male)..."

Preservice science teachers gave several examples for the positive effects of school science in their lives;

"…I know that I can not drink tea at 100 centigrade degree due to the boiling point (P2, Female)…"

"…Someone knowing the hypotenuse can use the shortest way to get somewhere (P5, Male)…"

Characteristics of scientists

Question: What can you say about the personality of an ordinary scientists?

Answers given to this item displayed the thoughts about the personality of an ordinary scientist. Respondents attributed many features to scientists. Preservice science teachers primarily mentioned about two features of scientists; they are patient (44%) and researcher (44%). One respondent said that:

> "…I can not be a scientist because I am not patient. A scientist must be patient to make science for example he or she develops a hypotheses and then makes thousands of experiments to carry the hypotheses to a theory or law (P4, Male)…"

About one fifth of the respondent defined scientists as people having fore-sight and another one fifth said that scientists are determined people. Curiosity, intelligence, creativeness, and ambitiousness were stated as the other important characteristics of scientists with equal percentages (22%). One of the respondents emphasized the realistic feature of the scientists but some other respondents emphasized the materialist and humanist feature of them. The preservice science teacher mentioning about the humanism of the scientists explained it as;

> "… They are humanist people since they gave their life energy to the scientific studies instead of waiting to others to do that (P5, Male)…"

On the other hand, one of the participant defined the scientists as anti-social people. This respondent thought scientists as people living in laboratories or their rooms and studying all the time. Other features of scientists defined by the preservice science teachers were that; scientists were honest, skeptic, systematic, self-sacrificing, hard working, self confident, and good observer.

Question: What can you say about the gender of the scientists; is there a numerical difference between two sexes; and does gender have an effect to the result of the discoveries?

As a response to this item, about one third of the participants claimed that there was not a difference between the males and females in number. Another one third said that males were higher in number due to social reasons. One tenth claimed that males were higher in numbers since this, responsibility of scientific study, was too heavy for women to carry. The participant stated this view as following;

> "…Women are much more emotional then males so they may not overcome some situations psychologically. Women cannot achieve their goals under hard-working conditions and they enjoy using time for themselves. Their sense of responsibility is higher then that the men have so they can

thought the responsibility of scientific studies as too heavy to carry. Women give high importance to details so they may have difficulty also due to this feature (P5, Male)…"

Another one tenth of the respondents stated that the number of males and females could change depending on the field of study. According to this participant:

> "…I think women are higher in number in the field of educational studies but they are fewer in the field of physics, mathematics etc. The reason underlying that situation could be the higher tendency of males for this area due to the cultural effects on upbringing (P8, Female)…"

About one tenth of the participants claimed the higher number of women in scientific area due to their patience.

Coming to the differences in the results of discoveries made by different sexes, a consensus was observed. About 90% of the respondents claimed that gender did not have an effect on the results of discoveries. Only one tenth of the participants advocated the difference in discoveries. According to this view the difference comes from the different thinking styles of two different sexes.

Question: What do you think about the daily life of a scientist?

Scientists' daily lives were seen as the same with the other people by one third of the respondents. About one fifth of the participants stressed the anti-social lives of the scientists but one tenth of the preservice science teachers emphasized the scientists with developed social relations. One of the respondents stated the common features of scientists as the people that studied-hard during his/her university life. According to this participant, today's scientists are determined by this criteria instead of using the main criteria of a scientist such as curiosity or intelligence. According to another respondent, scientists relate everything with science in their daily lives. One of the participant claiming the similarity of a scientist's life to the any usual person gave the following example:

> "…One of my friend that I think he has ability to do science he prefers to use the armchair from the last line of the bus since it is the closest chair to the door and by this way he can walk less to get his home. Indeed it walks the minimum length everyday (P3, Male)…"

Almost one tenth of the participants defined scientists' daily lives as planned and productive lives.

Social construction of scientific knowledge?

Question: Does a group of scientists from any part of the world examine a subject for example "atom" in the same way?

Almost half of the participants claimed that a group of scientists from any part of the world examine a subject in the same way since the theories were common. About one third of the participants pointed the difference between the past and the present. According to them, in the past communication was not easy so different ways could be seen but today communication is very easy and rapid so any subject can be examined in the same way by the scientists all over the world. One of the participants explained that by giving the following example:

> "…I remember the TV program, Sesame Street. There was a man discovering the things that were already discovered. He was living in an obscure island and do not know anything about the life from the other parts of the world. For example he discovered the microphone and called it as, speaking stick. Since the man did not be aware of the discovery of microphone he rediscovered it by using his own way (P5, Male)…"

Only one fifth of the preservice science teachers accepted the different ways. According to them the difference come from the cultural and personal differences. One of them said that;

> "…There are accepted theories related with invisible things such as atom. If scientists study scientifically, we expect them to work in the same way on such topics. On the other hand, religion, culture, and beliefs may affect the studies on some other subjects such as genome project (P2, Female)…"

Social construction of technology

Question: Who decides on the technological developments?

More than half of the respondents (66%) claimed that the decisions on the technological developments should made by public. One of the preservice science teachers advocated this view as;

> "…There is an offer-demand relation. If the society demands something, producers absolutely produce this technology (P4, Male)…"

The other decision agencies thought as politics and advertisement (11%), and several institutions (11%). Student claiming the institutions as decision makers stated that:

> "…. If the people are not conscious, these kinds of institutions don't work due to the presence of uneducated, unconscious personals (P1, Male)…"

One of the respondents stated that he did not have any idea about the decision makers.

Epistemology nature of scientific knowledge

Question: Is there any method followed by scientists during the scientific investigations, if yes how?

All of the participants answered this question in the same way. All of them claimed that there was a method followed by scientists during the scientific investigations. They defined this method as the way that most of the science books wrote; observations, hypothesis, experiments etc. One of the respondents explained her view as;

> "…The scientific method that is taught us as hypothesis, experiments, theories etc. must exist otherwise a chaos can be observed. Scientists should use an international scientific method to avoid confusions (P2, Female)…"

Another participant said that;

> "…There is a scientific method starting from hypothesis and going through the experiments and so on (P5, Male)

When the question asked whether this method is valid for every scientists and in every time or not he stated that;

> Yes it is valid but there are some topics that can not be tried due to their invisible features such as Earth Formation. Indeed these subjects were tested in artificial environments (P5, Male)…"

Question: Does scientific knowledge change in time?

The most popular answer for this question was that theories can change but laws cannot. One of the preservice science teacher explained it as:

> "…Scientific knowledge can be changed although it has low probability to change if it is in the form of theory but law cannot be changed (P7, Male)…"

Another student claimed that;

> "…Scientific knowledge can change. We thought about the last centuries scientific knowledge as superficial, inadequate, or wrong. In the future, today's knowledge can be evaluated like that of course under the light of new data (P5,Male)…"

About one fifth of the participants claimed that scientific knowledge cannot change but can evolve with new details found and scientific data may change. While one tenth emphasized the subjective structure of the observations that may lead to change in scientific knowledge, the other ten percent stressed the new knowledge that could change the scientific knowledge.

Results of the present study enlightened several poins about the views of the participants on science-technology-society issue. According to these results, that can be said that preservice science teachers have some misconceptions or traditional views on some topics but they have contemporary views on some other topics.

CHAPTER 5

DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

This study aimed at investigating the views of preservice science teachers on science-technology-society issues. This chapter presents discussions of the results and implications for practice and future studies.

5.1. Discussion

Results of this study revealed that there are some problems in the perceptions of preservice science teachers on science-technology-society topics. They have several misconceptions. Their views are mostly traditional on the science and technology concepts and their relations with each other and with society.

The present study displayed that there was no consensus on the definition of science. The study performed by Aikenhead and Ryan (1992), and Yakmaci (1998) gave the similar results with this study. According to the results of those studies subjects did not acquire a uniform view of science. In the present study, some of the preservice science teachers were confused about the terms of science and technology that may be the result of the fact that in recent years, science is usually reflected in technology form in our lives. Although many of the preservice science teachers defined science as content or process, they also thought it as something to make world a better place to live in. Like many other studies (Bradford and Rubba, 1995; Botton and Brown, 1998), the present study also indicated the decisiveness on to defining technology as application of science, which is the way of most of the science books, did. Preservice science teachers have a consensus on the close relation of science and technology which reminds us their confusion about science and technology. These results were confirmed by the interview part. All of the participants gave different definitions for science. Although many definitions of science given by the participants of the present study, only two definitions given for technology. Indeed preservice science teachers did not differentiate science and technology before they were asked to do so. Definitions given for science changed from life to application of technology. These descriptions also include technology. On the other hand, when we asked the definition of technology they emphasized two views. One of them “application of science” was the most famous definition of technology given almost all textbooks and during most of the science courses. The other definition “something that process science to make people’s life easier” was related with the social aspects of technology and includes the point that is a part of contemporary views on technology. These definitions may result from the image of today’s world. Most of the time science came our lives after wearing a uniform called as technology.

Many preservice science teachers indicated the need to give money to make world a better place to live in but most of the time scientific studies are performed just to learn. Making world a better place to live in is primarily the aim of technology not science. Participants also stated one of the aim of science is to Turkey does not fall behind other countries and become dependent upon them. This brings the expectations to science much more than investigations. These expectations may come from the belief about showing the science as the same thing with technology. This belief may be caused by the inadequate development of science and technology in Turkish society. Results obtained from high-school graduates in Canada by Fleming (1987) for this point emphasized the investment risk that must be taken. On the other hand, participants from our country seemed to ignore that while giving the money to researches we take an investment risk. Turkish people may feel the pressure coming from the developed countries in many respects such as economic, politic, and cultural. So there is a need to overcome this dependency somehow. These results indicated that most of the respondents seemed science and technology as the way to be independent in all respects.

One of the interesting findings of this research was that most of the preservice science teachers stated the effects of society on science and technology. On the other hand, the percent claiming the ineffectiveness of society was not very low. This showed that many preservice science teachers rejected social aspect of given decisions about science and technology and thought science/technology as something private. Results of the study of Aikenhead (1987) with high-school graduates in Canada reported the similar thoughts. According to his study, most of the respondents agreed on the effects of social contacts on the discoveries but only one fourth of the participants rejected the effects of social contacts which is similar to the traditional belief of objectivity of science. The interview results displayed the same misconception about the question of effects of society on science and technology. Although all participants accepted the effects of society, several explanations were given for that. Most of the respondents explained that with offer-demand relations which is mainly related with technology not science.

Results of the study also indicated that; most of the preservice science teachers had a consensus on the possible positive effects of upbringing and the importance of education given to high school students about the use of science and technology. This idea brings the good news for the future of scientific and technologic studies that would be done in Turkey because this thought may increase the support given to be a scientist by the whole society and it will also give the opportunity to the well-educated citizens to decide on scientific and technological issues consciously.

A consensus was observed about that science classes should have the positive effects in our daily lives. Although there was a consensus on this point, participants did not clear whether it has the positive effect or not. They claimed that there must be but they were some doubts about the existence of this effect. Most of the participants claimed that textbooks, methods of science teachers are far from the real life. Some of the respondents claimed that the reason of that as coming from the students and teachers. According to them it depends on the attitudes and beliefs of students and teachers. On the other hand, most of the students thought the underlying reason as in the fundamental base. Shortly, students had some contradictions between the ideals and the realities of the science classes.

One of the most striking findings of the research was about the social responsibility of scientists and technologists. Most of the preservice science teachers involved in the present study claimed that scientists are concerned with all the effects of their experiments. Study of Ryan (1987) with high-school graduates displayed similar results about the social responsibility of the scientists. Respondents of his study claimed that scientists are concerned all the effects of their experiments because the goal of science is to make the world a better place to live in. We can compare this with the case of miner mining to the iron. This views claims that he should consider the possible murders committed by the knife produced from this iron mine. According to the contemporary views this is not the job of science. Scientists can divide the atom but the atomic bomb is not the result of their study. Indeed, it is the result of technological studies.

Participants hold the views that decisions such as the built of a nuclear reactor should be made completely or mostly by scientists which is the contemporary view. The public also impressed the importance of the involvement of citizens to these decisions. This result can be emerged from the increasing awareness of the public in scientifically and technologically developed countries. Last decades have displayed some examples for such decisions in Turkey. Although Turkish education system does not give priority for the ability of making social decisions, these discussions may have increased the level of contemporary tendency to the views on these subjects.

Another interesting result obtained from the study was that most of the participants thought scientists as anti-social people. They defined scientists as the people leaving away from the society and a little bit crazy. This belief about the anti-social feature of the scientists may come from the universities, which are seen as the only address to make science in our country. Although scientific and technological studies need hard working, there can be some other reasons. Since getting higher position at these universities is so difficult and there is a big competition for these degrees, sometimes scientists fall the mistake of trying to do science in small laboratories instead of using the world as a big laboratory. Indeed, they do not have much time to study. They must publish new articles in a short time to get higher degrees at these universities.

There is not a consensus on that scientists can solve any practical everyday problem best. One of the reasons for this can be the isolated life of scientists. Any common citizen does not have the opportunity to observe a scientist. They live in the same planet but in different worlds. As it was indicated also in the interview results, scientists were thought as the anti-social people. According to the participants, they have isolated lives going through in a bounded social environment composed of their family and their colleagues. When the interview result was analyzed, some details were founded for scientists' daily lives. The majority of the respondents stated that scientists have a daily life like the others but also they emphasized that scientists always think about everything in every time and they always investigate for something even during their every day lives.

Interestingly there was an emphasis on the personal differences of scientists onto the discoveries by the respondents who ignored scientists' personal differences in another item. Most preservice science teachers claimed that there was not any difference between males and females in terms of discoveries. The majority supporting this view can be thought as a surprise in a country such as Turkey which is usually seemed as a country from the out of western societies.

Many preservice science teachers thought that scientists could break the rules of science. The respondents gave several reasons for that but the underlying idea was the breaking rules no matter what the reasons were. This result reminds us the most contemporary debates in scientific, political, and social area. Although some countries and institutions rejected the study on the human genome, it is known that there are several studies on this issue in different parts of the world.

Another interesting finding came from the relations of science/technology and economic well-being. Although most of the participants believed that science/technology brings economic well being, only one fifth claimed this with efficiency, productivity, and progress. Most of the respondents explained this economic well being with the independence of Turkey from the other countries. They claimed that by this way Turkey could produce by itself. This point shows the strong tie of independence and economic well being and scientific/technological developments in preservice science teachers' mind. This relation can be explained by the success of the scientifically and technologically developed countries among the others during history. Unfortunately, efficiency, productivity, and progress were not claimed as the main sources of development by all of respondents.

Preservice science teachers evaluated the military strength and scientific and technological development of a country as the same things. Most probably the visual shows presented by the developed countries as in the form of television wars have a big effect on this view. Images of TV wars prove the relations among the economic wealth of a country and its military power.

A traditional view observed during this study was about the objectivity of scientists in their work. Again the contemporary aspect of the topic was ignored by the participants. They gave only little importance to the personality of scientists and they described them in a few features which all scientists should possess. This idea of the preservice science teachers can be thought another reflection of our traditional educational system onto the future educators.

Only small portion of the respondents mentioned about the aim of scientific publications as sharing ideas publicly and to have the discovery evaluated by other scientists. On the other hand majority of the participants emphasized that "both to benefit personally any credit, fame or fortune and to advance science and technology." This showed a contemporary view of respondents by stressing the social and personal aspects of the scientists.

The present study also displayed another contemporary view of preservice science teachers about the effects of social interactions on scientists' work. Most of the participants were against the traditional view that claims the ineffectiveness of social contacts to the scientists' work. The contemporary view held by participants indicated the increased consciousness level of respondents about seeing science something alive in life. A similar result emerged from the question about the effects of different countries to the ways of looking at a scientific problem, which is another example to recognized effect of the country on the scientific and technological studies.

Besides the efficiency, usefulness to society, and effect on employment, participants emphasized the effect of how well a technological development works before putting into practice. According to the results, cost effectiveness and well works evaluated as the unnecessary. Interestingly, ten percent of the respondents advocated that the decision on to whether a technological development will put into use or not made by looking its harmful effects. This view is close to the views of the majority of media controlled by the technology producers. We know that there were many debates appeared from the uncertainty of the potential effects of newly developed technology. Recently, many debates observed in Turkey about the uncertain effects of new technologies that were put into practice such as cyanide technology used in gold-mining, nuclear reactors built in the seismic zone, and base stations developed for communication.

The present study also indicated that citizens could control technological developments. The most popular way suggested by the participants was that citizens could control only after it comes to put into use, not the original development itself. Another popular explanation for this was done by using offer-demand relations. This result gave bright light to the future of our society in terms of the recognizing of the power of citizens in this field. Both being as future educators, and just as a member of the society, the answer of the subjects gave us some hopes about the future when the scientifically and technologically literate citizens use their power in making decisions. On the other hand interview results gave some more details about the decision agencies defined by the participants. Differently, according to the results of interview, preservice science teachers had a confusion about the power deciding the technological developments. While some of them were stating it as "public" some others mentioned about the institutions. Some of the respondents did not give any clear information about the decision agency. The underlying reason for this confusion can be that the citizens were not given the opportunity to feel that they can live in a technological environment that they decide on the technological changes.

Contemporary views claim that scientists' actions are heavily influenced by their previous values, experiences and beliefs. Most of the participants supported the contemporary views in the item related with the effects of different theories onto the scientific discoveries.

The tentativeness of scientific knowledge; one of the main attributes of science that makes it different than the other forms of knowledge and prevents it from being dogmatic. One of the most important results of the present study is that most science teachers were aware of this tentative nature of science. Some of the respondents claimed that scientific data and scientific observations can change but scientific reality cannot change. They have seen a difference between the scientific theories and laws in terms of tentativeness. They claimed that theories could change but laws were absolute. These results were very similar to the study of Yakmaci (1998), Ryan and Aikenhead (1992). In these studies, most of the participants stated the change in investigation. Additionally, the present study also found that science teachers' possess same misconceptions of the relationships between hypotheses, theories, and laws. Most of the sample selected a hierarchical relationship between them, but according to contemporary views, they are all different kinds of statements so a linear relation does not exist among them.

Although preservice science teachers accepted that sometimes originality and creativity should be employed in a scientist's work, they view the scientist as someone working in an ordered fashion. It is interesting that only one of the preservice science teachers in the sample selected the realistic alternative reflecting the most contemporary view about the subject when they were asked about the nature of the scientific investigations. According to this view, there really is no such thing as the scientific method. The underlying reason can be that participants may find this interpretation so simple that it is not proper for complex scientific studies. Yakmaci's study also displayed a very similar result at that point. Since the point about the classical and unique scientific method was repeated several times at every levels of education, starting from primary school and going through the university, the participants might fail to develop more contemporary views on this subject.

Another promising finding of this research is that most of the preservice science teachers were aware of the cause-and-effect relationships about the scientific and technological issues. This result gave some hopes us to the positive effects of science education. This finding may be a base for the development of a system to include more people into science education to be literate both scientifically and technologically.

Another part of the answers indicated our time as the rapid communication era. The preservice science teachers differentiate the past and the present in terms of this communication. Respondents claimed that as a result of this speed in communication, today every scientist investigates the same subject as in the same way of the others living from the other parts of the world. On the other hand, they advocated that in the past there were many different ways possessed by scientists that were uninformed about the studies performed in the other parts of the world. This is another contemporary view of the participants which may be the result of their informed minds about the rapid communication era.

Scientific ideas may be interpreted differently in one field than in another. Only a small portion of the preservice science teachers claimed that since all sciences are related to each other, scientific ideas refer to the same thing in nature, regardless of the discipline of the individual scientists. On the other hand about half of the participants claimed that scientific ideas may refer to different things in nature depending on the discipline. Yakmaci's study (1998) gave similar results such as that scientific ideas can have different meanings in various fields and a smaller amount claimed that a scientific idea would have the same meaning in all fields. This view is another contemporary view obtained from the results of the present study.

Finally we should keep in mind that all of the participants had taken many science courses starting from the primary education and went through the university education and more importantly they have taken the course of STS. All contemporary and traditional views obtained from the results must be evaluated under the light of this information.

5.2.Implications

Primary aim of science education is to train scientifically literate individuals for a healthy and developing society. To achieve that, science teachers must be scientifically literate person at first. The science-technology-society is one of the most important dimensions of scientific literacy. Therefore, science teachers must possess contemporary views about the science-technology-society. This study gives insights about the views of preservice science teachers on science-technology-society. According to the results of the present study, it may be concluded that preservice science teachers held inconsistent views on the science-technology-society issue. For this reason, some interventions must be made in order to improve the situation.

Students should be introduced with new concepts in a way that help them to relate abstract scientific knowledge with their daily lives.

STS education should be a part of the curriculum starting from primary schools and going through the university education.

During the life of education, students should be prepared to give decisions on socio-scientific issues. Classroom discussions on current socio-scientific problems should be part of the education at all levels.

Teacher training programs should be revised to improve their understanding of science-technology-society issue and the way that how this knowledge can be introduced to the students from any levels of education.

STS education should be given at schools and should be spread to all society. A conscious society brings conscious individuals to the education.

5.3. Recommendations

On the basis of findings of this study, the following recommendations can be given:

This study was conducted at only three different universities in Ankara. Thus to increase generalizability of the results, it is worth to conduct similar studies in different universities of Turkey.

In the study, the sample of students was preservice science teachers. It is also necessary to conduct researches on other grades such as primary and high school level, and public itself. Additionally, studies conducting with the people from other fields of study such as all natural and social sciences departments would be helpful to get much more information.

The present study displayed that there may be some problems about curriculum such as lack of the STS content. Thus another study can be conducted to explore these problems deeply and compare with other countries curricula.

This study was conducted with descriptive technique to investigate the views of preservice science teachers on science-technology-society. An inferential study can be conducted with a larger sample to support the findings of this study.

The general picture that we get from the results bears some implications for teacher training programs. These programs must give place to courses on philosophy and history of science and emphasize contemporary philosophies of science.

This study may be evaluated as one of the few studies which try to reveal preservice science teachers' views on science-technology-society in Turkey. By taking this one as a basis, some further studies are recommended. After this study, the first attempt may be to develop teacher education programs emphasizing the science-technology-society issue.

Moreover, researchers may attempt to assess the relationship between students', their science teachers' and their parents' views on science-technology-society in the future.

REFERENCES

Aikenhead, G. S. (1973). The measurement of high school students' knowledge about science and scientists. Science Education, 57(4), 539-549.

Aikenhead, G. S. (1987). High school graduates' beliefs about science-technology-society. III. Characteristics and limitations of scientific knowledge. Science Education, 71(4):459-487.

Aikenhead, G. S., Fleming, R.W., Ryan, A.G. (1987). High school graduates' beliefs about science-technology- society. I. Methods and issues in monitoring student views 1. Science Education, 71(2), 145-161.

Aikenhead, G. S., Fleming, R.W., Ryan, A.G. (1989). CDN 5 form of VOSTS, {Online}. Available: http://www.usask.ca/education/people/aikenhead/vosts.pdf {2002, November}

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.

Aikenhead, G. (1992). The integration of STS into science education. Theory into Practice, 31(1), 27-35.

Aikenhead, G. S. (1994).What is STS Science Teaching? In Joan Solomon and Glen Aikenhead (Ed.), STS Education: International Perspectives on Reform. New York: Teachers College Press.

Aikenhead, G. S. (1997). Toward a first nations cross-cultural science and technology curriculum. Science Education, Vol.81, Iss.2, p. 217, 22p.

Aikenhead, G. S. 1998. Many students cross cultural borders to learn science: implications for teaching. Australian Science Teachers Journal, Vol.44, Iss.4

Akerson, V. L., Khalick, F. A., Lederman, N. G. (2000). Influence of a reflective explicit activity-based approach on elementary teachers' conceptions of nature of science.Journal of Research in Science Teaching, vol. 37, no.4, 295-317.

Akindehin, F. (1988). Effect of an instructional package on preservice science teachers' understanding of the nature of science and acquisition of science-related attitudes. Science Education, 72(1), 73-82.

Alanso, A.V., Mas, M. A. M. (1999). Response and scoring models for the "views on science-technology-society" instrument. International Journal of Science Education Vol. 21,No.3, 231-247.

Aldridge, J., Taylor, P., Chen, C. (1997). Development, validation and use of the beliefs about science and school science questionnaire BASSSQ. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (NARST) 1997 Symposium, Chicago.

Bell, R., Khalick, F.A., Lederman, N.G., McComas, W., Matthews, M. R. (2001). The nature of science and education: BIBLIOGRAPHY. Science Education , 10, 187-204.

Bennett, J., Rollnick, M., Green, G., White, M. (2001). The development and use of an instrument to assess students' attitude to the study of chemistry. International Journal of Science Education, Vol.23, No 8, 833-845.

Bhaduri, S. (2003). Science, society, and technology-three cultures and multiple visions. Journal of Science Education and Technology, Vol.12, No.3, 303-308.

Bingle, W. H., Gaskell, P. J. (1994). Scientific Literacy for decision making and the social construction of scientific knowledge. Science Education, 78(2),185-201.

Botton, C., Brown, C. (1998). The reliability of some VOSTS items when used with preservice secondary science teachers in England. Journal of Research in Science Teaching, Vol.35, No.1, 53-71.

Bradford, C. S., Rubba, P. A. (1995). Views about Science-Technology-Society interactions held by college students in general education physics and STS course. Science Education, 79(4), 355-373.

Brickhouse, N. W., Dagher, Z. R., Letts, W. J., Shipman, H. L. (2000). Diversity of students' views about evidence, theory, and the interface between science and religion in an astronomy course. Journal of Research in Science Teaching, Vol.37,No.4, 340-362.

Bybee, R.W. (1987). Science Education and the science-technology-society (S-T-S) Theme. Science Education, 71(5), 667-683.

Bybee, R. W., Ellis, J. D., Matthews, M. R. (1992). Teaching about the history and the nature of science and technology: an introduction. Journal of research in science teaching, vol.29, no.4, 327-329.

Bybee, R. W., Powell, J. C., Ellis, J. D., Giese, J. R., Parisi, L., Singleyton, L. (1991). Integrating the history and nature of science and technology in science and social studies curriculum. Science Education, 75(1),143-155.

Cajas, F. (2001). The science/technology interaction: implications for science literacy. Journal of Research in Science Teaching, vol. 38, no.7, 715-729.

Cannon, J. R. (2000). Professional Development in Nevada: The Traveling Science Boxes Program of the Desert Research Institute. Electronic Journal of Science Education, Vol.5, No.2, December 2000.

Cheek, D. W. (1992). Evaluating Learning in STS Education. Theory into Practice, Vol. XXXI, Number 1, Winter, 1992.

Chen, C. C., Taylor, P. C., Alridge, J. M. (1997). Development of a questionnaire for assessing teachers' beliefs about science and science teaching in Taiwan and Australia. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (NARST) 1997 Symposium, Chicago.

Chisman, D. G. (1984). Science Education and national development. Science Education, 68(5), 563-569.

Cho, J. (2002). The development of an alternative in-service programme for Korean science teachers with an emphasis on science-technology-society. International Journal of Science Education, Vol.24, No. 10, 1021-1035.

Cobern, W. W. (1989). A comparative analysis of NOSS profiles on Nigerian and American preservice, secondary science teachers. Journal of Research in Science Teaching, Vol.26, No.6, 533-541.

Cobern, W. W. (1996). Worldview theory and conceptual change in science education. Science Education, 80(5), 579-610.

Cobern, W. W., Gibson, A. T., Underwood, S. A. (1999). Conceptualizations of nature : an interpretive study of 16 ninth graders' everyday thinking. Journal of Research in Science Teaching, vol36, no5, 541-564.

Cotham, J. C., Smith, E. L. (1981).Development and validation of the conceptions of scientific theories test. Journal of of Research in Science Teaching, Vol.18, no.5, 387-396.

Craven, J., Hand, B., Prain, V. (2002).Assessing explicit and tacit conceptions of the nature of science among preservice elementary teachers. International Journal of Science Education, Vol.24, No.8, 785-802.

Cross, R. T., Yager, R. E. (1998). Parents, social responsibility and science, technology and society (STS): a rationale for reform. Research in Science and Technological Education, Vol.16, Iss.1 Database: Academic search premier.

Cutcliffe, S. H., Mitcham, C. (2001). Visions of STS. New York: State University of New York.

Ebenezer, J. V., Zoller, U. (1993).Grade 10 Students' perceptions of and attitudes toward science teaching and school science. Journal of research in science Teaching, Vol.30, No.2, PP.175-186.

Fleming, R. (1987). High school graduates' beliefs about science-technology-society. II.The interaction among science, technology and society. Science Education, 71(2), 163-186.
Fraser, B. J. (1978). Development of a test of science related attitudes. Science Education, 62(4), 509-515.

Gallagher, J. J. (1991). Prospective and practicing science teachers' knowledge and beliefs about the philosophy of science. Science Education, 75(1), 121-133.

Gilbert, S.W. (1991). Model Building and a definition of science. Journal of Research in Science Teaching. Vol.28,no.1, 73-79.

Good, R., Herran, J. D., Lawson, A. E., Renner, J. W. (1985). The domain of science education. Science Education, 69(2),139-141.

Griffits, A. K., Barman, C. R. (1995). High school students' views about the nature of science: results from three countries. School Science and Mathematics, Vol.5, Issue 5.

Hand, R. J. (1999). Science education: consensus versus critique. Teacher in Higher Education, vol.4, ıssue 4.

Hodson, D. (1988). Toward a philosophically more valid science curriculum. Science Education, 72(1), 19-40.

Hodson, D. (1999). Going beyond cultural pluralism: science educational for sociopolitical action. Science Education, 83(6), 775-796.

Hughes, G. (2000). Marginalization of socioscientific material in science-technology-society science curricula: some implications for gender inclusivity and curriculum reform. Journal of research in science Teaching, Vol. 37, No.5, 426-440.

Kellough, R.D., Cangelosi, J.S., Collette, A.T., Chiapetta, E.L., Souviney, R., Trawbridge, L.W., and Bybee, R.W. (1996). Integrating Mathematics and Science for Intermediate and Middle School Students. New Jersey: Merril.

Khalick, F. A., Bell, R. L., Lederman, N. G. (1998). The nature of science and instructional practice: making the unnatural nature. Science Education, Vol82, Iss.4, 417-436.

Khalick, F. A., BouJaoude, S. (1997). An exploratory study of knowledge base for science teaching. Journal of Research in Science Teaching, Vol.34, No.7, 673-699.

Laforgia, J. (1988). The affective domain related to science education and its evaluation. Science Education 72(4), 407-421.

Latour, B. (2000). British Journal of Sociology. Vol.51, Iss.No.1, 107-124.

Laugksch, R. C., Spargo, P. E. (1996). Development of a pool of scientific literacy test-items based on selected AAAS literacy goals. Science Education, 80(2), 121-143.

Lawrence, C., Yager, R., Sowell, S., Hancock, E., Yalaki, Y., Jablon, P. (2001). The philosophy, theory and practice of science-technology-society orientations. Proceedings of the 2001 Annual International Conference of the Association for the Education of Teachers in Science.

Lederman, N. G. (1986). Relating teaching behavior and classroom climate to changes in students' conceptions of the nature of science. Science Education , 70(1), 3-19.

Lederman, N. G. (1992). Students' and teachers' conceptions of the nature of science: a review of the research. Journal of Research in Science Teaching, vol.29, no.4, 331-359.

Lederman, N. G. (1999). Teachers' understanding of the nature of science and classroom practices: factors that facilitate or impede the relationship. Journal of Research in Science Teaching,Vol.36, No.8, 916-929.

Lederman, N. G., Khalick, F. A.,Bell, R. L., Schwartz, R. S. (2002). Views of NOS questionnaire: toward valid and meaningful assessment of learners' conceptions of Nature of science. Journal of Research in Science Teaching, Vol.39, No.6, 497-521.

Lederman, N. G., O'Malley, M. (1990). Students' perceptions of tentativeness in science: development, use, and sources of change. Science Education, 74(2), 225-239.

Lederman, N., Wade, P., and Bell, R.L. (2000).Assessing Understanding of the Nature of Science: a historical Perspective. In McComas, W.F. (Ed.), The Nature of science in science education (pp.331-350). Dordrecht; Kluwer Academic.

Lederman, N. G., Zeidler, D. L. (1987). Science teachers' conceptions of the nature of science: do they really influence teaching behavior? Science Education, 71(5), 721-734.

Loving, C. C. (1991). The scientific theory profile: A philosophy of science model for science teachers. Journal of Research in Science Teaching, vol.28, no.9, 823-838.

May, W. T. (1992). What are the subjects of STS really? Theory into Practice, Vol. XXXI, Number, 1.

Mbajiorgu, N. M., Ali, A. (2001). Relationship between STS approach, scientific literacy, and achievement in biology. Science Education, V.87(1), 31-39.

McComas, W., Almazroa, H., Clough, M. P. (1998). The nature of science in science education: an introduction. Science Education, 7, 511-532.

McGinn, R. E. (1991). Science, technology and society. New Jersey: Prentice Hall.

McGinnis, J. R., Simmons, P. (1999). Teachers' perspectives of teaching science-technology- society in local cultures: a sociocultural analysis. Science Education, 83(2), 179-211.

Moss, D. M., Abrams, E. D., Robb, J. (2001). Examining student conceptions of the nature of science. International Journal of Science Education, vol.23, no.8, 771-790.

Munby, A. H. (1973). Some implications of language in science education. Science Education, 60(1), 115-124.

Pedretti, E. (1996). Learning about science, technology, and society (STS) through an action research project: co-constructing an issues-based model for STS education. School Science and Mathematics, Vol. 96, Iss.8.

Pomeroy, D. (1993). Implications of teachers' beliefs about the nature of science: comparison of the beliefs of scientists, secondary science teachers, and elementary teachers. Science Education, 77(3), 261-278.

Rankin, G. (1995). A challenge to the theory view of students' understanding of natural phenomena, Science Education, 79(6), 693-700.

Robinson, J. T. (1998). Reflections on "science teaching and the nature of science". Science Education, 7, 635-642.

Roth,W. M., Lucas, K. B. (1996). From "truth" to "invented reality": a discourse analysis of high school physics students' talk about scientific knowledge. Journal of Research in Science Teaching, vol.34, no.2, 145-179.

Rubba, P. A., Andersen, H. O. (1978). Development of an instrument to assess secondary school students' understanding of the nature of scientific knowledge. Science Education 62(4), 449-458.

Rubba, P. A., Schoneweg, B. C., Harkness, W. J. (1996). A new scoring procedure for the Views on science-technology-society instrument. International Journal of Science Education, 18, 387-400.

Ryan, A.G., Aikenhead, G. S. (1992). Students' preconceptions about the epistemology of science. Science Education, 76(6), 559-580.

Ryan, A. G. (1987). High school graduates' beliefs about science-technology-society. IV. The characteristics of scientists. Science Education 71(4), 489-510.

Ryder, J., Leach, J., Driver, R. (1999). Undergraduate science students' images of science. Journal of Research in Science Teaching, vol.36, no.2, 201-219.

Schwirian, P. M. (1968). On measuring attitudes toward science. Science Education, vol.52, no.2, 172-179.

Shiang-Yao, L., Lederman, N. G. (2002). Taiwanese gifted students' views of nature of science. School Science and Mathematics, Vol.102, Iss.3, 114-124.

Solbes, J., Vilches, A. (1997). STS Interactions and the teaching of physics and chemistry. Science Education, 81(4), 377-386.

Solomon, J., Aikenhead, G. (1994). STS Education: International perspectives on reform. Teacher Collage Press, New York

Solomon, J., Scott, L., Duveen, J. (1996). Large-scale exploration of pupils' understanding of the nature of science. Science Education, 80(5), 493-508.

Splittgerber, F. (1991). Science-technology-society themes in social studies: historical perspectives. Theory into Practice, Vol. XXX.

Tairab, H. H. (2001). How do preservice and in-service science teachers view the nature of science and technology. Research in Science &Technological Education, Vol.19, No.2.

Thier, H. D. (1985). Societal Issues and concerns: A new emphasis for science education. Science Education, 69(2), 155-162.

TIMSS, (1999). http://timss.bc.edu/timss1999.html {Online}. Available: {2004, January}

Tsai, C. C. (1998). An analysis of scientific epistemological beliefs and learning orientations of Taiwanese Eight graders. Science Education, 82, 473-489.

Tsai, C. C. (1999). The progression toward constructivist epistemological views of science: a case study of the STS instruction of Taiwanese high school female students. International Journal of Science Education, Vol.21, No.11, 1201-1222.

Tsai, C. C. (2000). The effects of STS-oriented instruction on female tenth graders' cognitive structure outcomes and the role of student scientific epistemological beliefs. International Journal of Science Education, vol.22, no.10, 1099-1115.

Vilches, A., Solbes, J. (1997). STS Interactions and the teaching of physics and chemistry. Science Education, 81(4), 377-386.

Wiley, D. A. (1991). Implementing a one-year science-technology-society course. The Clearing House, vol 65, No 2, 102-104.

Yager, R. E. (1983). Editorial. Defining science education as a discipline. Journal of Research in Science Teaching, Vol.20,No.3, 261-262.

Yager, R. E. (1984). Defining the discipline of science. Science Education 68(1), 35-37.

Yager, R. E. (1985). In defense of defining science education as the science/society interface. Science Education, 69(2), 143-144.

Yager, R. (1990). Science student teaching centers. Journal of Science Teacher Education, 1(4), 61-65.

Yager, R. E. (1993). Science-technology-society as reform. School Science and Mathematics. Volume93(3), March 1993, 145-151.

Yager, R. E. (2000a). The history and future of science education reform. The Clearing House, Vol.74, No.1, 51-54.

Yager, R. E. (2000b). A vision for what science education should be like for the first 25 years of a new millenium. School Science and Mathematics, Vol.100(6), 327-341.

Yager, R.E. (2001). Science-Technology-Society and Education: a focus on learning and how persons know. Cutclife, S.H., Mitcham, C. (Ed.). Visions of STS (pp.81-97). New York, State University of New York.

Yager, R. E., Lutz, M. V. (1995). STS to enhance total curriculum. School Science & Mathematics, Vol.95, Iss1. database academic search premier.

Yager, R. E., Pennick, J. E. (1984). What students say about science technology and science teachers. Science Education, 68(2), 143-152.

Yager, R., Tamir, P. (1993). STS Approach: Reasons, Intentions, Accomplishments, and Outcomes. Science Education, 77(6), 637-658.

Yager, R. E., Zehr, E. (1985). Science Education in US graduate institutions during two decades 1960-1980. Science Education. 69(2), 163-169.

Yakmacı, B. (1998). Views on Nature of Science. Unpublished master thesis, Bosphorus University.

Yalvaç, B., Crawford, B. A. (2002). Eliciting prospective science teachers' conceptions of the nature of science in Middle East Technical University (METU), in Ankara. Proceedings of the 2002 Annual International Conference of the Association for the Education of Teachers in Science.

Zeidler, D. L., Walker, K. A., Ackett, W. A., Simmons, M. L. (2001). Tangled up in views: beliefs in the nature of science and responses to socioscientific dilemmas. Science Education, 86, 343-367.

APPENDIX A

1. Bilimi tanımlamak zordur; çünkü bilim, karmaşıktır ve birçok konuyla ilgilidir. Fakat bilim asıl olarak:

A. Biyoloji, fizik ve kimya gibi alanlardır.
B. Yaşadığımız dünyayı (maddeyi, enerjiyi ve yaşamı) açıklayan prensipler, kanunlar ve teoriler gibi bilgilerdir.
C. Dünyamız ve evren hakkında bilinmeyenleri araştırmak, yeni şeyleri ve nasıl çalıştıklarını keşfetmektir.
D. Yaşadığımız çevrenin problemlerini çözmek için deneyler yapmaktır.
E. Bir şeyler icat etmek ya da tasarlamaktır (yapay kalpler, bilgisayarlar ve uzay araçları gibi).
F. Bu dünyayı yaşam için daha iyi bir yer yapmada gerekli olan bilgiyi bulma ve kullanmadır (hastalıkları tedavi etmek, kirliliği çözümlemek ve tarımı geliştirmek gibi).
G. Yeni bilgileri keşfetmek için fikir ve tekniklere sahip olan insanların (yani bilim adamlarının) bir araya gelmesidir.

H. Hiç kimse bilimi tanımlayamaz.

I. Anlamadım
J. Bir seçim yapmak için yeterli bilgiye sahip değilim.
K. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

2. Teknoloji Türkiye'de pek çok şey yaptığı için onu tanımlamak zordur.
Fakat teknoloji asıl olarak:

A. Bilime çok benzer.
B. Bilimin uygulamasıdır.
C. Günlük kullanım için yeni yöntemler, araçlar, makineler, bilgisayarlar ya da pratik aletlerdir.
D. Robotlar, elektronik araçlar, bilgisayarlar, iletişim sistemleri veya otomasyondur.
E. Bir şeyleri yapma tekniği ya da gündelik problemleri çözme yoludur.
F. İcat etmek, tasarlamak ve bir şeyleri test etmektir (örneğin yapay kalpleri, bilgisayarları, uzay araçlarını).
G. Bir şeyleri tasarlamak ya da imal etmek, işçileri, iş adamlarını ve kadınlarını, tüketicileri organize etmek ve toplumu geliştirmek için gerekli olan fikirler ve tekniklerdir.

H. Anlamadım.
I. Bir seçim yapmak için yeterli bilgiye sahip değilim.
J. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

3. Bilim ve teknoloji birbiriyle yakından ilgilidir.

A. Her ne kadar teknolojinin bilime olan yardımını görmek zor olsa da **bilim ve teknoloji birbiriyle yakından ilgilidir;** çünkü teknolojik gelişmelerin temeli bilimdir.
B. **Bilim ve teknoloji birbiriyle yakından ilgilidir;** çünkü bilimsel araştırmalar teknolojideki gelişmelere rehberlik eder ve teknolojik gelişmeler de bilimsel araştırmaları hızlandırır.
C. **Bilim ve teknoloji birbiriyle yakından ilgilidir**; çünkü farklılıklarına rağmen, birbirlerine sıkıca bağlandıklarından ayrı olduklarını söylemek zordur.
D. Her ne kadar teknolojinin bilime olan yardımını görmek zor da olsa **bilim ve teknoloji birbiriyle yakından ilgilidir;** çünkü teknoloji bütün bilimsel gelişmelerin temelidir.

E. Teknoloji ve bilim hemen hemen aynı şeydir.

F. Anlamadım.
G. Bir seçim yapmak için yeterli bilgiye sahip değilim.
H. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

4. Türkiye Cumhuriyeti hükümetinin bilim adamlarına doğada ve evrende merak edilenleri araştırıp bulmak için parasal destek vermesi gerekmektedir.

A. Türkiye diğer ülkelerin gerisinde kalmasın ve onlara bağımlı olmasın diye, **bilimsel araştırmalar için para harcanmalıdır.**

B. İnsanın bilimsel merakını uyandıran içgüdüyü tatmin etmek için **paranın bilimsel araştırmalara harcanması gerekir**.

C. Genellikle araştırmanın yararlı olup olmadığını söylemek imkansızdır; ama yine de **bilimsel araştırmalar için para harcanması gerekir,** çünkü bu almamız gereken bir yatırım riskidir.

D. **Bilimsel araştırmalar için para harcanması gerekir;** çünkü bilim adamları, dünyamızı daha iyi anlayarak (örneğin doğanın kaynaklarını ve çevreyi en yararlı şekilde kullanarak) yaşamak için daha iyi bir yer haline getirebilirler.

E. **Para,** sadece doğrudan sağlığımızla (özellikle hastalıkların tedavisiyle), çevremizle ya da tarımla ilgili ise **bilimsel araştırmalar için harcanmalıdır**.

F. Bilimsel araştırmalar için ya az para harcanmalı ya da hiç para harcanmamalıdır, çünkü para Türkiye'deki işsizlere, ihtiyacı olanlara ya da diğer fakir ülkelere yardım gibi amaçlar için harcanmalıdır.

G. Anlamadım.

H. Bir seçim yapmak için yeterli bilgiye sahip değilim.

I. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

5. Bazı toplumların, doğa ve insan üzerine belirli görüşleri vardır. Bilim adamları ve bilimsel araştırmalar, çalışmanın yapıldığı yerdeki kültürün dini ya da ahlaki görüşlerinden etkilenirler.

A. **Dinî ya da ahlaki görüşler bilimsel araştırmaları etkiler;** çünkü bazı toplumlar kendi yararları için araştırmaların yapılmasını isterler.
B. **Dinî ya da ahlaki görüşler bilimsel araştırmaları etkiler;** çünkü bilim adamları farkında olmadan kendi kültürlerinin bakış açısını destekleyen araştırmaları seçebilirler.
C. **Dinî ya da ahlaki görüşler bilimsel araştırmaları etkiler;** çünkü birçok bilim adamı kendi inançlarına ve yetiştiriliş tarzlarına uymayan araştırmaları yapmazlar.
D. **Dinî ya da ahlaki görüşler bilimsel araştırmaları etkiler;** çünkü herkes kendi kültürüne farklı şekilde tepki verir. Bu bireysel farklılıklar, yapılan araştırmanın türünü etkiler.
E. **Dinî ya da ahlaki görüşler bilimsel araştırmaları etkiler;** çünkü belirli bir dini, politik ya da kültürel inanışı temsil eden güçlü gruplar, belirli araştırma projelerini destekleyecek ya da belirli araştırmaların yapılmasını engellemek için para verecektir.

F. **Dinî ya da ahlaki görüşler bilimsel araştırmaları etkilemez;** çünkü araştırmalar, bilim adamları ve belirli dini ya da kültürel gruplar arasındaki tartışmalara rağmen devam eder (örneğin, evrim ve yaratılış tartışmaları).
G. **Dinî ya da ahlaki görüşler bilimsel araştırmayı etkilemez;** çünkü bilim adamları kültürel ve ahlaki görüşleri dikkate almayarak, bilim ve bilim adamları için önemli olan konuları araştıracaklardır.

H. Anlamadım.
I. Bir seçim yapmak için yeterli bilgiye sahip değilim.
J. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

6. Türkiye'deki bilim ve teknolojinin başarısı, halkın bilim adamlarına, mühendislere ve teknisyenlere ne kadar destek verdiğine bağlıdır. Bu destek Türkiye'de bilim ve teknolojinin nasıl kullanıldığını öğrenen öğrencilere yani gelecekteki toplumu oluşturacak olan bireylere bağlıdır.

A. **Evet**, öğrenciler bilim ve teknoloji hakkında ne kadar çok şey öğrenirlerse ülke o kadar gelişecektir. Öğrenciler geleceğimizdir.
B. **Evet**, öğrenciler bilim ve teknoloji hakkında ne kadar çok şey öğrenirlerse aralarından o kadar fazla sayıda bilim adamı, mühendis ve teknisyen çıkacak, böylece Türkiye zenginleşecektir.
C. **Evet**, öğrenciler bilim ve teknoloji hakkında ne kadar çok şey öğrenirlerse o kadar bilgili olacak, daha iyi fikirler oluşturacak ve teknoloji ile bilimin nasıl kullanılacağı konusunda daha iyi katkı sağlayacaklardır.
D. **Evet**, öğrenciler bilim ve teknoloji hakkında ne kadar çok şey öğrenirlerse toplum, bilim ve teknolojinin önemini o kadar iyi kavrayacak; uzmanların görüşlerini daha iyi anlayacak, bilim ve teknoloji için gerekli desteği sağlayacaktır.

E. **Hayır**, halkın bilim adamlarına, mühendislere ve teknisyenlere verdiği destek, öğrencilerin bilim ve teknolojiyi daha çok öğrenmelerine bağlı değildir. Bazı öğrenciler bilim konularıyla ilgilenmez.

F. Anlamadım.
G. Bir seçim yapmak için yeterli bilgiye sahip değilim.
H. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

7. Bazı toplumlar diğer toplumlara göre daha çok bilim adamı yetiştiriyor. Bu durum, ailelerin, okulun ve toplumun çocukları yetiştirme tarzından kaynaklanmaktadır.

A. **Yetiştirme tarzı çok önemli bir faktördür;** çünkü bazı toplumlar (örneğin, Adapazarı gibi endüstriyel şehirler) diğerlerine göre bilime daha fazla önem verir.
B. **Yetiştirme tarzı çok önemli bir faktördür;** çünkü bazı aileler çocuklarını soru sormaya ve meraka teşvik eder. Aileler hayatımız boyunca taşıyacağımız tüm değerleri öğretirler.
C. **Yetiştirme tarzı çok önemli bir faktördür;** çünkü bazı öğretmenler ve okullar diğerlerine göre daha iyi fen dersleri verir ya da öğrencileri daha çok öğrenmek için teşvik eder.
D. **Yetiştirme tarzı en önemli faktördür;** çünkü aile, okullar ve toplum çocuklara bilimsel beceri kazandırır: bilim adamı olmak için cesaret ve fırsat verir.

E. **Bir şey söylemek zordur**. Yetiştirme tarzının kesin olarak etkisi vardır, fakat kişinin kendisi de önemlidir (örneğin, zeka, yetenek ve bilime olan doğal ilgi).Yetiştirme tarzı ve birey aynı oranda etkilidir.

F. **Çoğunlukla zeka, yetenek ve bilime olan ilgi kimin bilim adamı olacağını belirlemede etkilidir**. Bununla birlikte yetiştirme tarzının da etkisi vardır.
G. **Çoğunlukla zeka, yetenek ve bilime olan ilgi etkilidir;** çünkü insanlar bu özelliklerle doğarlar.

H. Anlamadım.
I. Bir seçim yapmak için yeterli bilgiye sahip değilim .
J. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

8. Birçok Türk bilim adamı, buluşlarının doğuracağı sonuçların potansiyel etkileriyle (yararlı ve zararlı) ilgilenmektedir.

A. Bilim adamları buluşları yaparken ya da bu buluşları uygularken, **sadece faydalı yönleri** ile ilgilenirler.
B. Bilim adamları buluşlarının olası **zararlı etkileri** ile daha fazla ilgilenirler, çünkü bilimin amacı dünyayı yaşanabilecek daha iyi bir yer haline getirmektir. Bu nedenle bilim adamları buluşların zararlı etkilerinin oluşmasını önlemek için çalışırlar.
C. Bilim adamları deneylerinin **bütün etkileri** ile ilgilidirler. Çünkü bilimin amacı dünyayı yaşanabilecek daha iyi bir yer haline getirmektir. İlgili olmak bilimin doğal bir parçasıdır çünkü bilim adamlarının kendi buluşlarını anlamalarına yardımcı olur.
D. Bilim adamları deneylerinin etkileri ile ilgilidirler. Fakat muhtemelen buluşlarının **tüm uzun vadeli etkilerini tahmin edemezler.**
E. Bilim adamları deneylerinin etkileri ile ilgilidirler. Fakat buluşlarının tehlikeli amaçlar için kullanılıp kullanılmayacağını **pek fazla kontrol edemezler.**
F. **Bilimin dallarına bağlıdır**. Örneğin, Türk bilim adamları en çok tıp alanıyla en az nükleer güç ve askeri araştırmalar konularıyla ilgilidirler.
G. Bilim adamları deneylerinin etkilerini dikkate alırlar, fakat bu durum onların, kendi gelecekleri, ünleri veya sadece zevkleri için buluş yapmalarını engellemez.

H. Anlamadım.
I. Bir seçim yapmak için yeterli bilgiye sahip değilim.
J. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

9. Bilim adamları ve mühendisler, nükleer reaktörlerin inşa edilip edilemeyeceğine veya edilecekse nerede inşa edilmesi gerektiğine karar vermesi gereken kişilerdir, çünkü gerçekleri en iyi bilenler, bilim adamları ve mühendislerdir.

A. **Bilim adamları ve mühendislerin karar vermeleri gerekir;** çünkü onların konuyu daha iyi anlamalarını sağlayan eğitim ve bilgileri vardır.
B. **Bilim adamları ve mühendislerin karar vermeleri gerekir;** çünkü onlar bilgi sahibidirler, finansal ve kişisel anlamda bu işe ilgi duyan hükümet bürokratlarından ya da özel şirketlerden daha iyi karar verebilirler.
C. **Bilim adamları ve mühendislerin karar vermeleri gerekir;** çünkü onlar konuyu daha iyi anlamalarını sağlayan eğitim ve bilgiye sahiptirler, fakat toplum da ya bilgilendirilerek ya da danışılarak bu sürece katılmalıdır.

D. Kararların **eşit olarak** alınması gerekir. Toplumu etkileyen kararlarda bilim adamlarının ve mühendislerin, diğer uzmanların ve bilgilendirilmiş toplumun görüşlerinin hepsi dikkate alınmalıdır.
E. **Hükümetin** karar vermesi gerekir; çünkü bu konu temelde politiktir. Bilim adamları ve mühendisler önerilerde bulunmalıdır.
F. **Toplumun** karar vermesi gerekir; çünkü bu karar herkesi etkileyecektir, bilim adamları ve mühendisler önerilerde bulunmalıdır.
G. **Toplumun** karar vermesi gerekir; çünkü toplum, bilim adamlarını ve mühendisleri kontrol etmekle görevlidir. Bilim adamları ve mühendisler konu hakkında idealist ve dar bir bakış açısına sahiplerdir ve bu nedenle nükleer reaktör inşasının sonuçlarına pek fazla dikkat etmezler.

H. Anlamadım.
I. Bir seçim yapmak için yeterli bilgiye sahip değilim.
J. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

10. Bilim adamları herhangi bir gündelik problemi en iyi şekilde çözebilirler (örneğin bir arabayı hendekten çıkarma, yemek yapma ya da evcil bir hayvana bakma). Çünkü bilim adamları diğer insanlardan daha bilgilidirler.

A. Bilim adamları herhangi bir pratik problemi çözmede diğer insanlardan daha iyilerdir. Mantıklı problem çözme düşünceleri ya da özelleşmiş bilgileri, problemleri çözerken onlara avantaj sağlar .

B. Bilim adamları herhangi bir gündelik problemi çözmede diğer insanlardan daha iyi değillerdir; çünkü fen bilgisi dersleri herkese yeterince problem çözme yeteneği ve pratik problemleri çözme bilgisi verir.
C. Bilim adamları herhangi bir gündelik problemi çözmede diğer insanlardan daha iyi değillerdir; çünkü genelde bilim adamlarının eğitimi günlük sorunları çözmede yardımcı olmaz.
D. Bilim adamları herhangi bir gündelik problemi çözmede diğer insanlardan daha iyi değillerdir; çünkü gündelik yaşamda bilim adamları da herkes gibidir. Gündelik problemleri deneyim ve sağduyu çözer.

E. Bilim adamları herhangi bir gündelik problemi çözmede büyük bir ihtimalle diğer insanlardan daha kötüdür; çünkü onlar karmaşık bir dünyada gündelik yaşamdan uzak olarak çalışırlar.

F. Anlamadım.
G. Bir seçim yapmak için yeterli bilgiye sahip değilim.
H. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

11. Türkiye'nin bilim ve teknolojisi ne kadar çok gelişirse, o kadar refah içinde olacaktır.

A. **Bilim ve teknoloji Türkiye'nin zenginliğini artıracaktır;** çünkü bilim ve teknoloji çok daha fazla verimlilik, üretim ve gelişme getirir.

B. **Bilim ve teknoloji Türkiye'nin zenginliğini artıracaktır;** çünkü daha fazla bilim ve teknoloji, Türkiye'yi diğer ülkelere daha az bağımlı yapar ve bu şekilde daha fazla şeyi kendimiz üretebiliriz.

C. **Bilim ve teknoloji Türkiye'nin zenginliğini artıracaktır;** çünkü bu şekilde Türkiye kâr için yeni fikirleri ve teknolojiyi diğer ülkelere satabilir.

D. Bu hangi bilim ve teknolojiye harcama yapıldığına bağlıdır. Bazı sonuçlar risklidir. Bilim ve teknolojinin yanında Türkiye'ye zenginlik getirecek başka yollar da olabilir.

E. Bilim ve teknoloji Türkiye'nin zenginliğini **azaltır** çünkü bilim ve teknolojiyi geliştirmek büyük miktarda paraya mâl olur.

F. Anlamadım.

G. Bir seçim yapmak için yeterli bilgiye sahip değilim.

H. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

12. Dünyanın güçlü ülkeleri, üstün bilim ve teknolojilere sahip oldukları için, güçlü bir orduya da sahiplerdir.

A. **Güçlü bir ordu büyük ölçüde bilim ve teknolojiye bağlıdır;** çünkü bilim ve teknolojideki gelişmeler ne kadar büyük olursa, silahlar da daha modern, daha mükemmel ve daha yıkıcı olur.
B. **Güçlü bir ordu büyük ölçüde bilim ve teknolojiye bağlıdır;** çünkü silahlı kuvvetler genellikle hükümette belli bir güce sahiptir ve ordu, kendi gücünü oluşturmak için bilim ve teknolojinin kullanılmasında ısrar eder.
C. **Güçlü bir ordu büyük ölçüde bilim ve teknolojiye bağlıdır;** çünkü ülkenin bilim ve teknolojisi ne kadar ileri olursa, o ülke o kadar zengin olur. Böyle bir ülkenin parası, orduyu güçlendirmek için harcanabilir.

D. Bir ülkenin askeri gücü sadece güçlü silahlar için bilim ve teknolojiye dayanmaz. Bunun yanı sıra o ülkenin **silahlı kuvvetlerinin büyüklüğüne** de bağlıdır.
E. Askeri güç **kısmen** bilim ve teknolojiye, **kısmen** de hükümetlerin gücünü artırmak için yeni silahlar üretme kararına bağlıdır.
F. Askeri güç, bilim ve teknolojiye değil, **hükümete bağlıdır**. Bilim ve teknolojide güçlü olan bazı ülkeler (örneğin Japonya) zayıf bir orduya sahiptir. Bilim ve teknolojide güçsüz olan bazı ülkeler (örneğin Çin) ise güçlü bir orduya sahiptir.

G. Anlamadım.
H. Bir seçim yapmak için yeterli bilgiye sahip değilim.
I. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

13. Başarılı bilim adamları daima çalışmalarında **çok açık fikirli, mantıklı, önyargısız ve tarafsızdırlar**. Bu kişisel özellikler bilimi en iyi şekilde uygulamak için gereklidir.

A. **Başarılı bilim adamları bu özellikleri taşırlar**. Aksi halde bilim kötüye gidecektir.
B. **Başarılı bilim adamları bu özellikleri taşırlar**, çünkü bu özellikleri ne kadar fazla taşırsanız, bilimi o kadar iyi yaparsınız.
C. **Bu özellikler yeterli değildir**. Başarılı bilim adamlarının hayal gücü, zeka ve dürüstlük gibi diğer kişisel özelliklere de sahip olmaları gerekir.

D. **Başarılı bilim adamlarının bu kişisel özelliklere sahip olması şart değildir;** çünkü bazen en iyi bilim adamları kendi alanlarıyla öyle yoğun uğraşırlar ki çalışmalarında her zaman mantıklı olamayabilirler ve bazen yeni fikir ve görüşlere açık olmayabilirler.
E. **Başarılı bilim adamlarının bu kişisel özelliklere sahip olması şart değildir;** çünkü bu kişisel olarak bilim adamlarına bağlıdır. Bazıları çalışmalarında daima açık fikirli, tarafsız iken bazıları saplantılı ve taraflıdır.

F. Başarılı bilim adamları bu kişisel özelliklere herhangi bir bilim adamından daha fazla sahip değillerdir. Bu özellikler iyi bilim yapmak için **şart değildir**.

G. Anlamadım.
H. Bir seçim yapmak için yeterli bilgiye sahip değilim.
I. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

14. Bugün eskiden olduğundan çok daha fazla sayıda bilimle uğraşan kadın vardır. Bu, yapılan bilimsel buluşlarda bir farka neden olur. Kadınlar tarafından yapılan bilimsel buluşlar, erkekler tarafından yapılanlardan farklı olacaktır.

A. **Kadın ve erkek bilim insanlarının yaptıkları keşifler arasında fark yoktur;** çünkü herhangi iyi bir bilim insanı kesinlikle diğer iyi bilim insanlarıyla aynı buluşu yapacaktır.
B. **Kadın ve erkek bilim insanlarının yaptıkları keşifler arasında fark yoktur;** çünkü kadın ve erkek bilim insanları aynı eğitimi alır.
C. **Kadın ve erkek bilim insanlarının yaptıkları keşifler arasında fark yoktur;** çünkü genelde kadın ve erkek eşit derecede zekidir.
D. **Kadın ve erkek bilim insanlarının yaptıkları keşifler arasında fark yoktur;** çünkü bilimde keşfetmek istedikleri konular açısından kadın ve erkek aynıdır.
E. **Kadın ve erkek bilim insanlarının yaptıkları keşifler arasında fark yoktur;** çünkü araştırma hedefleri, bilim insanlarının yanı sıra bilim insanları dışından insanların da talep ve arzularıyla belirlenir.
F. **Kadın ve erkek bilim insanlarının yaptıkları keşifler arasında fark yoktur;** çünkü yaptıkları ne olursa olsun, herkes eşittir.
G. **Kadın ve erkek bilim insanlarının yaptıkları keşifler arasında fark yoktur;** çünkü buluşları arasındaki herhangi bir fark, aralarındaki bireysel farktan dolayıdır. Bu tür farklar kadın ya da erkek olmakla ilgili değildir.

H. **Kadınlar oldukça değişik buluşlar yapacaktır**; çünkü doğaları ve yetiştirilmeleri ile kadınlar farklı değerlere, bakış açılarına, perspektiflere veya özelliklere (örneğin sonuçlara duyarlılık) sahiptirler.
I. **Erkekler oldukça farklı buluşlar yapacaklardır**; çünkü erkekler bilimde kadınlardan daha iyidirler.
J. **Kadınlar erkeklerden daha iyi buluşlar yapabileceklerdir**; çünkü kadınlar genelde hafıza ve içgüdü gibi şeylerde erkelerden daha iyidirler.

K. Anlamadım.
L. Bir seçim yapmak için yeterli bilgiye sahip değilim.
M. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

15. Bilim adamlarının çalışmalarını bilimsel dergilerde yayınlamalarının amacı, bu araştırmaları destekleyen kurumların ve diğer bilim adamlarının gözünde kendi değerlerini ve başarılarını kanıtlamaktır. Bu durum onların kendi kariyerlerinde uzmanlaşmasını sağlar.

A. Bilim adamları çalışmalarını temelde **kendi başarılarına güven sağlamak, daha iyi tanınmak ya da herhangi bir başarıdan kar sağlamak için** yayınlar. Eğer bilim adamları bu kişisel çıkarları inkar etselerdi bilim ilerleyemezdi.
B. Bilim adamları kendi çalışmalarını **bu çalışmalardan yarar sağlamak , birbirlerinin fikirlerini paylaşmak ve birbirlerinin çalışmalarıyla gelişerek bilim ve teknolojinin ilerlemesini sağlamak için** yayınlar.
C. Bilim adamları kendi buluşlarını temelde **bilim ve teknolojinin ilerlemesini sağlamak için** yayınlarlar. Bilim adamları, fikirlerini yayınlayarak birbirlerinin çalışmalarını geliştirirler. Bu iletişim olmadan, bilimin ilerlemesi mümkün olmaz.
D. Bilim adamları kendi buluşlarını, **diğer bilim adamlarının bu çalışmaları değerlendirmeleri için** yayınlarlar. Bu değerlendirmeler, bilimin doğru sonuçlara dayanarak ilerlemesini sağlar.
E. Bilim adamları kendi buluşlarını **diğer bilim adamları değerlendirsin diye ve onlarla fikirlerini paylaşmak için** yayınlarlar.
F. Bilim adamları kendi buluşlarını temelde **dünyanın her tarafındaki bilim adamlarına yardımcı olması için** yayınlarlar. İyi iletişim, yapılan çalışmaların diğer bilim adamları tarafından tekrarını önler ve bilimin ilerlemesini hızlandırır.
G. Bilim adamları kendi buluşlarını, **herkesi son buluşlar hakkında bilgilendirmek, bilim ve teknolojinin iyi bir iletişim yoluyla ilerlemesini sağlamak için** yayınlarlar.

H. Anlamadım.
I. Bir seçim yapmak için yeterli bilgiye sahip değilim.
J. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

16. Bilim adamları, araştırmalarına maddi destek sağlayan kurumlardan bu desteği almak için ve bir buluşu yapan ilk kişi olmak için yarışırlar. Bazen bu acımasız yarış, bilim adamlarının gizlilik içinde davranmasına, başka bilim adamlarının fikirlerini çalmalarına ve para için kulis yapmalarına yol açar. Diğer bir değişle, bazen bilim adamları (paylaşma, dürüstlük, bağımsızlık gibi) bilimin kurallarını çiğnerler.

A. **Bazen bilim adamları, bilimin kurallarını çiğnerler;** çünkü başarıya ulaşmayı sağlayacak yol budur. Rekabet, bilim adamalarını daha sıkı çalışmaya iter.
B. **Bazen bilim adamları bilimin kurallarını** kişisel ve parasal ödüllere ulaşmak için **çiğnerler**. Bilim adamları gerçekten istedikleri şey için yarıştıklarında, onu elde etmek için yapabilecekleri her şeyi yaparlar.
C. **Bazen bilim adamları** çözüme ulaşmak için **bilimin kurallarını çiğnerler**. Onlar için çözümleri işe yaradığı sürece onu nasıl elde ettikleri önemli değildir.

D. Bazen bilim adamları bilimin kurallarını **duruma bağlı olarak çiğnerler**. Bilim diğer mesleklerden farklı değildir. Bazıları ilerlemek için kuralları çiğneyecek, diğerleri çiğnemeyecektir.
E. Birçok bilim adamı birbiriyle **yarışmaz** . Bilim adamları için başarıya ulaşmanın en iyi yolu, bilimin kurallarını izlemek ve iş birliği yapmaktır.

F. Anlamadım.
G. Bir seçim yapmak için yeterli bilgiye sahip değilim.
H. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

17. Bilim adamı tenis oynayabilir, partilere gidebilir ya da konferansa katılabilir. Bu sosyal ilişkiler, bilim adamının çalışmasını etkileyeceği için bu çalışmanın içeriğini de etkileyebilir.

A. **Sosyal ilişkiler buluşun içeriğini etkileyebilir;** çünkü bilim adamları etkileşim içinde oldukları insanların fikirlerinden, deneyimlerinden ve heveslerinden yararlanır.
B. **Sosyal ilişkiler buluşun içeriğini etkileyebilir;** çünkü bu ilişkiler, dinçleştirici özelliğiyle -bilim adamı için bir ara görevi yaparak- bilim adamını canlı tutar.
C. **Sosyal ilişkiler buluşun içeriğini etkileyebilir;** çünkü bu ilişkiler, bilim adamlarını insanlar tarafından toplumun ihtiyaçlarıyla ilgili araştırmalar yapmaya teşvik eder.
D. **Sosyal ilişkiler buluşun içeriğini etkileyebilir;** çünkü sosyal ilişkiler, bilim adamlarının insan davranışlarını ve diğer bilimsel olayları gözlemesini sağlar.

E. **Sosyal ilişkiler buluşun içeriğini etkilemez**; çünkü bilim adamının çalışmalarının sosyalleşmeyle herhangi bir ilgisi yoktur.

F. Anlamadım.
G. Bir seçim yapmak için yeterli bilgiye sahip değilim.
H. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

18. Farklı ülkelerde eğitim almış bilim adamları, bilimsel bir probleme farklı açılardan bakarlar. Bu, bir ülkenin eğitim ve kültür sisteminin bilim adamının ulaşacağı sonuçları etkileyebileceği anlamına gelir.

A. **Bir ülkenin eğitim ve kültür sistemi bilim adamlarının ulaşacağı sonuçları etkiler;** çünkü eğitim ve kültür, bilimsel bir problemi düşünme tarzı dahil hayatın tüm alanlarını etkiler.
B. **Bir ülkenin eğitim ve kültür sistemi, bilim adamlarının ulaşacağı sonuçları etkiler;** çünkü her ülke, bilim eğitimi için farklı sistemlere sahiptir. Bilim adamlarına problemleri çözmek için öğretilen yol, bilim adamlarının ulaşacağı sonuçları etkiler.
C. **Bir ülkenin eğitim ve kültür sistemi, bilim adamlarının ulaşacağı sonuçları etkiler;** çünkü ülkenin yönetimi ve endüstrisi sadece kendi ihtiyaçlarına uyan projeler için maddi destek verir. Bu, bilim adamının neyi araştıracağını etkiler.

D. Bu **duruma göre değişir**. Bir ülkenin bilim adamlarını eğitme şekli, bazı bilim adamlarının düşünme tarzını etkiler. Fakat başka bilim adamları da kişisel görüşlerine dayanarak problemlere kişisel yolla bakabilirler.

E. **Bir ülkenin eğitim ve kültür sistemi, bilim adamlarının ulaşacağı sonuçları etkilemez çünkü** bilim adamları içinde eğitildikleri toplum ne olursa olsun, problemlere kişisel yolla bakarlar.
F. **Bir ülkenin eğitim ve kültür sistemi, bilim adamlarının ulaşacağı sonuçları etkilemez çünkü** tüm dünyadaki bilim adamları benzer sonuçlara götüren aynı bilimsel yöntemi kullanırlar.

G. Anlamadım.
H. Bir seçim yapmak için yeterli bilgiye sahip değilim.
I. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

19. Yeni bir teknoloji geliştirildiğinde (örneğin yeni bir bilgisayar) uygulamaya konabilir ya da konmayabilir. Yeni bir teknolojinin kullanılması kararı, temelde bu teknolojinin ne kadar iyi çalıştığına bağlıdır.

A. Yeni bir teknolojiyi kullanma kararı temelde onun **ne kadar iyi çalıştığına bağlıdır**. İyi çalışmayan bir şeyi kullanmazsınız.
B. Karar, **bir çok şeye bağlıdır,** örneğin maliyetine, toplum için faydasına, kullanışlı olup olmadığına, yeterliliğine ve insan gücü kullanımındaki etkisine.

C. **Karar, teknolojinin ne kadar iyi çalıştığına değil**, maliyetine bağlı olabilir.
D. **Karar, teknolojinin ne kadar iyi çalıştığına değil**, toplumun ne istediğine ve ihtiyacına bağlıdır.
E. **Karar, teknolojinin ne kadar iyi çalıştığına bağlı değil** insanlara yardım edip etmemesine ve olumsuz etkisi olup olmamasına bağlıdır. Yeni teknolojiler zararlı ise kullanılmaz.
F. **Karar, teknolojinin ne kadar iyi çalıştığına bağlı olmayabilir;** ama hükümetin destekleyip desteklememesine bağlıdır.
G. **Karar, teknolojinin ne kadar iyi çalıştığına bağlı olmayabilir;** ama onun bir şirket için kar yapıp yapmayacağına bağlıdır.
H. **Karar, teknolojinin ne kadar iyi çalıştığına bağlı olmayabilir;** çünkü bazı teknolojiler yeterince iyi çalışmadan önce uygulamaya konup daha sonra geliştirilir.

I. Anlamadım.
J. Bir seçim yapmak için yeterli bilgiye sahip değilim.
K. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

20. Teknolojik gelişmeler vatandaşlar tarafından kontrol edilebilir.

A. **Evet,** çünkü teknolojiyi geliştirecek olan her bilim adamı ve teknoloji uzmanı toplumda yaşayan vatandaşlar arasından yetişir. Böylece vatandaşlar, teknolojideki ilerlemeyi zaman içinde yavaş yavaş kontrol ederler.
B. **Evet,** çünkü teknolojik ilerlemeler hükümetler tarafından mali olarak desteklenir. Vatandaşlar hükümetleri seçerek, neyin destekleneceğini kontrol edebilirler.
C. **Evet,** teknoloji tüketicilerin ihtiyaçlarına hizmet eder. Teknolojik ilerlemeler daha fazla talep ve kar getirebilecek alanlarda olur.
D. **Evet,** ama teknolojik gelişmelerin vatandaşlar tarafından kontrol edilmesi sadece yeni gelişmeler kullanıma konduğu zaman olabilir. Vatandaşlar, gelişmenin kendini kontrol edemezler.
E. **Evet,** ama sadece vatandaşlar bir araya geldiklerinde ve yeni gelişme lehine veya aleyhine konuştuklarında kontrol edebilirler. Organize olmuş insanlar hemen hemen her şeyi değiştirebilirler.

F. **Hayır**, vatandaşların teknolojik gelişmede söz hakkı yoktur; çünkü teknoloji öyle bir hızla gelişir ki normal bir vatandaş teknolojik gelişmelerin gerisinde kalabilir.
G. **Hayır,** çünkü vatandaşlar, teknolojiyi geliştirme gücünü elinde tutan insanlar tarafından gelişmeleri kontrol etmekten alıkonabilir.

H. Anlamadım.
I. Bir seçim yapmak için yeterli bilgiye sahip değilim.
J. Seçeneklerin hiçbiri kişisel görüşlerimi yansıtmıyor.

21. Eğer yetenekli bilim adamları farklı teorilere inanıyorlarsa yaptıkları gözlemler de genellikle farklı olacaktır.

A. Evet, çünkü bilim adamları farklı yöntemler kullanarak deney yapacaklar ve farklı şeylere dikkat edecekler.
B. Evet, çünkü bilim adamları farklı düşünecekler ve bu da onların gözlemlerini farklılaştıracaktır.

C. Bilim adamları farklı teorilere inansalar bile bilimsel gözlemler çok fazla değişmez. Bilim adamları gerçekten yetenekliyse, gözlemleri de benzer olacaktır.

D. Hayır, çünkü gözlemler olabildiğince kesindir. Bilim bu şekilde gelişir.
E. Hayır, gözlemler gördüklerimizden başka bir şey değildir ve gerçektir.

F. Anlamadım.
G. Konu hakkında seçim yapmak için yeterli bilgiye sahip değilim.
H. Seçeneklerin hiçbiri kişisel görüşlerime uymuyor.

22. Bilim adamlarınca yapılan araştırmalar doğru olarak yapılsa bile, araştırma sonunda varılan bulgular zaman içinde değişebilir.

A. **Bilimsel bilgi değişir**; çünkü bilim adamları, kendilerinden önceki bilim adamlarının teorilerini ya da buluşlarını çürütür. Bilim adamları bunu yeni teknikleri ve geliştirilmiş araçları kullanarak, daha önce gözden kaçırılmış faktörleri bularak veya ilk araştırmadaki hataları ortaya çıkararak yaparlar.
B. **Bilimsel bilgi değişir**; çünkü eski bilgiler yeni buluşların ışığında yeniden yorumlanır. Bilimsel gerçekler değişebilir.

C. **Bilimsel bilgi değişir gibi görünür**; çünkü eski gerçeklerin yorumu veya uygulaması değişebilir. Doğru şekilde yapılan deneyler **değişmez** gerçeklere yol açar.
D. **Bilimsel bilgi değişir gibi görünür**; çünkü yeni bilgiler eski bilgilerin üzerine eklenir; eski bilgiler aslında değişmez.

E. Anlamadım.
F. Konu hakkında seçim yapmak için yeterli bilgiye sahip değilim.
G. Seçeneklerin hiçbiri kişisel görüşlerime uymuyor.

23. Bilimsel düşünceler, hipotezlerden teorilere doğru gelişir; ve sonuçta yeterince güçlüyseler bilimsel kanun olur.

A. **Hipotez teoriye, teori kanuna dönüşebilir**; çünkü hipotez deneylerle test edilir, ve doğruluğu kanıtlanırsa teori olur. Teoriler, bir çok defa ve uzun zaman boyunca, farklı insanlar tarafından test edilip doğruluğu **kanıtlanırsa** kanun olur.
B. **Hipotez teoriye, teori kanuna dönüşebilir**; çünkü hipotez deneylerle test edilir eğer destekleyen kanıtlar varsa teori olur. Bir teori bir çok defalar test edilip doğru olduğu görüldükten sonra, bu teorinin kanun olması için yeterlidir.
C. **Hipotez teoriye, teori kanuna dönüşebilir;** çünkü bilimsel düşüncenin gelişmesi için hipotezin teoriye, teorinin kanuna dönüşmesi mantıklı bir yoldur.

D. **Teoriler kanun olamaz;** çünkü bunlar farklı türdeki düşüncelerdir. Teoriler kesinliğinden tam olarak emin olunamayan bilimsel düşüncelere dayanır ve doğrulukları kanıtlanamaz. Ancak kanunlar sadeve gerçeklere dayanır ve %100 kesindirler.
E. **Teoriler kanun olamaz;** çünkü bunlar farklı tür düşüncelerdir. Kanunlar olguıları genel olarak tanımlar. Teoriler ise bu kanunları açıklar. Ancak destekleyici kanıtlarla, hipotezler teorilere veya kanunlara dönüşebilir..

F. Anlamadım.
G. Konu hakkında seçim yapmak için yeterli bilgiye sahip değilim.
H.Seçeneklerin hiçbiri kişisel görüşlerime uymuyor.

24. Bilim adamları araştırma yaptıklarında, **bilimsel yöntemi** izlerler.

A. **Bilimsel yöntem**, genellikle bilim adamları tarafından dergide ya da kitapta yazılan ve deney yapılırken izlenmesi gereken işlemler ya da tekniklerdir.
B. **Bilimsel yöntem** sonuçların dikkatlice kaydedilmesidir.
C. **Bilimsel yöntem** deney değişkenlerinin, yoruma yer bırakmaksızın dikkatlice kontrol edilmesidir.
D. **Bilimsel yöntem** gerçeklerin, teorilerin ve hipotezlerin etkili şekilde elde edilmesidir.
E. **Bilimsel yöntem** test etmek ve tekrar test etmektir. Bir şeyin doğruluğunu veya yanlışlığını geçerli şekilde kanıtlamaktır.
F. **Bilimsel yöntem** Teoriyi kanıtlamak için deney oluşturmaktır.
G. **Bilimsel yöntem** soru sorma, hipotez, veri toplama ve sonuca varmaktır.
H. **Bilimsel yöntem** problem çözmede mantıklı ve kabul gören bir yaklaşımdır.
I. **Bilimsel yöntem** bilim adamlarını çalışmalarında yönlendiren bir tutumdur.

J. Bilim adamlarının aslında ne yaptıkları düşünülürse, gerçekte **bilimsel yöntem** diye bir şey **yoktur**.

K. Anlamadım.
L. Konu hakkında seçim yapmak için yeterli bilgiye sahip değilim.
M. Seçeneklerin hiçbiri kişisel görüşlerime uymuyor.

25. Eğer bilim adamları, asbestle çalışan insanların akciğer kanserine yakalanma ihtimalinin ortalama bir insanınkinin iki misli olduğunu bulurlarsa, bu asbestin akciğer kanserine sebep olduğu anlamına gelmelidir.

A. Gerçekler açık şekilde asbestin akciğer kanserine sebep olduğunu kanıtlar. Eğer asbest işçilerinin, akciğer kanserine yakalanma ihtimali daha fazlaysa, bu durumda kanserin sebebi asbesttir.

B. **Gerçekler asbestin akciğer kanserine sebep olduğu anlamına gelmeyebilir;** çünkü akciğer kanserine asbestin mi veya başka bir maddenin mi yol açtığını bulmak için **daha fazla araştırmaya** ihtiyaç vardır.

C. **Gerçekler asbestin akciğer kanserine sebep olduğu anlamına gelmeyebilir;** çünkü asbest **başka şeylerle birlikte** veya dolaylı olarak etkide bulunabilir (örneğin akciğer kanserine yakalanmaya sebep olan diğer şeylere karşı direnci zayıflatabilir).

D. **Gerçekler asbestin akciğer kanserine sebep olduğu anlamına gelmeyebilir;** çünkü eğer asbest kanser yaptıysa, **tüm** asbest işçileri akciğer kanserine yakalanmış olurdu.

E. Asbest akciğer kanserinin nedeni **olamaz** çünkü asbestle çalışmayan bir çok insan da akciğer kanserine yakalanmaktadır.

F. Anlamadım.

G. Bir seçim yapmak için yeterli bilgiye sahip değilim.

H. Seçeneklerin hiçbirisi kişisel görüşlerimi yansıtmıyor.

26. Farklı alanlardaki bilim adamları aynı şeye çok farklı yönlerden bakabilirler (örneğin, H+ kimyagerlerin asiti düşünmelerine, fizikçilerin ise protonları düşünmelerine sebep olur). Bunun anlamı, bilimsel düşüncenin bilim adamının çalıştığı alana bağlı olarak farklı anlamlara gelmesidir.

A. Çünkü bilimsel düşüncelerin yorumu alandan alana değişir.
B. Çünkü bilimsel düşünceler bilim adamının görüşlerine veya sahip olduğu bilgiye göre farklı şekilde yorumlanabilir.

C. **Bilimsel bir düşünce tüm alanlarda aynı anlama gelir;** çünkü bilim adamının bakış açısı ne olursa olsun , düşünce yine doğadaki aynı şeyleri ifade eder.
D. **Bilimsel bir düşünce tüm alanlarda aynı anlama gelir;** çünkü tüm bilim alanları birbirleriyle yakın ilişkilidir.
E. **Bilimsel bir düşünce tüm alanlarda aynı anlama gelir;** Farklı alanlardaki insanların birbirleriyle iletişim kurmaları için bu gereklidir. Bilim adamları aynı anlamları kullanmak için anlaşmalıdırlar.

F. Anlamadım.
G. Konu hakkında seçim yapmak için yeterli bilgiye sahip değilim.
H. Seçeneklerin hiçbiri kişisel görüşlerime uymuyor.

APPENDIX B

GÖRÜŞME SORULARI

1- Sizce bilim nedir?

2- Teknoloji nedir, bilimle ilişkisi var mıdır, açıklayınız?

3-Bilim ve teknoloji içinde oluşturulduğu toplumdan, ve o toplumun kültüründen etkilenir mi (örn. Amerika-Mısır farklı kültür ve ekonomilere sahip)?
Evet, çünkü ………………
Hayır, çünkü ……………..

4-Toplum, bilim ve teknolojinin sonuçlarından nasıl etkilenir?
(örneğin, dünyadaki yiyecek dağıtımı, tarım ürünleri, işsizlik, suç oranları, nüfus fazlalığı, kirlilik, nükleer reaktor inşası kararı gibi)

5-Okuldaki fen öğretiminin insanların günlük hayatlarına bir katkısı olur mu?
Evet, ………………..
Hayır,……………..…

6- Bilimle uğraşan sıradan bir bilim insanı için neler söylenebilir?

a-Kişisel özellikleri nelerdir?

b-Cinsiyeti ahkkında neler söyleyebiliriz?
-yapılan buluşlarda cinsiyet bir fark yaratır mı?
-sayıca eşit mi?

c-Günlük hayatları nasıldır?

7-Dünya'nın her hangi bir bölgesindeki bir grup bilim adamı (örn. Japonya, Türkiye, Almanya, Hindistan. Amerika) mesela atoma temelde aynı şekilde mi yaklaşır ve inceler?

Evet,………………
Hayır,………………..

8-Teknolojik gelişmelerin kullanılması kararı kim tarafından ve neye dayanılarak verilir? (politikacılar, bilim adamları, halk,…)

9-Bilim adamlarınca takip edilen bilimsel bir yöntem var mıdır?
Evet, …………………
Hayır, ………………..

10-Bilimsel bilgi zamanla değişir mi?