

RELATIONSHIPS AMONG PRE-SERVICE SCIENCE TEACHERS'  
EPISTEMOLOGICAL BELIEFS, KNOWLEDGE LEVEL AND  
TRUSTWORTHINESS ON INFORMATION SOURCES: CLIMATE CHANGE,  
NUCLEAR ENERGY, AND ORGAN DONATION AND TRANSPLANTATION

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## **ABSTRACT**

### **RELATIONSHIPS AMONG PRE-SERVICE SCIENCE TEACHERS’ EPISTEMOLOGICAL BELIEFS, KNOWLEDGE LEVEL AND TRUSTWORTHINESS ON INFORMATION SOURCES: CLIMATE CHANGE, NUCLEAR ENERGY, AND ORGAN DONATION AND TRANSPLANTATION**

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The aims of this study are to investigate how pre-service science teachers evaluated the trustworthiness of different information sources given about three different SSI: climate change, nuclear energy, organ transplantation and donation; their criteria of trustworthiness; the epistemological beliefs of pre-service science teachers; pre-service teachers’ accumulation of knowledge about the SSI topics; and whether there is a relationship among the epistemological beliefs, knowledge levels about three SSI and evaluation of trustworthiness to different sources of pre-service science teachers or not.

During 2012-2013 spring semester, 630 pre-service science teachers from four public universities participated in the study. Survey method was used in this research. Data were collected through Schommer’s Epistemological Questionnaire, Knowledge Test, and Trustworthiness Questionnaire. Multivariate analysis of variance, correlational analysis, and mixed-design analysis of variance were conducted.

The analyses revealed that pre-service teachers displayed a relatively sophisticated epistemological beliefs towards science, 45 % of them had an adequate

knowledge of climate change, 41 % of them had an adequate knowledge of nuclear energy, and only 23 % of them had an adequate knowledge of organ donation and transplantation. Averagely, pre-service teachers put less emphasis on author while reading texts about climate change and nuclear energy, whereas they put less emphasis on publication date of the texts written about organ donation and transplantation. The results revealed that high achiever pre-service teachers found all the texts more difficult to comprehend than low achievers; and high achievers gave more importance to the content while evaluating the trustworthiness of sources than low achievers did.

**Keywords:** pre-service science teachers, socioscientific issues, epistemological beliefs, knowledge level, trustworthiness on information sources

## ÖZ

### FEN BİLGİSİ ÖĞRETMEN ADAYLARININ EPİSTEMOLOJİK İNANÇLARI; İKLİM DEĞİŞİKLİĞİ, NÜKLEER ENERJİ, VE ORGAN BAĞIŞI VE NAKLİ HAKKINDAKİ BİLGİ DÜZEYLERİ İLE BİLGİ KAYNAKLARINA OLAN GÜVENLERİ ARASINDAKİ İLİŞKİLER

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Bu çalışmanın amaçları fen bilgisi öğretmen adaylarının üç farklı sosyobilimsel konu: iklim değişikliği, nükleer enerji, ve organ bağışı ve nakli hakkında verilen farklı bilgi kaynaklarından alınan metinlerin güvenilirliklerini nasıl değerlendirdiklerini; güvenilirlik kriterlerinin neler olduğunu; fen bilgisi öğretmen adaylarının epistemolojik inançlarını ve sosyobilimsel konulardaki bilgi birikimlerini incelemek; fen bilgisi öğretmen adaylarının epistemolojik inançları, üç sosyobilimsel konu hakkındaki bilgi düzeyleri ve farklı kaynakların güvenilirliklerini değerlendirmeleri arasında bir ilişki olup olmadığını incelemektir.

2012-2013 bahar dönemi boyunca yürütülen bu çalışmada dört devlet üniversitesinde öğrenim görmekte olan 630 fen bilgisi öğretmen adayı yer almıştır. Araştırmada tarama yöntemi kullanılmıştır. Veriler Schommer'ın Epistemolojik İnanç Ölçeği, Başarı Testi ve Güvenirlik ölçeği aracılığı ile toplanmıştır. Çoklu varyans analizi (MANOVA), ilişki analizi ve karışık tasarım varyans analizi (mixed-ANOVA) uygulanmıştır.

Analizler, fen bilgisi öğretmen adaylarının bilime karşı nispeten sofistike epistemolojik inançlara sahip olduğunu, katılımcıların % 45'inin iklim değişikliği, %

41'inin nkleer enerji, ve yalnızca % 23'nn organ baęıřı ve nakli testinde yeterli bilgi sahibi olduęunu gstermiřtir. Ortalama olarak, fen bilgisi ęretmen adayları organ baęıřı ve nakli hakkında yazılmıř olan metinleri okurken metinlerin yayınlanma tarihine daha az nem verirken, iklim deęiřiklięi ve nkleer enerji hakkındaki metinleri okurken ise yazar kriterine daha az nem vermiřtir.

İliřki analizi sonularına gre, daha bařarılı fen bilgisi ęretmen adayları, az bařarılı fen bilgisi ęretmen adaylarına gre dokuz metnin tmn kavraması daha zor olarak deęerlendirmiřtir. Ayrıca yine daha bařarılı olanlar bilgi kaynaklarını deęerlendirirken her bir metnin ierięine az bařarılı olanlara oranla daha fazla nem vermiřtir.

Anahtar kelimeler: fen bilgisi ęretmen adayları, sosyobilimsel konular, epistemolojik inanlar, bilgi dzeyleri, bilgi kaynaklarına olan gven

I dedicate this thesis to my dearest family  
Burcu Saylan Haspolat, Sabriye Saylan and Halil Saylan



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## LIST OF ABBREVIATIONS

|      |   |
|------|---|
| EFA  | Exploratory Factor Analysis                           |
| FBÖA | Fen Bilgisi Öğretmen Adayları                         |
| IPCC | Intergovernmental Panel on Climate Change             |
| MONE | Ministry of National Education                        |
| OECD | Organization for Economic Cooperation and Development |
| PISA | Programme for International Student Assessment        |
| PST  | Pre-service Science Teacher                           |
| SBK  | Sosyobilimsel Konular                                 |
| SEQ  | Schommer's Epistemological Questionnaire              |
| SSIs | Socioscientific Issues                                |
| STS  | Science, Technology and Society                       |
| STSE | Science, Technology, Society and Environment          |
| TAEA | Turkish Atomic Energy Agency                          |
| UNDP | United Nations Development Programme                  |
| WNA  | World Nuclear Association                             |

## **CHAPTER 1**

### **INTRODUCTION**

Science and technology are parts of our daily life in that technological inventions and scientific discoveries such as airplanes, automobiles, communication satellites, computers, and three dimensional televisions, etc. change our lives and become inevitable. Besides products, science and technological developments revealed some issues such as GMOs (genetically modified organisms), gene cloning, euthanasia and animal testing for medical purposes, etc. For these issues people in the societies hold different points of views. For example; scientists, politicians, environmentalists, economists, citizens, curriculum developers, etc. hold different perspectives. This type of science, technology and society-oriented issues are investigated in the field of socioscientific issues (SSIs) research. According to Sadler (2011, p. 80), “ SSI movement seems to be growing in that there is evidence of increased classroom use of SSI as well as more frequent SSI contributions to the science education literature base.” During last ten years, this line of research has produced a huge amount of information and has even an impact on our country’s curriculum. In Turkey, science education curriculum has been started to change and SSI constituted a part under the dimension of science, technology, society, and environment (Ministry of National Education, [MONE], 2013).

SSI are controversial science related societal issues which make students participate in dialogues, scientific discussions and debates. These issues require the use of evidence-based reasoning and provide a context for understanding scientific information (Zeidler & Nichols, 2009). People need to use their moral reasoning which is an integral part of informal reasoning or evaluate the ethical components while forming their decisions about these issues. Socioscientific topics are different from other scientific issues as they are contentious, open-ended, consist of ill-structured and debatable problems that subject to more than one perspective and solution; resolution and negotiation of these problems are best characterized by informal reasoning (Sadler & Zeidler, 2005). While the conclusions reached are certain, inevitable and inescapable in formal reasoning, they are probable, reasonable and believable in informal reasoning. Formal reasoning is used when the problem is well-defined rather than controversial and complex. However, informal reasoning deals with ill-structured problems having no definite solution. Zohar and Nemet (2002) described this term as follows:

Informal reasoning involves reasoning about causes and consequences and about advantages and disadvantages, or pros and cons, of particular propositions or decision alternatives. It underlies attitudes and opinions, involves ill-structured problems that have no definite solution, and often involves inductive reasoning problems (p. 38).

Students will be able to participate in public debate and political decisions about society goals by the help of learning about SSI (Barrué & Albe, 2011). SSI approach to teach controversial scientific concepts is an important part of science instructions and newly accepted definitions of scientific literacy also accepted the need for SSI inclusion in science courses to raise a scientifically literate generation

(Roth & Barton, 2004). To achieve this goal, pre-service science teachers (PSTs) play a key role. First they need to have adequate scientific knowledge about SSI and have a conception about how to incorporate these issues into classroom and then they let their students to meet the goals of science education. There have been many experiences to improve students' scientific knowledge as well raising their interest for scientific topics through these activities about SSI that imply values and beliefs and affective aspects (Sadler, 2004; Sadler & Zeidler, 2005; Zeidler & Matthew, 2003). Castells (2014) stated that the science taught in schools should incorporate SSI interests and social debates as well as ethical and moral values. In this way, as students gain scientific knowledge, they will have the opportunity to become scientifically literate citizens and participate in social debates.

Second PSTs obtain scientific knowledge from different sources such as courses, newspapers, journals etc. Which sources they will rely on may depend on their perception about trustworthiness of information sources (Jackob, 2010). Successful informal reasoning requires people to go beyond what they are told, by searching and applying other information sources to look for other relevant information (Galott, 1989). Therefore, the current study investigated PSTs' knowledge levels about some SSI topics (Climate Change, Nuclear Energy, and Organ Donation and Transplantation) and trustworthiness on information sources which are nine texts about the topics obtained from a newspaper, a scientific journal, website of a foundation, and some online newspapers.

Research studies about SSI have increased rapidly in recent years (Baltacı & Kılınç, 2014; Eroğlu, 2009; Koçak, Aktaş, Şenol, Kaya, & Bilgin, 2010;

Nuangchalerm, 2009; Oluk & Oluk, 2007; Özdemir, & Çobanoğlu, 2008; Sadler, 2004; Sadler, & Zeidler, 2004; Sander, & Miller, 2005; Şenel, & Güngör, 2008). The focus of the literature that has emerged around SSI has been varied from investigation of students' knowledge levels about different SSI topics (e.g., Eroğlu, 2009; Lewis & Leach, 2006), how SSI-based approaches relate to scientific literacy (e.g., Hodson, 2003; Zeidler & Keefer, 2003), the relationship between epistemological beliefs and informal reasoning regarding SSI (e.g., Angeli & Valanides, 2012; Hogan & Maglienti, 2001; Kitchener, 1983; Weinstock & Cronin, 2003; Wu & Tsai, 2010) to patterns of informal reasoning in the context of socioscientific decision making (e.g., Bell & Lederman, 2003; Chang & Chiu, 2008; Hogan, 2002; Öztürk, 2011; Sadler & Zeidler, 2005; Yang, 2004; Topçu, Yılmaz-Tüzün & Sadler, 2010).

Wu and Tsai (2010) stated that students' epistemological views towards science and scientific knowledge contributes to their informal reasoning skills. Also, according to Kitchener (1983), solving ill-defined problems require epistemic assumptions because they do not possess certain solutions and may possess more than one solution. Although there are also some studies reported that there is not a systematic connection between these two concepts (Angeli & Valanides, 2012; Topçu, 2011), majority of the studies support there is a relationship between students' epistemological beliefs and informal reasoning with regard to SSI (Bendixen & Schraw, 2001; Bendixen, Dunkle, & Schraw, 1994; Bendixen, Schraw, & Dunkle, 1998). Therefore in this study, the relationship among the PSTs'

knowledge level on three SSI, epistemological beliefs and their evaluation of trustworthiness will be investigated.

In the following part, how epistemological beliefs, content knowledge and trustworthiness were used in this study explained in detail.

### **1.1. Epistemological Beliefs**

Epistemology is a branch of philosophy that investigates the origin, nature, methods and limits of human knowledge (Muis, Bendixen, & Haerle, 2006) and it addresses some questions such as “What is knowledge?”, “How and from where do people get their knowledge?”, “How do they know if they really have knowledge?” and “What provides a justification for any knowledge that they have?” Epistemological beliefs are the beliefs regarding the nature of knowledge and learning (Elby, & Hammer, 2001; Schommer, 1993; Schommer-Aikins, 2004; Schommer-Aikins, Mau, Brookhart, & Hutter, 2000). In recent years, psychologists and educators have also wondered if people have beliefs about epistemological questions (called personal epistemological beliefs) and whether these beliefs affect their learning and reasoning. Perry (1968) was the first person who investigated students’ personal epistemological beliefs. He found that students have personal assumptions about the origins of knowledge and of value, and stated that personal epistemology is unidimensional and consists of developmental stages. However, this assumption has been challenged by Schommer (1990). Schommer (1990) stated that personal epistemology is multidimensional and students’ beliefs towards knowledge are related with five basic dimensions:

1. Source of knowledge: From knowledge is handed down by omniscient authority to knowledge is reasoned out through objective and subjective means. (Omniscient Authority)
2. Certainty of knowledge: From knowledge is absolute to knowledge is constantly evolving. (Certain Knowledge)
3. Organization of knowledge: From knowledge is compartmentalized to knowledge is highly integrated and interwoven. (Simple Knowledge)
4. Control of learning: From ability to learn is genetically predetermined to ability to learn is acquired through experience. (Fixed Ability)
5. Speed of learning: From learning is quick or not-at-all to learning is a gradual process. (Quick Learning) (p. 499).

The results of the Schommer's study indicated that epistemological beliefs affect the students' processing of information and monitoring of their comprehension. Schommer-Aikins and Hutter (2002) suggested that epistemological beliefs have an effect on ill-structured, controversial everyday life problems such as global warming, or gene cloning. Many other research also revealed that epistemological beliefs are important predictors in students' learning (Chan, 2004; Chan, 2011; Hofer & Pintrich, 1997; Schommer, 1993; Zeidler et al., 2003). According to these studies, students use different decision making skills and therefore, they have different beliefs even if about a same concept. These beliefs affect their learning and problem-solving. Several studies indicated that epistemological views of students affect their decision making (Sadler, Chambers, & Zeidler, 2004; Schommer-Aikins, & Hutter, 2002; Walker, Zeidler, Simmons, & Ackett, 2000; Liu, Lin, & Tsai, 2010). Liu et al. (2010) proposed that critical thinking about controversial issues includes the mind-set of flexibility while considering alternatives and opinions, and that is likely to reflect epistemological belief in the tentativeness aspect of nature of science. According to the study of Bell and Lederman (2003), epistemological beliefs and decision making process in SSI

are related; however, this relationship is not so clear and direct. For that reason, future researches are needed to investigate the interactions among epistemological beliefs and socioscientific reasoning. However, they are insufficient and there is a need to conduct more researches on this topic.

In the following section, students' use of content knowledge while reasoning about SSI was clarified.

## **1.2. Content Knowledge and Socioscientific Issues**

One of the primary goals for science education has been the promotion of conceptual understanding of science content knowledge (Jenkins, 1990; Laugksch, 2000). Understanding science content is necessary for informed (as opposed to whimsical or poorly thought-out) decisions regarding SSI (American Association for the Advancement of Science, 1990; National Research Council, 1996; Patronis et al., 1999; Pedretti, 1999). Perkins and Salomon (1989) stated that decision-making requires a basic understanding of relevant concepts. For example, global warming is one of the most important issues facing society today. In the context of global warming, an individual must have some basic knowledge of greenhouse gases, radiation, atmosphere, and climate in order to meaningfully engage in informal reasoning.

Teachers need to know the subject that they are teaching in order to help others learn (Shulman, 1986). Science teachers have a crucial role on science education and teaching SSI in classrooms. Being a teacher requires competence in

scientific knowledge. According to PISA Science Framework 2015, scientific knowledge consists of three distinguishable but related elements:

Content knowledge: Explaining scientific and technological phenomena, for instance, demands a knowledge of the content of science,

Procedural knowledge: Recognising and identifying the features that characterise scientific enquiry requires a knowledge of the standard procedures that are the foundation of the diverse methods and practices used to establish scientific knowledge,

Epistemic knowledge: an understanding of the rationale for the common practices of scientific enquiry, the status of the knowledge claims that are generated, and the meaning of foundational terms such as theory, hypothesis and data (pp. 5-6).

Individuals who have adequate scientific knowledge would be able to propose how a scientific question might be investigated appropriately, and they understand the importance of developing a sceptical disposition to all media reports in science (OECD, 2013). SSIs are authentic real life situations and often media-reported (Ratcliffe & Grace, 2003). These indicate people apply their scientific knowledge in real-life situations such as SSIs and by having adequate scientific knowledge, they would determine whether an information source written about a SSI is trustworthy or not. Since PISA is implemented in many countries, it was constructively accepted. Hence, the philosophy adopted by this implementation has also been adopted by many countries. being a structure that needs to be investigated in different cultures, the relationship between SSI and content knowledge emphasized by PISA have attracted the attention of researchers. As a result, this relationship was investigated within this study.

The conducted studies underline the role of content knowledge in socioscientific reasoning (e.g., Hogan, 2002; Lewis & Leach, 2006; Sadler &

Zeidler, 2005; Zeidler & Schafer, 1984). The findings of the study of Zeidler and Schafer (1984) and Lewis and Leach (2006) supported that there is a tangential relationship between content knowledge and informal reasoning and understanding content knowledge affects the quality of informal reasoning with respect to SSI based on that content knowledge. Sadler and Zeidler (2004) reported that there is a positive relationship between undergraduate college students' understanding of content knowledge and the quality of informal reasoning regarding SSI based on that content knowledge. Sadler and Zeidler (2005) also stated that the existent differences in content knowledge is related to diversities in the quality of informal reasoning. Their study revealed that teachers should take into account their students' knowledge about different SSI while determining the appropriateness of issues to be included in instruction. Thus, teachers, especially science teachers should be careful on this point as they use SSI in their course. Hence, in the present study, the content knowledge level of PSTs on each of the three SSIs.

In Turkey, there are some studies conducted to investigate students' content knowledge in the context of SSI. For instance, Özdemir and Çobanoğlu (2008) conducted a study about pre-service teachers' attitudes towards nuclear energy usage and construction in Turkey. According to results of the study, most of the participants stated that they did not have sufficient scientific knowledge about nuclear energy. As another finding, the students stated that they get information about the topic mostly from textbooks, seminars. They also learn from health care and environmental organizations, radio and TV. Although a number of studies were conducted to investigate medical faculty students' content knowledge levels about

the topic, there is a clear lack of research conducted about knowledge levels of pre-service teachers regarding organ transplantation and donation. Also similar studies conducted about content knowledge regarding SSI topics in the related literature were reviewed and PSTs' misconceptions about the topics were taken into consideration while forming the knowledge test. Table 1.1 shows the common misconceptions and the items about them. For example, there is a common misconception that ozone layer depletion is due to the global warming (Bahar & Aydın, 2002; Bozdoğan & Yanar, 2010; Khalid, 2001, 2003; Matkins & Bell, 2007; Pekel, 2005). Kahraman, Yalçın, Özkan and Aggöl (2008) reported that Turkish prospective teachers had some misunderstandings about global warming. One of them is global warming is defined as the hole of ozone layer due to the hazardous substances. A common misconception about nuclear energy is that nuclear reactions take place with the exchange of electrons (Erçoklu, 2001; Yalçın & Kılıç, 2005). Yet another one about nuclear energy is that nuclear energy is renewable (Boylan, 2008). Yalçın and Kılıç (2005) stated that high school students have a misconception about radioactive rays and radiation concepts are identical in meaning. Additionally, students think that radiation is dangerous and harmful. (Orna, 1994; Kılıç & Yalçın, 2004). As a misconception about organ donation and transplantation, Çetin and Harman (2012) reported that to be an organ donor, the approval of a first-degree relative is necessary. Similarly, another misconception is that to be organ donors, getting a health report is necessary (Akış et al., 2008; Çetin & Harman, 2012).

Table 1.1 Common misconceptions discovered during the literature review process and related items

| <b>Topic</b>                       | <b>Misconception</b>  | <b>Reference(s)</b>  |
|------------------------------------|---|--|
| Climate change                     | Ozone layer depletion is due to the global warming.                                   | Bahar & Aydın, 2002; Bozdoğan & Yanar, 2010; Khalid, 2001, 2003; Matkins & Bell, 2007; Pekel, 2005 |
|                                    | Global warming is defined as the hole of ozone layer due to the hazardous substances. | Kahraman et al., 2008  |
| Nuclear energy                     | Nuclear energy is renewable energy.   | Boylan, 2008   |
|                                    | Nuclear reactions take place with the exchange of electrons.                          | Erçoklu, 2001; Yalçın & Kılıç, 2005  |
|                                    | Radioactive rays and radiation concepts are identical in meaning.                     | Yalçın & Kılıç, 2005   |
|                                    | Radiation is dangerous and harmful.   | Orna, 1994; Kılıç & Yalçın, 2004   |
| Organ donation and transplantation | In order to be organ donors, getting a health report is necessary.                    | Akış et al., 2008; Çetin & Harman, 2012  |
|                                    | In order to be organ donors, the approval of a first-degree relative is necessary.    | Çetin & Harman, 2012   |

### 1.3. Trustworthiness on Information Sources

SSI are controversial issues confront people with difficult choices. When they faced with an event in daily life, they enter into the process of decision making which is a cognitive process and while doing that, they use rational, emotional or intuitive forms of informal reasoning. Every decision making process produces a final choice. Rationalistic informal reasoning described reason-based considerations; emotive informal reasoning described care-based considerations; and intuitive

reasoning described considerations based on immediate reactions to the context of a scenario (Sadler & Zeidler, 2005). In intuitive decision making process, one can encircle the ability to know valid solutions for the problems. For instance, people can make fast decisions without comparing different options. The rational decision making includes selecting one choice systematically among different possible solutions of a problem. It is based on reasoning, making observations, and factualness. In emotional reasoning, somebody believes that what s/he feels is true without regard to an evidence. People use all these decision making processes when they read a text about a socioscientific event from a source. A scientifically literate person must have the ability to make thoughtful decisions on SSI. Decision-making process on these issues includes critical evaluation of different scientific claims and arguments. Students gain information about SSI through a variety of information sources such as newspaper articles, media, television and radio programs, the internet, textbooks, politicians, teachers, family, friends etc. They should get in the habit of evaluating the degree to which the different information sources they encounter can be more trusted. The findings of many studies suggested that information evaluation needs to be a strong component of SSI curricula and instruction (Kolstø, 2001; Korpan, Bisanz, Bisanz, & Henderson, 1997; Sadler, Chambers, & Zeidler, 2002; Tytler, Duggan, & Gott, 2001).

McAllister (1995) suggested that trust is considered as two separate dimensions: cognitive trust and affective trust. He stated that cognitive dimension of trust reflects issues such as the reliability, integrity, honesty, and/or fairness of a referent whereas the affective dimension of trust reflects a special relationship with

the referent that may cause the referent to demonstrate concern about one's welfare. The basis of cognitive-based trust is cognitive reasoning. While affective trust is emotion-driven, cognitive trust is knowledge-driven as it arises from an accumulated knowledge. Several studies have been conducted in order to determine these reasonings (e.g. Bråten, Strømsø, & Britt, 2009; Bråten, Strømsø, & Salmerón, 2011; Strømsø, Bråten, & Britt, 2011; Sadler, & Zeidler, 2005; Strømsø, Bråten, & Samuelstuen, 2008). Bråten et al. (2009) investigated source evaluation's role in pre-service teachers' construction of meaning within and across multiple texts. According to the results, what students find trustworthy and their criteria used while evaluating trustworthiness are independent predictors of their comprehension of different texts about global warming. Bråten et al. (2011) stated while pre-service teachers evaluating trustworthiness of different information sources about climate change, they place most emphasis on content and least on publication date. In the study of Strømsø et al. (2011), it was found that participants put most emphasis on the content of information sources about climate change. Moreover, it was found that participants trusted the text produced by a scientific institution more than a newspaper article. Sadler and Zeidler (2005) investigated how individuals negotiate and analyse genetic engineering dilemmas. In their study, it was found that the participants frequently relied on combinations of the three reasoning patterns – rationalistic, emotive and intuitive- during the resolution of socioscientific scenarios. The information sources that were used in these studies are mainly textbooks, popular science articles, newspaper articles, and research magazines. Due to these reasons, in this study how PSTs evaluate the trustworthiness of different information sources given about 3 different SSIs: climate change, nuclear energy, and organ

donation and transplantation will be dealt with. Additionally, the criteria emphasized by PSTs when evaluating trustworthiness across texts will also be discussed.

In the next part, the relationship among PSTs' content knowledge about SSI, epistemological beliefs, and the way of evaluation of trustworthiness is presented.

#### **1.4. The Relationship Among Content Knowledge about SSIs, Epistemological Beliefs, and Evaluation of Trustworthiness**

##### **1.4.1 The Relationship Between Content Knowledge about SSIs and Epistemological Beliefs**

Duell and Schommer-Aikins (2001) expressed that personal epistemological beliefs have an important role in education and learning process. These beliefs were found to have an effect on students' achievement indirectly by means of effecting learning approaches (Cano, 2005). Additionally, several studies stated that students' personal epistemological beliefs play an important role in their acquisition of scientific content knowledge levels (Cavallo, Rozman, Blickenstaff & Walker, 2003; Tsai, 1998). The positive effect of epistemological beliefs on science content learning was well-investigated before (Tsai, 1998; Yang & Tsai, 2012). However, there is a need to make a study to find a relationship between PSTs' epistemological beliefs and content knowledge levels on the basis of sub-dimensions of epistemological beliefs and high-low achievers. For instance, Cano (2005) stated that the students having poor academic performance had more naive beliefs. Starting from this point, these low achiever students would probably have a poor performance on the knowledge test in the present study. Regarding their epistemological beliefs, it was

expected that low achiever PSTs believe that knowledge is certain or simple in opposition to the high achievers. Additionally, the low achievers would probably believe that ability to learn is genetically predetermined and learning is quick or not-at-all. Therefore, the possible relationship between PSTs' epistemological beliefs and knowledge levels regarding SSIs will be examined in detail.

#### **1.4.2 The Relationship Between Content Knowledge about SSIs and Evaluation of Trustworthiness**

By working on SSIs, the students' abilities to evaluate information, to make decisions and to argue would be developed and scientific literacy would be promoted (Erduran & Jiménez-Aleixandre, 2007). Undoubtedly that having an adequate content knowledge about SSIs requires the efficient use of various information sources and evaluation of these sources. There are several studies conducted all around the world that proved this remark (e.g., Jensen & Schnack, 2006; Kobow & Walpuski, 2014). For instance, in the study of Özdemir and Çobanoğlu (2008), most of the PSTs stated they had insufficient scientific knowledge about nuclear energy. The participants who have some formal knowledge about the topic stated that sources of their knowledge are the mass media, environmental courses and textbooks. According to results of the research of Eroğlu (2009), PSTs' scientific knowledge level about global warming is above average; however, they have a lack of knowledge about some issues such as the relationship between forest fires and global warming, CFCs (Chloro Fluro Carbons) etc. Şenel and Güngör (2008) also examined pre-service teachers' opinions about global warming and climate change topics. The results revealed that prospective teachers have adequate knowledge about

global warming. They stated that their sources of knowledge are the mass media, conversations with friends, courses, and conferences according to order of precedence. Koçak et al. (2010) investigated the knowledge levels of medical faculty students about organ donation. It was found that participants stated they have not adequate knowledge about the topic. These studies revealed that university students get information about SSIs by using various sources and some students have insufficient knowledge about the topic. Korpan et al. (1997) investigated university students' criteria for judging trustworthiness of scientific knowledge claims, but their research did not focus on SSIs. Hence, this type of research needs to be conducted by selecting SSIs.

There is a limited number of studies that investigate the relationship between scientific content knowledge level and trustworthiness of PSTs about SSIs (e.g., Strømsø et al., 2011). For this reason, the relationship between PSTs content knowledge about SSIs and their way of evaluation of trustworthiness of information sources needs to be investigated. It is important to know how students make decisions in SSIs and how they evaluate contradictory scientific information by taking into consideration their content knowledge levels. Some authors considered that students are led to emphasize personal experiences or values (Sadler et al, 2004), others underlined that the overriding considerations are social or epistemological (Ryder, 2002) and some authors have questioned the importance of using scientific knowledge when SSI have to be settled. PST's epistemological beliefs should be paid attention while they transfer science content knowledge to their students. Hence, it is crucial to explore these beliefs in teacher education programs and develop them

because these beliefs would influence the way teachers instruct. Additionally, people use their epistemological beliefs in decision making processes of SSIs (King & Kitchener, 1994). In the following part, the possible relationship between epistemological beliefs and the way of evaluation of trustworthiness was examined.

### **1.4.3 The Relationship Between Epistemological Beliefs and Evaluation of Trustworthiness**

In this study, examining the possibility that the influence of task on multiple-text comprehension might be moderated by personal epistemological beliefs or vice versa. There are some reasons to investigate this relationship. First, personal epistemological beliefs was thought of as important when people work on complex learning tasks such as SSIs (Hartley & Bendixen, 2001; Stahl, Hynd, Britton, McNish & Bosquet, 1996; Wolfe & Goldman, 2005). There is a rapidly growing literature that supports the view that personal epistemology is one of the most important predictors of higher level text processing and comprehension (e.g., Bråten & Strømsø, 2008) and of evaluation and integration of online sources (e.g., Barzilai & Zohar, 2012). Bråten and Strømsø (2006) stated that the readers with more sophisticated epistemological beliefs engage more in deep level processing in the form of elaboration and monitoring. Second, from the other direction, Tsai (2008) stated that the use of Internet for studying open-ended debatable issues increased the sophistication of personal epistemological beliefs of the students. Similarly, Kienhues, Stadtler and Bromme (2011) also found that reading multiple Web sources led to an advance in personal epistemological beliefs of the students. To sum up, although the related literature remain incapable, several authors have argued for the

importance of examining personal epistemological beliefs and the way of evaluation of trustworthiness of different information sources of students. Therefore, this study investigated whether there is a relationship between PSTs' epistemological beliefs and trustworthiness on multiple information sources or not.

In conclusion, the above mentioned studies pointed out a possible relationship among PSTs' epistemological beliefs, content knowledge levels about SSIs, and the way of evaluation of trustworthiness of different information sources. Hence in this study, this relationship was investigated.

### **1.5 Purpose of the Study**

The main purpose of this study is to investigate whether there is a relationship between PSTs' epistemological beliefs, knowledge levels about three SSIs and evaluation of trustworthiness on different information sources or not. Hence, the study explores PSTs' epistemological beliefs and knowledge levels about the three SSIs. Another aim of this study is to investigate how PSTs evaluated the trustworthiness of different information sources given about three different SSI: climate change, nuclear energy, organ transplantation and donation, and what are the criteria of trustworthiness for them. The last thing to investigate is to have information about pre-service teachers' accumulation of knowledge about the SSI topics.

### **1.6 Research Questions**

Based on the purposes of this study, research questions are:

Research Question 1: How do PSTs evaluate the trustworthiness of different information sources given about 3 different SSIs: climate change, nuclear energy, organ donation and transplantation?

Research Question 2: What kind of criteria do PSTs emphasize when evaluating trustworthiness across texts?

Research Question 3: What is the content knowledge level of PSTs on each of the three SSIs?

Research Question 4: What are the PSTs' epistemological beliefs?

Research Question 5: Is there a relationship between the PSTs' knowledge level on three SSIs, epistemological beliefs and their evaluation of trustworthiness?

### **1.7 Significance of the Study**

There is a huge number of related literature about importance of SSI in the science education. However, decision making about SSI is an important aspect of science and technology education worldwide today and there is a limited number of studies about trustworthiness of the students about different information sources given about SSI. According to the accessible literature, there is a clear lack of the literature about this issue in the world, especially in Turkey. In Turkey, informational education orienting students towards mostly exam achievement is still a common problem in science education. Science has a broken link with other lessons and daily life. Like many countries, Turkey also needs scientifically literate citizens. In order to achieve this goal we must educate pre-service teachers, firstly. Hence, one of the

aims of science education is to help children to understand the importance of evidence when making decisions and to judge whether the claims of the media, teachers, scientists, advertisers, politicians, journalists etc. are evidence-based and reliable or not. On basis of the above-mentioned studies, a variety of information sources – online newspapers, a scientific and technical journal, some experts in their fields, professors, a doctor, a non-governmental environmental organization, the president of Turkish Kidney Foundation were selected in the present study. One of the reasons to choose them is each source has a different viewpoint on the topics. Different people have different points of view and they carry their opinions to people with different sources. For example, while one source is proponent of the effect of human activity on climate change, another source may support that it is a natural phenomenon. Additionally, it was taken into account that the sources are easily accessible and have different publication dates. The sources are notably popular among the age group of the sample. It was also considered to collect texts from the sources that consist of reliable information.

PSTs were chosen to be participants in this study. The reason for this was first of all, one of the aims of science education curriculum in Turkey is to raise scientifically literate students. The goal of raising scientifically-literate citizens can only be achieved if pre-service teachers are well-informed and improved themselves not only about basic science courses, but also about SSI. With the new regulations in science curriculum, science textbooks include topics such as ‘Human and Environment’ that includes environmental problems and their effects in our life and climate change, and ‘Systems in Our Body’ that includes organ transplantation topic.

Also elementary students should have a basic knowledge about nuclear energy via their textbook and science courses. Science teachers need to have a deep information about these three topics at all points. Hence, this study would be more appropriate for PSTs as they should have adequate knowledge about SSI to teach their students.

The three topic climate change, nuclear energy and organ donation and transplantation were selected because they are controversial and current issues these days. Firstly, the concept of climate change has been started to be used in our daily life and it is widely accepted as one of the major environmental problems facing the earth. Secondly, constructing a nuclear power plant has been discussed in Turkey's energy agenda. Although many citizens are against it, Turkish government is planning to construct four nuclear power plant in Mersin Akkuyu and overall, a total of 6 reactor will be operated in the year 2018 at the latest (The Ministry of Energy and Natural Resources report, 2011, pp. 51-52). Also in many university, nuclear energy and climate change topics are applied as a SSI topic in classroom debates. Hence, knowledge level of PSTs about these recent topics of discussion in Turkish media will be investigated. Lastly, organ donation and transplantation is another important topic. There is a need to give importance to education at schools in this regard and increase organ donation campaigns and programs through the media to raise awareness (Koçak et al., 2010). Some studies support that university students have a lack of knowledge about organ donation and transplantation (Koçak et al., 2010; Doğan, Toprak, Sunal, & Doğan, 2012). Thus, there is a need to investigate this issue more deeply. Also the study topics of climate change, nuclear energy, and

organdonation and transplantation are chosen because they include each science discipline namely chemistry, biology and physics.

Exploring the relationships among PSTs' between the epistemological beliefs, knowledge levels about three SSI and evaluation of trustworthiness on information sources makes the study unique since there is not any accessible study investigating these relationships in just one study. Also the present study will be one of the few studies conducted considering Turkish context.

## **1.8. Definition of Important Terms**

In this section, the definitions of important terms used in this study were presented.

### **1.8.1. Socioscientific Issues**

SSI were defined as social issues with conceptual and technological relations to science and are controversial in nature (Sadler, 2004) such that, in this study, opposing points of views will be given in some cases to the students and they will be evaluated by them.

### **1.8.2. Personal Epistemological Beliefs**

In the present study, epistemological beliefs refer to the beliefs of PSTs about nature of knowledge and knowing.

### **1.8.3. Climate Change**

As human activities continue to add greenhouse gases—water vapor, carbon dioxide, methane, nitrous oxides, and ozone—to the Earth’s atmosphere, global temperatures are expected to rise, causing the Earth’s climates to change. These climate changes may affect precipitation patterns, severe and extreme weather events, and over time environmental systems. Furthermore, human health and agriculture may be sensitive to climate change. Therefore, if science education aims to promote a citizenry that is knowledgeable about global warming and climate change, it is essential to determine what students’ conceptions are about global warming and climate change (Osborne & Freyberg, 1985) in order to plan curriculum and design instruction that builds on these conceptions. Climate change is a SSI since besides its scientific context, there is a variety of disputes regarding its nature, causes, and consequences. The highly disputed issues involve the causes of global warming, i.e. whether this warming trend is unprecedented or within normal climatic variations, whether humankind has contributed significantly to it, and whether this increment is fully or partially because of the poor measurements, and what the consequences of global warming will be.

The present study expands on previous research, university students’ conceptions about climate change as well as providing new insights into their conceptions about the potential environmental impact of climate change by providing three cases from different information sources.

#### **1.8.4. Nuclear Energy**

Nowadays, nuclear energy is a controversial topic especially in Turkey. It can be defined as getting energy by splitting of uranium atoms. Nuclear energy is a SSI since besides its scientific context, it has both some advantages and presents some serious threats. Proponents of it think it is a sustainable energy source which reduces carbon emissions, decreases dependence on imported energy sources, and produces almost no air pollution. According to them, the risks of waste storage are so small and can be reduced by the help of modern technology. However, the opponents think that nuclear power poses numerous threats to both people and the environment. They also stated that nuclear power plants are so complex that many things that there may be serious nuclear accidents. In conclusion, authors, politicians, scientists and environmentalists look this issue from different aspects and this study will investigate how PSTs trust on these information sources.

#### **1.8.5. Organ Donation and Transplantation**

The term “organ transplant” typically refers to transplants of the solid organs: heart, lungs, kidneys, liver, pancreas and intestines. Organ donation is to donate tissue or an organ of the human body, from a living or dead body (donor) to a living body (recipient). Organ donation and transplantation is a SSI because of some controversies. First, there are certain groups that oppose organ donation on religious grounds whereas most of the religions support donation. Second, some people believe that livers should not be given to alcoholics in danger of reversion, while others view alcoholism as a medical condition like diabetes. Third, everyone in need

of organ should be able to receive a transplant; however, since the cost of a transplant is high many poor people never undergo this process. Last, although medical urgency is commonly taken into account in ranking potential recipients, the assessments may not wholly objective and may be biased. In conclusion, organ donation and transplantation is a SSI because of these types of dilemmas among people. In this study, PSTs will read three paragraphs from different sources about organ donation and transplantation.

#### **1.8.6. Trustworthiness**

Trustworthiness can be defined as students' relying on different information sources such as newspaper, textbook, teacher, media etc. about given SSI: climate change, nuclear energy, organ transplantation.

#### **1.8.7. Evaluation**

Three cases from three different sources about the three SSI will be available to be read by pre-service teachers. They will make decisions about these informations and choose the most confidential one for them. Also the students' criteria for selecting them will be noticed.

## **CHAPTER 2**

### **LITERATURE REVIEW**

In this chapter of the study, a brief review of the previous studies on science education and SSI, informal reasoning and SSI, epistemological beliefs and personal epistemology, SSI content knowledge, and trustworthiness on different information sources is presented respectively.

#### **2.1. Science Education and Socioscientific Issues**

One of the reasons for SSI's important role in science education is that SSI is at the center of the concept of scientific literacy (Sadler & Zeidler, 2005). There are two ways of looking at the aims and objectives of science education which represent two different perspectives. In his book *Handbook of Research on Science Education*, Roberts (2007) defined these perspectives as Vision I and Vision II. Vision I is characterized by content-driven, scientist-centered, and decontextualized science knowledge. According to this approach, science education makes students understand scientific products, concepts and processes. Traditional science education fits in this approach. Vision II is a context-driven, student-centered approach which aims to prepare students for informed civic engagement. Constructivist science education fits in this approach. Most importantly, SSI framework follows Vision II approach as it includes reasoning and personal decision making about real life

situations related to science and social, political, economical, moral, and ethical perspectives. Sadler, Barab, & Scott (2006) also argue for SSI is a platform for learning the scientific content. They stated that students gain both conceptual knowledge and an understanding of the nature of science when working with SSI.

In recent years, SSI and teaching SSI topics started to draw attention in science education literature and a lot of research about these issues has been published. These research studies have proved that the utilization of SSI provides students with the thinking, moral reasoning and argumentation skills needed to develop scientific literacy, and empathy. Hence, the researchers have argued for the inclusion of SSI in the science curriculum (Driver, Newton & Osborne, 2000; Kolstø, 2001; Sadler, 2004; Sadler, & Zeidler, 2005; Zeidler & Sadler, 2008).

Many countries in the world started to include SSI in science teaching programs. Also in Turkey's science education curriculum, one of the sub fields of Science, Technology, Society, and Environment (STSE) education is SSI. This sub field was defined in the program as "SSI involves scientific and moral reasoning skills with regard to the solution of socio-scientific problems about science and technology" (MONE, 2013). In fact, SSI and STS(E) education are related and both connect science to societal issues but SSI differs from STS(E) because of its emphasis on psychological and epistemological growth of the child, development of character and virtue as well as content knowledge (Sadler, 2004; Pedretti, & Nazir, 2011). Accordingly, the role of SSI goes beyond STS(E). For this reason, some researchers suggested that SSI should replace STS(E) (Tal & Kedmi, 2006; Zeidler, Sadler, Simmons, & Howes, 2005). Science education that includes

SSI not only in theory but also in practice challenge students' moral reasoning, critical thinking and provides motivation to learn science content by making it seem more relevant and interesting (Zeidler & Nichols, 2009).

The above-stated aims and objectives of science education suggest that learning and teaching of SSI in science classrooms is one of the crucial aspects of science education today.

## **2.2. Epistemological Beliefs and Personal Epistemology**

Epistemology was firstly used in philosophy, and then Piaget introduced it in education (Hofer, 2000). Epistemological beliefs is a growing research area in education which is investigated by philosophers, educational, developmental, and instructional psychologists; researchers in counseling, higher education, reading and literacy studies, teacher education, science and mathematics education (Hofer, 2002). Epistemological beliefs involves people's beliefs about the certainty of knowledge, the organisation of knowledge, and their controls over knowledge (Schommer-Aikins & Hutter, 2002). Hofer (2001) described personal epistemology as "students' thinking and beliefs about knowledge and knowing, and typically includes some or all of the following elements: beliefs about the definition of knowledge, how knowledge is constructed, how knowledge is evaluated, where knowledge resides, and how knowing occurs" (p. 355).

### **2.2.1. Epistemological Theories**

There are many different definitions of the personal epistemology. Regarding this issue, Hofer (2001) stated that “the research on personal epistemology, although not united in terminology, addresses students’ thinking and beliefs about knowledge and knowing, and typically includes some or all of the following elements: beliefs about the definition of knowledge, how knowledge is constructed, how knowledge is evaluated, where knowledge resides, and how knowing occurs” (p. 355).

A literature review of the various researches about personal epistemology reveals that there are mainly three different points of view in personal epistemology: Developmental perspective (Baxter Magolda, 1992; Belenky, Clinchy, Goldberger, & Tarule, 1986; King & Kitchener, 1994; Kuhn, 1991; Perry, 1970), epistemology as a system of independent beliefs (Schommer-Aikins, 2002), and alternative conceptions of personal epistemology (Hofer & Pintrich, 1997; Elby & Hammer, 2001).

Research concerning the relationship between personal epistemological beliefs and learning trace back to Perry’s (1970) study. He initiated and defined personal epistemology from a developmental perspective as “a structure in which individuals construe the nature and origins of knowledge, of value, and of responsibility in a sequential and logical process”. He conducted a study to explore the theories and beliefs Harvard freshman undergraduates hold about knowledge and knowing, and the manner in which such epistemological premises are a part of and an influence on the cognitive processes of thinking and reasoning”. The study took

four years. He assumed that students transform their own beliefs about knowledge from a position of dualistic thinking toward relativistic thinking (p. 54). He assumed that students had different views on knowledge due to their approaches to knowledge from different positions. Finally, by using participants' responses to the open-ended interviews, he developed the Perry scheme— a model in order to understand how undergraduate students' views of knowledge. He stated that most of the first-year college students believe that knowledge is simple, certain, and handed down by omniscient authority. When they reach their senior year, they mostly believe that knowledge is complex and tentative. Based on these findings of his study, Perry scheme is composed of four clusters: dualism, multiplicity, relativism, and commitment with relativism. Within these stages, there are nine developmental positions:

1. Dualism: Authorities know the truth and learners receive knowledge without questioning.
2. Multiplicity: There are no absolute answers and there may be no solution or more than one solution to a problem. Individuals believe that all views are equally valid and everyone has a right to their own opinion.
3. Relativism: Knowledge is contextual and relativistic. Students form their opinions according to the sources and evidences, and they scrutiny even if the experts.
4. Commitment within relativism: Knowledge contextual, relativistic, uncertain and tentative. People make and affirm commitments and choices to values, careers, relationships, and personal identity. Individuals in that category make and affirm commitments to values, careers, relationships, and personal identity (Hofer & Pintrich, 1997).

Perry (1970) also suggested that an individual could be in various developmental positions at the same time concerning to different subjects and experiences. However, Perry's (1970) study was criticized for the limitation of generalizability to the general population of university students because his study has

a sample elite male students in Harvard. For this reason, several years later, Belenky et al. (1986) decided to examine the stages of Perry scheme is applicable to women and how women's ways of knowing was shaped by academic institutions and maternal practice. They interviewed with 135 women from different ages, economic status, educational and ethnic backgrounds. Although they used Perry's scheme in the interview, given answers did not fit with this scheme. In the study, he metaphor of voice was used to describe stages of women's intellectual development. They constructed the second model of personal epistemology and their study revealed that that women comprehend knowledge from five different epistemological perspectives:

1. Silence: a position in which women experience themselves as mindless and voiceless and subject to the whims of external authority.
2. Received Knowledge: a perspective from which women conceive of themselves as capable of receiving, even reproducing, knowledge from the all-knowing external authorities but not capable of creating knowledge on their own.
3. Subjective Knowledge: a perspective from which truth and knowledge are conceived of as personal, private, and subjectively known or intuited.
4. Procedural Knowledge: a position in which women are invested in learning and applying objective procedures for obtaining and communicating knowledge.
5. Constructed Knowledge: a position in which women view all knowledge as contextual, experience themselves as creators of knowledge, and value both subjective and objective strategies for knowing (Belenky et al., 1986, p. 15).

Similar with Perry's stages, these stages also sorted from simple to complex. The study of Baxter Magolda (1992) is another study that was conducted based on Perry's model. Different from Perry's and Belenky's studies, her study includes individuals from both gender from undergraduate and graduate levels. She developed a model named as Epistemological Reflection Model. Similar to the previous two

models, according to this model at the beginning of college life, students believe that the authority knew the truth. Over years, they started to believe that knowledge is contextual and constructed by experts (Baxter Magolda, 1992, p. 89). The third model of personal epistemology, Epistemological Reflection Model consists of four stages each has five categories: the natures of knowledge, the role of the learner, the role of the instructor, the role of peers, and evaluation:

1. Absolute knowing: knowledge is certain and authorities have all the answers.
2. Transitional knowing: authorities do not know all the answers and knowledge is uncertain.
3. Independent knowing: knowledge is mostly uncertain. Authority is not the only source of knowledge and students started to view their own opinions as valid as that of the authority.
4. Contextual knowing: knowledge is uncertain and contextual, and it is constructed by individuals with appropriate expertise. People judge knowledge on the basis of evidence in context (Baxter Magolda, 1992, p. 89).

As the fourth model of personal epistemology, King and Kitchener (1994) developed Reflective Judgment Model based upon study of Perry (1970) and Dewey's (1938) study on reflective thinking. They focused on the development of reasoning in adults and interviewed with from high school students to middle-aged people about four ill-structured problems. In their model, there are seven developmental stages classified into three levels:

1. Pre-reflective thinking (Stages 1-3): people believe that knowledge is certain and gained by authority, each question has only one correct answer. They also think that no matter well-defined or ill-defined, all problems are well-structured.
2. Quasi-reflective thinking (Stages 4-5): people think that knowledge is uncertain, subjective and contextual. "What is known is always limited by the perspective of the knower" (King & Kitchener, 1994, p. 62). People use evidence and provide different perspectives in reasoning about

debatable issues even if they are not sure about the link between how evidence is gained and a conclusion made.

3. Reflective thinking (Stages 6-7): people think knowledge is uncertain and contextual, and expert authority is critically evaluated. They use evidence and provide different perspectives in reasoning about debatable issues by coordinate knowing and justification to draw a conclusion. People aware of that all conclusions may be reevaluated and that some judgments are more valid or reasonable.

Being the fifth and last model that supports personal epistemology is developmental, Kuhn (1991) developed Argumentative Reasoning Model. Her primary aim was to investigate people's argumentative thinking. In her study, the relationship between epistemological beliefs of participants and their argumentation skills by topic was explored. She interviewed with four different age groups which are teens, 20s, 40s, and 60s. The questions were about three social dilemmas and based on the responses of participants, three epistemological views were identified:

1. Absolutist: Knowledge is absolute and certain.
2. Multiplist: People accept other opinions without judging. They assume that all beliefs are equal.
3. Evaluativist: knowledge is uncertain. People compare and examine all views based on their relative situation.

As a result of the study, Kuhn (1991) found that as the educational level increases, participants are more likely to be in the evaluative category and people in this category are more likely to use counterargument and alternative theory generation. Hence it was concluded that "it is primarily the emergence of the evaluative epistemology that is related to argumentative skill development" (Kuhn, 1991, p. 195).

A different perspective about personal epistemology was developed by Schommer (Schommer,1990; Schommer et al., 1992). Schommer (1990) proposed

that “personal epistemology is a belief system that is composed of several more or less independent dimensions” and “there is more than one belief to consider in personal epistemology” (Schommer-Aikins, 2002, p. 104). Schommer (1990) proposed that epistemological beliefs system has five dimensions which are namely, beliefs about (a) the stability of knowledge, ranging from tentative to unchanging, (b) the structure of knowledge, ranging from isolated bits to integrated concepts, (c) the source of knowledge, ranging from handed down by authority to collected from observation and reason, (d) the speed of knowledge acquisition, ranging from quick-all-or-none learning to gradual learning, and (e) the control of knowledge acquisition, ranging from fixed at birth to lifelong improvement. Schommer (1990) developed a 63 Likert-type item questionnaire named The Schommer Epistemological Questionnaire based upon the study which has a sample of 117 junior college students and 149 university students. She identified five dimensions: Simple knowledge, Omniscient authority, Certain knowledge, Quick learning, Innate or fixed ability. Simple Knowledge means "Knowledge is simple rather than complex". Omniscient Authority implies "Knowledge is handed down by authority rather than from reason and empirical evidence". Certain Knowledge indicates "Knowledge is unchanging rather than tentative". Quick Learning implies "Learning is quick or not at all". Innate Ability means "The ability to learn is innate rather than improvable later". Table 2.1 indicates the five epistemological dimensions. In 1994, Schommer developed a theoretical framework concerning epistemological belief system:

1. Personal epistemology may be conceptualized as a system of beliefs that is personal epistemology is composed of more than one belief.
2. Beliefs within the system are more or less independent, that is, it cannot be assumed that beliefs will be maturing in synchrony.

3. Epistemological beliefs are better characterized as frequency distributions rather than dichotomies or continuums.
4. Epistemological beliefs have both indirect and direct effects.
5. Whether epistemological beliefs are domain general or domain independent will vary over time for any particular individual.
6. Epistemological belief development and change is influenced by experience. These experiences include engaging in problem solving and learning from family, friends, formal education, and life experiences (Schommer-Aikins, 2002, p. 106).

Table 2.1 Schommer's (1990) Hypothesized Epistemological Dimensions

| Epistemological Beliefs | Definition  |
|-------------------------|---|
| Simple Knowledge        | Knowledge is simple rather than complex.  |
| Omniscient Authority    | Knowledge is handed down by authority rather than from reason and empirical evidence. |
| Certain Knowledge       | Knowledge is unchanging rather than tentative.  |
| Quick Learning          | Learning is quick or not at all.  |
| Innate Ability          | The ability to learn is innate rather than acquired                                   |

Quick learning and innate ability dimensions are related with beliefs concerning learning. Schommer-Aikins stated that studying both beliefs regarding knowledge and beliefs regarding learning would provide deeper understanding of personal epistemological beliefs in that these two beliefs are interrelated. Exploratory factor analysis results revealed four of these five hypothesized factors namely innate ability, simple knowledge, quick learning, and certain knowledge. Similarly, some other researchers replicated this four-factor structure (Kardash & Scholes, 1996; Kılınç & Seymen, 2014; Schommer, 1993; Schommer, Crouse, & Rhodes, 1992; Schraw, Dunkle, & Bendixen, 1995; Yılmaz-Tüzün & Topçu, 2008, 2013). However, these studies revealed different factors with different names. For example, Yılmaz-Tüzün and Topçu (2008) investigated the relationship between PSTs'

epistemological beliefs, epistemological world views, and self efficacy beliefs. SEQ was used and factor analysis revealed four epistemological dimensions: Innate ability, certain knowledge, simple knowledge and omniscient authority. This study suggested that epistemological beliefs of PSTs may undergo a change in time and these beliefs are related with the students' academic success. Given these results, it may be useful to conduct a study that investigate all grades of PSTs' epistemological beliefs in order to put forward the difference between their beliefs clearly. Kılınç and Seymen (2014) conducted a study to explore the relationship between motivations behind PSTs' career choice and their epistemological beliefs. Similar with the study of Yılmaz-Tüzün and Topçu (2008), they also revealed four epistemological belief factors: Innate ability, quick learning, omniscient authority and certain knowledge. According to the results, PSTs' career motivations are predicted by beliefs in omniscient authority and innate learning.

Hofer and Pintrich (1997) reviewed above-mentioned studies about epistemological beliefs and stated that "Defining the construct based on existing research is problematic, as there are discrepancies in naming the construct as well as defining the construct, to the extent that it is sometimes unclear to what degree researchers are discussing the same intellectual territory" (p. 111). In their "Epistemological Theories Model", Hofer and Pintrich (1997) proposed that epistemological beliefs have a theory-like structure and tried to explain the structural nature of epistemology, disputing both development perspectives and a system of beliefs. They defined personal epistemology as views about *the nature of knowledge*

including certainty of knowledge and simplicity of knowledge, and *the nature of knowing* including the source of knowledge and justification of knowledge, but not views about the nature of learning.

Yet another approach to personal epistemology named “Epistemological Resources Model” is provided by Hammer and Elby in 2002. They investigated informal knowledge of children age of three. They proposed that epistemology consists of epistemological resources which are more fine-grained than a theory and more context-specific than other models. They stated that epistemological beliefs are stable and robust across contexts and knowledge is free creation, and propagated and fabricated stuff (Hammer & Elby, 2002).

Other than these research studies including basic epistemological models, there is a growing body of literature on personal epistemological beliefs today. For instance, Whitmire (2003) stated that epistemological beliefs affect topic, the use of mediators such as faculty and graduate student advisors, writing tutors, and peers, searching techniques; the evaluation of trustworthiness on the information sources, and the ability to recognize authority. Also, epistemological beliefs of undergraduates affect topic selection, prefocus and focus formulations, and information sources collection. These findings supported there is an effect of undergraduates’ epistemological beliefs on their information-seeking behavior. This result can be correlated with the students’ prior knowledge about different SSI topics in such a way that epistemological beliefs of a student will affect his/her information seeking behavior. Then, s/he will gather the knowledge from different information sources and using this knowledge level about the topic, s/he will evaluate

trustworthiness of them. By doing these, s/he will have a brief knowledge about the SSI topic. Hence, while looking at the evaluation of trustworthiness on different information sources, the knowledge level of students about the related topic and their epistemological beliefs should also be investigated.

### **2.2.2. Epistemological Beliefs and Informal Reasoning**

As the governments invest money to SSI to enhance their economic development, these issues occupy the agenda and people need to make informed decisions at local and global levels (Ratcliffe & Grace, 2003). For similar reasons, many countries have incorporated SSI into their science education programs and students, future citizens, started to learn how to deal with these issues and develop skills necessary for making informed decisions (Day, & Bryce, 2010). The related studies supports that incorporation of SSI into science classrooms enhances scientific literacy, improves beliefs about nature of science and develop moral and ethical sensitivity (Chang & Chiu, 2008; Driver et al., 2000; Kolstø, 2001; Sadler, 2011; Zeidler, Osborne, Erduran, Simon, & Monk, 2003; Zeidler et al., 2002). In addition to this, it is known that epistemological background is crucial in the development of teaching efficacy for SSI education (Baltacı, & Kılınc, 2014).

There are many research studies supporting that personal epistemological beliefs affect people's reasoning about ill-structured problems (Bendixen & Schraw, 2001; Bendixen et al., 1994; Schraw, & Dunkle, 1998; Schommer & Dunnell, 1997; Sinatra, Southerland, McConaughy, & Demastes, 2003). People use their epistemological beliefs in making decisions about ill-structured problems such as SSI

(King & Kitchener, 1994). Schraw et al. (1995) stated that ill-structured and well-structured problems are independent of each other, and they engaged different epistemological beliefs. Kitchener (1983) found that personal epistemological belief is an important component in developing justification for ill-structured problems. Schommer and Dunnell (1997) indicated that the more students believed that knowledge is fixed at birth and unchanging, and learning is quick, the more likely they were to generate responses that were simplistic and unchanging.

### **2.2.3. Epistemological Beliefs and Scientific Knowledge/Academic Achievement**

It is well known that students' epistemological belief systems have an important role in their learning and motivation in the classroom. Students with more advanced, mature epistemic beliefs were found to have deeper level of comprehension (Schommer, 1990), better academic performance (Kember, 2001; Many, Howard, & Hoge, 2002; Schommer et al., 1992; Schommer-Aikins, Duell, & Hutter, 2005; Schommer-Aikins & Easter, 2006), higher ability to solve ill-structured problems, but not well-structured ones (Lodewyk, 2007; Schraw et al., 1995), more elaborated moral reasoning (Bendixen et al., 1998), higher ability to integrate competing claims and reach the right conclusions (Kardash & Scholes, 1996), and higher ability to consider evidence and evaluate alternative points of view, and they are more critical of inconsistencies and misconceptions (Nussbaum, Sinatra, & Poliquin, 2008) than students with naïve epistemic beliefs. Results of the study of Muis and Franco (2009) show that epistemological beliefs affect students' achievement goals, learning strategies and academic achievement. More specifically, Schommer (1990, 1993) found that at university and high school levels students'

epistemological beliefs related to innate ability, simple knowledge, quick learning, and certain knowledge significantly predicted their academic achievement. Also elementary students' epistemological beliefs were significantly related with their level of use of science content knowledge in daily problems (Evcim, Turgut, & Şahin, 2011).

### **2.3. Informal Reasoning and Socioscientific Issues**

People use cognitive and emotional processes in resolution and negotiation of SSI which is best characterized by informal reasoning process (Sadler, 2004). In the science education literature, there are various studies conducted for the analysis of informal reasoning in the context of SSI (Patronis et al., 1999; Sadler, 2004; Sadler & Zeidler, 2005; Topçu, Sadler, Yılmaz-Tüzün, 2010; Topçu, Yılmaz-Tüzün, Sadler, 2010; Wu & Tsai, 2007, 2010, 2011; Yang & Anderson, 2003). There are some different frameworks for conceptualization of informal reasoning regarding SSIs (Patronis et. al., 1999; Sadler & Zeidler, 2005; Yang and Anderson, 2003; Wu & Tsai, 2007, 2010). Patronis and colleagues (1999) constructed a study with 14 year-old students and reported four informal reasoning modes regarding a SSI: Social, ecological, economic, and practical modes. Yang and Anderson (2003) explored reasoning modes of high school students regarding nuclear energy usage and described three reasoning modes: Scientifically oriented, socially oriented, and equally disposed. This categoration was made based upon reasoning of a person depends on scientific information, social factors, or diverse sources of information. Sadler and Zeidler (2005) conducted a study with undergraduates and described three informal reasoning patterns regarding genetic engineering issues: Rationalistic,

emotive, and intuitive. The results of the study of Yılmaz-Tüzün and Topçu (2008) and Topçu et al. (2010) also supported this finding. In parallel with results of the study of Patronis et al., Wu and Tsai (2007, 2010) explored informal reasoning of high school students regarding nuclear energy and reported four main modes: Social-oriented, economic-oriented, ecology-oriented, and science-oriented or technology-oriented arguments.

There are different views about the factors influencing informal reasoning. Some of the research studies concluded that there are mainly four factors that significantly influence informal reasoning: Personal experiences (Albe, 2008; Bell & Lederman, 2003; Sadler et al., 2004; Topçu et al., 2010), nature of science conceptualizations (Bell & Lederman, 2003; Sadler et al., 2004; Zeidler et al., 2002), moral perspectives (Bell & Lederman, 2003; Pedretti, 1999; Zeidler & Schafer, 1984; Topçu et al., 2010), and content knowledge (Albe, 2008; Hogan, 2002; Zeidler and Schafer, 1984). Topçu et al. (2010) added technological concerns and social considerations factors to these. The relationship between content knowledge and informal reasoning will be discussed in the next part in detailed.

### **2.3.1. SSI Content Knowledge and Informal Reasoning**

One of the primary aims for science education has been the promotion of conceptual understanding of science content knowledge (Jenkins, 1990). Sadler (2004) stated to negotiate and make decisions about SSIs, people must possess requisite knowledge about science underlying the issues or the skills needed to acquire that knowledge. There is a common assumption that informal reasoning

quality and content knowledge regarding a SSI are positively correlated as it is obvious that people need to have enough knowledge about a topic in order to make informed decisions.

Investigation of students' knowledge levels about different SSI topics is a popular research subject among researchers from both Turkey and the other countries. There are too many studies conducted to investigate knowledge level of university students about some SSI topics. For instance, Baytelman and Constantinou (2014) conducted a study to examine how PSTs' prior domain-specific conceptual content knowledge about SSIs might affect their informal reasoning. They stated that this content prior knowledge includes the knowledge of concepts, principle, facts and theories of a subject, and understanding of how concepts and principles of the subject are organized (Shulman, 1986; Kleickmann, Richter, Kunter, Elsner, Besser, Krauss, & Baumert, 2012). Three different SSI-dilemmas one from Biology, one from Chemistry and one from Physics. The results showed that the relationships between PSTs' prior conceptual content knowledge about SSIs and informal reasoning about SSI-dilemmas may vary with context. Also it was found that participants' informal reasoning quality may be predicted by their prior knowledge again based on the context. This suggestion was also supported by the studies of Hogan (2002), Zeidler and Schafer (1984), and Simonneaux and Simonneaux (2009) before. Collaterally, two other studies revealed that a lack of conceptual understanding of science content knowledge limited informal reasoning (Fleming, 1986; Tytler et al., 2001). On the basis of their study, Baytelman and Constantinou (2014) pointed out some researchers stated content knowledge does not determine the informal reasoning

quality (Kuhn, 1991; Means & Voss, 1996; Perkins, Farady, & Bushey, 1991), hence more research is needed to describe this relationship robustly. In addition to this, because most of these studies were conducted qualitatively, quantitative research is also needed to be conducted. As Wu and Tsai (2011) stated, with quantitative analyses, the relationship between conceptual understanding and informal reasoning of students regarding SSI and the relationship between students' epistemological beliefs and informal reasoning regarding SSI can be re-examined. By doing this, whether epistemological beliefs or conceptual knowledge is the more dominant factor contributing to their informal reasoning regarding a specific SSI topic would also be determined.

Most of the time, knowledge level associated with attitude and behavior domains in the research studies. Currently, there is a lack of related literature about investigation of the relationship between knowledge level and epistemological beliefs of students; or knowledge level and evaluating trustworthiness on information sources; or between the three research subjects. In this part, it will be tried to give information about different studies including investigation of undergraduates' knowledge levels about three socioscientific issues: Climate change, nuclear energy, and organ donation respectively.

### **2.3.2. Studies about Climate Change**

Today, climate change is one of the crucial, scientific, and environmental problems in the World. In the Fifth Assessment Report (AR5) of Intergovernmental Panel on Climate Change (IPCC, 2013), it was stated that "Warming of the climate

system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased.” (p. 4). The report revealed that the evidences indicate sustain global warming beyond a threshold would lead to the near-complete loss of the Greenland ice sheet over a millennium or more and may cause a global mean sea level rise of about 7 m. While some people stated there are various reasons for climate change such as human activities like deforestation, land use changes, fossil fuel usage, and natural processes like volcano eruptions, El Nino events etc.; some of them support this phenomena is natural rather than man-made. Although governments have been developing local or global action plans to adapt climate change and minimize its effects, this remains incapable in raising public awareness and making people actively participate in mitigation and adaptation to climate change (United Nations Development Programme [UNDP], 2011). The International Panel on Climate Change (IPCC) defines mitigation and adaptation as follows:

Mitigation: an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases.

Adaptation: adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2001).

Citizens should be more involved with policy decisions such as global warming, sustainability, nuclear power plant construction. Teaching about global warming and climate change is vital for raising awareness in climate change. Science teachers have a crucial role in providing students accurate information about climate

change, and increasing public' climate science literacy accordingly. Being a science teacher requires competence in scientific knowledge about different socio-scientific topics, thus more and more studies should be conducted to investigate knowledge levels of PSTs about these issues.

There is a considerable amount of researches conducted on assessing knowledge, attitudes, and behaviors of pre-service teachers about climate change throughout the world. For instance, in a study conducted with 24 pre-service teachers, it was found that 50% of the participants had some misconceptions about green house effect, global warming and climate change (Oluk & Oluk, 2007). It was stated they also had lack of knowledge about these topics.

Another important study about climate change was carried out in order to determine knowledge level of PSTs about global warming (Eroğlu, 2009). Survey method was used and 271 PSTs were selected being a sample. A closed-form Likert type Questionnaire developed by the researcher was applied. Based on the results, although the knowledge level of PST about global warming was found above average, they had inadequate knowledge regarding the topic. It is the evidence for the necessity of an effective and comprehensive environmental education at all grade levels because the earlier students get information about SSI topics, the higher knowledge level they have. This education is especially necessary for PSTs urgently as they are the teachers of the future, and they would reach more and more people.

Kahraman et al. (2008) explored pre-service teachers' levels of awareness and knowledge about global warming and found that the majority of the participants have

low level of awareness and knowledge. According to the results, students have some misconceptions about the topic.

Güley (2009) conducted an extended research study with 1149 university students from different faculties to investigate their content knowledge level about global warming. The results revealed they had inadequate knowledge and Güley (2009) stated that education and courses given by the university governments about environmental problems would have impact in informing students and their practices thereon.

In addition to above-mentioned studies, most of the studies in the related literature suggested pre-service teachers had some misconceptions (Arsal, 2010; Bahar & Aydın, 2002; Bozdoğan & Yanar, 2010; Coşkun & Aydın, 2011; Çelikler & Aksan, 2011; Çelikler & Kara, 2011; Dove, 1996; Khalid, 2003) and lack of knowledge about some environmental issues such as global warming, ozone layer, climate change, greenhouse effect (Bahar & Aydın, 2002; Coşkun & Aydın, 2011; Dove, 1996; Güley, 2009). Also as Yazıcı and Seçgin (2010) pointed out global warming is ranked as the 29<sup>th</sup> of 70 controversial topics in Turkey's educational institutions. Güley (2009) suggested that the activities of governmental agencies, visual and print media, and non-governmental organizations have important role on raising environmental awareness.

### **2.3.3. Studies about Nuclear Energy**

Nuclear energy is an important energy resource and one of the most popular SSI topics. This topic was integrated into school curricula of some countries where

the nuclear energy is commonly used. According to WNA (World Nuclear Association) (2014) statistics, there were 434 nuclear reactors around the world in service with a total capacity of 374,611 MWe as of the date of June 2014. About half of Turkey's electricity comes from gas (41%-two thirds of this from Russia, most of the rest from Iran), 23% from coal, 24% from hydraulics, 8% from thermic and just 3% from wind by (2013 Turkey Energy Report). Because of some obstacles such as governmental problems, and opposition of environmentalists a nuclear energy has not been used in our country yet, but nowadays, construction of a nuclear power plant is in the agenda of Turkey. Recently, TAEA (Turkish Atomic Energy Agency) (2014) prepared the new nuclear program with the request of Turkish government. It was decided to build five nuclear power plants. The first nuclear power plant is decided to built in Mersin Akkuyu and second one in Sinop, in the following years.

Nuclear energy is becoming a hot discussion topic also among educational researchers newly. Some researchers conducted studies in order to investigate students' knowledge levels, attitudes, and views towards nuclear energy usage (Ateş & Saraçoğlu, 2013; Karagöz, 2007; Özdemir & Çobanoğlu, 2008). However, the number of conducted studies about nuclear energy is limited in comparison to climate change topic. One of these studies was conducted by Özdemir and Çobanoğlu (2008) to explore pre-service teachers' attitudes towards nuclear energy usage. The results showed that majority of the participants (51%) expressed that they did not have any formal knowledge on the topic. Atila (2004) investigated knowledge levels of high school teachers about nuclear topics. The results revealed the participants have a lack of knowledge about nuclear topics and Atila (2004)

suggested TAEA should have a role in informing the public about important issues such as usage area of nuclear technology, radiation and its effects, natural radiation resources, ways for radiation protection, definition and scope of task of TAEA, nuclear power plants, nuclear reactor accidents and risk analysis.

Benzer, Bayrak, Eren, & Gürdal (2014) reported PSTs have insufficient knowledge about energy and energy resources and concluded that the content of energy and energy resources of the new undergraduate program on sciences must be enriched and an interdisciplinary cooperation must be established in this sense. Based on the results of their comprehensive study, Ediger and Kentmen (2010) also suggested that Turkish society has a serious lack of knowledge about energy resources and demand information from the government. Yazıcı and Seçgin (2010) pointed out that nuclear energy is ranked as the 53<sup>rd</sup> of 70 controversial topics in Turkey's educational institutions. Kırbağ-Zengin, Keçeci, Kırılmazkaya and Şener (2011) stated that giving place to SSIs in science courses is important in terms of raising students' awareness. Hence, teachers and academicians need to include nuclear energy topic in their classroom. The PSTs' lack of knowledge in the fields of nuclear energy and energy resources poses a problem in respect to science education as they are science teachers of the future. Identifying and satisfying the lack of knowledge, which has been engrained in PSTs and has become permanent, can only be possible during their faculty education and to achieve this, the deficiencies of the education programs must be detected and eliminated (Benzer et al., 2014).

#### **2.3.4. Studies about Organ Donation and Transplantation**

Organ donation and transplantation is another socio-scientific topic which is less popular compared to other two research areas. Organ and tissue transplantation is a lifesaving hope for many people throughout the world. However, the number of recipients on waiting lists for different organs continue to expand. Undoubtedly, having information about organ donation process is one of the most important factors decision-making period of organ donation. This information includes the laws about organ donation and transplantation, brain death in organ donation, role of the family, medical transportation, and religion etc. Being a SSI, organ donation and transplantation should also be included in classrooms by teachers particularly science teachers because of the topic's scientific basis.

There is a limited number of studies conducted to investigate content knowledge levels of students about organ donation and transplantation. Sander and Miller (2005) conducted a study to determine public knowledge and attitudes toward organ and tissue donation in USA. In their study, participants having more favorable attitudes and more knowledge about the topic were found to be more willing to donate their organs and tissues after death. In parallel with this result, the respondents who have donor cards were found to be more knowledgeable and had more favorable attitudes toward donation.

Akiş et al. (2008) investigated knowledge and attitude of Süleyman Demirel University staff about organ and tissue donation and transplantation. The findings revealed that only 28% of the participants found themselves sufficient about organ

and tissue donation. The researchers stated that people do not have enough knowledge about organ donation and transplantation, and they hesitate to donate their organs and proposed that it would be better if associations and foundations make their duties properly.

Kara, Salman and Öngel (2012) carried out a study to explore the views of health personnel of Süleyman Demirel University Medical Faculty towards organ donation. The study revealed that participants who know patients that received an organ transplant, participants who know patients that are expecting an organ transplant and participants who has a family member willingly donated organs have a significant tendency of donating more organs. Although the researchers stated that there are some ethical factors like costumes, traditions and beliefs that may affect the donation, how they affect the viewpoint of the society was not known. They suggested that more study must be conducted to investigate these factors.

Koçak et al. (2010) carried out a study that investigates knowledge level of 171 medical students at Ege University about organ transplantation and donation. 36-items Evaluation of Knowledge Level and Views about Organ Transplantation and Donation Questionnaire was conducted. According to the results, %89 of the participants stated that they have some knowledge about organ donation but %58 of them found their knowledge about this topic inadequate. The results of this study revealed that medical students gain information about organ donation and transplantation mostly from school –textbooks and seminars. The second common information sources are social environment and healthcare organizations whereas radio and television are in the third place. It is an important finding that as the grade

level of students increases, their knowledge level about organ donation and transplantation also increases. This is an expected result considering they are medical students and they probably take courses that mention to these issues. On the other hand, it would be better to teach SSI topics to almost all levels of students. By doing this, organ donation percentage would increase. Keçecioglu (2003) indicated almost all the reasons that prevent organ donation results from in having missing or incorrect information about this topic in other words education of organ donation remains incapable at all levels. Thus, science teachers have an important role in teaching such SSI topics to students at earlier age. By selecting sample as PSTs, a similar study can be carried out.

#### **2.4. Trustworthiness on Different Information Sources**

There are many researches about evaluation of trustworthiness on different information sources. They usually focused on some certain themes like SSI topics, relationship of trustworthiness with knowledge level of participants about the interested topic, with content of the texts conducted in the study, with epistemological beliefs of them, and with their evaluation criteria.

Scientifically literate people and citizens need to negotiate and make informed decisions about SSIs in their daily lives. Although public interested in the resolution of these socioscientific disputes because of their impact on how we live, the information required to formulate a rational judgement on them is complicated, arising from multiple information sources and is often inconclusive (Barnes, 1985; Fleming, 1989).

In the study of Şenel and Güngör (2008), pre-service teachers' opinions regarding climate change and global warming were searched for. 220 pre-service teachers from Balıkesir University was selected as the sample and "Global Warming and Climate Change Attitude Scale" that was developed by the researchers was applied. According to the results, 99.5% of the participants had some information about the topics and they have different information sources. When it was asked students from where they got the information about global warming and climate change, %86 of the participants stated their information source is mass media, %39 chatting with friends, %57 courses, %30 conferences of relevant instructors and % 5 other information sources. As another important finding, just %29 of the pre-service teachers received education about climate change and global warming. Concluding these, selecting and evaluating trustworthiness of different information sources are important points especially in learning about SSI.

Özdemir and Çobanoğlu (2008) examined attitudes of prospective teachers towards nuclear energy usage and construction of nuclear power plants in Turkey. The results revealed %51 of the participants stated they had prior knowledge about the topic. The participants who stated they have a prior knowledge about the nuclear energy, also indicated that their information sources were mass media, environmental courses and their textbooks.

Results of another study conducted to evaluate high school students' prior knowledge about mass extinctions and loss of biodiversity revealed that the majority of the students chose generalist media including TV, Internet and Press as primary source of their knowledge (Almeida, Torres, & Vasconcelos, 2011). However, more

specific sources of science information such as science centres, scientific magazines or books were less selected. Aksan and Çelikler (2013) investigated pre-service teachers' views and perceptions with regard to global warming. Based on the results of their study, it was stated that media has an important role in generation of pre-service teachers' knowledge about the topic. In her study, Yıldırım (2013) indicated that high school students mostly use schools/teachers/textbooks as information sources to learn about climate change issues. Other sources are visual and printed media, and internet.

All these findings support knowledge level about a SSI topic is closely linked with evaluation of trustworthiness on different information sources.

#### **2.4.1. Evidence-based Decision Making Process**

Discussing SSIs in science classrooms encourage evidence-based decisionmaking, improve critical thinking, contribute to character education, and provide an interesting context for teaching required science content ( Zeidler & Nichols, 2009, p. 49). Making decisions about socioscientific dilemmas has to contain careful evaluation of scientific claims with comprehension of the connections among evidence, inferences, and conclusions. Reasoning using evidence, namely evidence-based reasoning, is crucial for being a scientifically-literate person. Hence, it is important to teach evidence-based reasoning at schools.

Facilitated discussion of a content driven SSI can allow students to practice using evidence-based reasoning in a setting that most closely resembles the ways

they may need to use evidence-based reasoning in their roles as citizens in a democratic society (Chandler, 2013).

Baxter Magolda says, “Contextual knowers looked at all aspects of a situation or issue, sought out expert advice in that particular context, and integrated their own and others’ views in deciding what to think.” (1999, p. 50). These relied on evidence from different sources to form their own positions.

#### **2.4.2. Students’ Judgement of Information Sources and Epistemological Beliefs**

Brem, Russell, and Weems (2001) investigated 9<sup>th</sup> and 12<sup>th</sup> graders’ criteria while evaluating scientific arguments. Results indicated that epistemic beliefs affected the way students used and emphasised specific criteria while evaluation websites. They focused more on identifying certain knowledge for websites which contain ambiguous information. They used the belief that knowledge should be certain as a criterion in their evaluation process. In 2004, a similar study was conducted by VanSledright, Alexander, Maggioni, Kelly, and Meuwissen. They explored teachers’ epistemological stances to the criteria they used when judging information sources and how they used these criteria and affirmed there is a relationship between readers’ beliefs and evaluation criteria and the process of source evaluation.

In another study, Whitmire (2003) investigated the relationship between epistemic beliefs of students and their online information seeking behaviour. Results showed that the students who see knowledge as more tentative and who are more

reluctant to blindly trust authority used criteria like author and institution while making a decision about whether trust a website or not.

In the work conducted by Strømsø et al. (2011) whether students' epistemological beliefs predict their evaluation of documents or not was investigated. 126 undergraduate students had 17-items multiple-choice test in order to assess their prior knowledge about climate change. Then, they read two texts about climate change –a popular science text and a newspaper article-, evaluated trustworthiness of them, and stated their rating criteria. It was found that participants that rely on personal interpretations more than on authorities trusted on both texts less. These participants' criteria for evaluating trustworthiness are the content of the texts and their own opinions. The results also indicated that some of the undergraduates believe the knowledge claims should be judged critically through logic and some rules. These participants evaluated the popular science text as more trustworthy than the other one and their criteria was their own opinion, the author of texts and text content. This study shows the importance of people's own opinion in trustworthiness process apart from the content, author and other criteria. However, being a limitation, just two texts about a topic was used during the study. It may not be realize what are the criteria of participants clearly. For this reason, using more texts may be beneficial for this type of studies.

Strømsø, Bråten, and Britt (2010) conducted another study that investigate whether undergraduate students' epistemic beliefs predict their judgement of trustworthiness on texts or not. Firstly, participants read two texts about climate change one is a popular science text, the other one is a newspaper article, and then

they judged trustworthiness by indicating their rating criteria. According to the results, the students found the popular science text more trustworthy than the newspaper article. They also found the newspaper article easier to comprehend than the popular science text. In judging the trustworthiness, the participants put emphasis mostly on content for both texts. Results supported that undergraduates who believe strongly in relying on personal interpretations rather than on authorities trusted both texts less and used the content or their own opinion as criteria in judging trustworthiness. Lastly, undergraduates who believe that knowledge claims should be critically evaluated through logic and rules found the popular science document more trustworthy and used their own opinions, author and content as criteria.

In brief, above-cited studies and many other research suggested that epistemological beliefs of people have an effect on what information they choose to trust and what criteria they use while evaluating an information source. However, the studies are very few and there is a need to investigate this relationship among students in Turkey.

### **2.4.3. Students' Judgement of Information Sources and Content Knowledge**

While evaluating an information source's trustworthiness, the reader would credit the content of the text. The source of the document provide the key information in process of evaluation of the trustworthiness of the text. As Wineburg (1991) stated, "Knowledge of the source helps you understand, helps you predict what you might find, and how reliable or unreliable it might be" (p. 79). In the study conducted by Bråten et al. (2011), how undergraduates judged trustworthiness of

different information sources that they read about climate change was explored. They studied with 128 undergraduate students. In the study, students' rate of trustworthiness of different information sources about climate change, types of criteria that students emphasize when evaluating trustworthiness across documents, and whether they emphasize different criteria when evaluating trustworthiness were investigated. Seven texts written from different viewpoints were read by participants. To determine prior knowledge of participants, 17-items multiple choice test and 49-item questionnaire with 7 items linked to each text were applied. The results showed participants trust more on textbook, official documents than newspapers and commercial agents; and they put more emphasis on content than the publication date. Also it was found that they emphasized criteria differently when evaluating textbook's trustworthiness than other information sources. As an important finding, results stated that undergraduates who are unsuccessful in topic knowledge test were more likely to trust on less trustworthy sources and they failed to differentiate between relevant and irrelevant criteria when evaluating the trustworthiness of sources. Being a limitation of this study, such a generalization may not be done because just seven text was read by the participants. Also, it may not be determined which criteria they used when evaluating the trustworthiness of texts. Lastly, each text type was only represented by one instance in this study, which makes it possible that text type was confounded with other variables such as content, writing style, and familiarity with the specific publication. The things not taken into account might have influenced the results. With addition of the epistemological beliefs of participants into the study, these types of limitations may be reduced by researchers. Similar with these findings, Rouet, Britt, Mason, & Perfetti (1996) and Rouet,

Favart, Britt, & Perfetti (1997) and Wineburg (1991) also observed that prior knowledge affects students' judgements of texts' trustworthiness and their criteria.

#### **2.4.4. Criteria Used in Judging Trustworthiness on Information Sources**

In order to make thoughtful decisions about SSIs, critical assessment of scientific claims, documents and arguments is crucial. An evaluation process includes a minimum of three elements: Object, subject, and the connection between object and subject (Poschmann, Riebenstahl, & Schmidt-Kallert, 1998). During evaluation process, people have to identify criteria, use evaluation strategies and finally make a decision (Jungermann, Pfister, & Fischer, 2005).

In the study of Kolstø, Bungum, Arnesen, Isnes, Kristensen and Mathiassen (2006), PSTs' critical examination of scientific information related to SSIs was investigated. Thirteen different criteria in four groups were identified: 1. Criteria focusing on empirical and theoretical adequacy (quality of references, consistency of argumentation, face validity of argumentation, and compatibility with subject knowledge), 2. Criteria focusing on completeness of information (completeness of references, completeness of an argument, and one-sidedness in the presentation), 3. Criteria focusing on social aspects (possible underlying interest, personal value-related qualities, author's or expert's competence, level of professional recognition, and level of expert agreement), 4. Criteria focusing on manipulative strategies.

Rouet et al. (1996) found that undergraduates rated primary documents like textbooks as more trustworthy than other types of documents. In their study, four types of justifications were defined: Author justifications, document type

justifications, content justifications, and opinion justifications. Author justifications indicates the characteristics of the author of a document, his or her position to the topic, motivation, and participation in the described events. Document type justifications referred to the form of the documents like textbooks, newspaper articles, popular science article... etc. Content justifications referred to the content of the document including mentions of specific contents and evaluation of the content. Lastly, opinion justifications indicates personal view or opinion of the students about the described issue. In the study of Rouet et al. (1996), it was found that undergraduate history students evaluated the documents' trustworthiness mostly based on the characteristics of the content. However, graduate students in history found other documents to be more trustworthy than the textbook and judged trustworthiness of documents considering document type mostly. In another study, graduate students in history relied on primary sources except textbook and evaluated trustworthiness of these primary sources based on author mostly (Rouet et al., 1997). In the same study, graduate students in psychology read the same texts, and stated that they found primary sources less trustworthy and used content justification. Similar with this research, Bazerman (1985) also observed that readers evaluated the trustworthiness of texts by referring to the competence of the author mostly.

Bråten et al. (2009) examined the role of source evaluation in undergraduates' construction of meaning within and across multiple texts. Firstly, the 17-items multiple choice test conducted to assess the participants' prior knowledge about climate change. Then, they read seven texts about different aspects of climate change. These texts were obtained from different information sources namely a

textbook, popular science articles, newspaper articles, a public information text, and a project presentation published by a company. Results of the study indicated trustworthiness ratings of the most reliable texts and using document type as their criteria independently predicted comprehension.

Most of the research on multiple-text reading has been in the domain of history (Wiley, Goldman, Graesser, Sanchez, Ash, & Hemmerich, 2009). However, sourcing matters also in science (e.g., Brem et al., 2001). Although there are very few studies conducted on this research area, based on these findings it can be concluded that more research including university students in different departments is needed to be constructed. Investigation of how PSTs evaluate information they might need to make decisions in their everyday life such as SSIs would contribute to the related literature.

#### **2.4.5. Multiple Documents Literacy and The Documents' Model**

Reading is good habit and a basic process in learning which started in school years. In the process of time, it became a fundamental tool for ongoing learning throughout life. The written and visual media provide the main sources of scientific information for most adults (Jarman & McClune, 2002). Media is the key element in the mediation of the 'relations of definition' between science, the public, and the political spheres (Beck, 1992). Reading is defined as understanding, interpreting, analysing and criticising texts and it is a basic meaning of literacy (Norris & Phillips, 2003). The readers need to know how to analyse the sources critically. This critical reading and critical thinking depend on the context and culture in which they are

situated (Yore, Craig, & Maguire, 1998). PSTs' scientific and media literacy have a particular importance in expanding their science knowledge and accessing further knowledge.

Multiple documents literacy means reading and comprehension of different text-based sources on the same topic or situation (Strømsø & Bråten, 2013). Studying multiple documents to learn about a topic can lead to a deeper, more complete understanding of the content (Wiley et al., 2009). Using multiple documents in science education enhances students' quality of learning by making them possess the required skills and knowledge. This research area is relatively new. Many researchers agreed that the most effectual framework for thinking about multiple text comprehension is the documents' model developed by Perfetti and colleagues (Britt, Perfetti, Sandak, & Rouet, 1999; Perfetti, Rouet, & Britt, 1999; Rouet, 2006). This model describes how readers manage to integrate multiple and possibly conflicting sources of information into coherent memory representations. This model consists of two additional levels of representation: situation model and intertext model. While situation model represents an integrated mental representation of the content in the different documents, the intertext model represents source information and relationships between the different documents (Strømsø & Bråten, 2014).

Multiple texts on the same topic probably lend themselves more to the evaluation and pertinence of trust than one single text does, especially when the different texts oppose each other (Perfetti et. al, 1999). Hence in the present study, multiple texts presenting opposing views on the controversial issues of climate

change, nuclear energy, and organ donation and transplantation were used in order to determine the evaluation criteria of PSTs.

The research study of Ratcliffe (1996) showed that some pupils and students accepted some information without evaluation and some others pointed out insufficient evidence or possible role of scientists' integrity or beliefs. Also in the study of Kolstø (2001), pupils have some problems in many aspects of trustworthiness. He suggested that science education should put more emphasis on knowledge of the characteristics of different kinds of information sources of scientific information. Critical examination, including criteria and knowledge enabling the use of these, needs to be taught explicitly in science teacher education (Kolstø, et al., 2006). Within any course, critical thinking should be taught explicitly.

According to the accessible literature, there is a clear lack of the literature about investigation of trustworthiness of PSTs on different information sources in Turkey. The investigation of a relationship only between trustworthiness and the criteria used while evaluating different information sources would be insufficient since there may be some independent effects remaining unexamined. Hence, there is a need to conduct more and more research that investigate this topic deeply. To achieve this goal, a study which investigates multiple relationships among three variables namely epistemological beliefs, trustworthiness criteria, and content knowledge of PST about different controversial topics can be conducted. In addition to this, there was not found any research consisting organ donation conducted with PSTs. Most of the related studies were conducted with medical personnel or medical students. Also, although nuclear energy and climate change are popular SSI topics,

there is a lack of related literature about evaluation of trustworthiness on different texts looking from different aspects to these topics both in the world and in Turkey. Future research should address these issues.

Taking all these suggestions and findings of researchers into consideration, the present study will fill the gap in the literature by exploring the relationship between PSTs' epistemological beliefs, knowledge level and trustworthiness on information sources regarding climate change, nuclear energy, and organ donation and transplantation.

## **CHAPTER 3**

### **METHOD**

In this part, methods used for the study were described in detail. The chapter consists of information about the research design, sample, data collection instruments and procedure, data analyses, internal validity threats and assumptions and limitations of the study respectively.

#### **3.1. Research Design**

The main aim of this study was to explore relationships among PSTs' epistemological beliefs, knowledge level and the way of evaluating of trustworthiness on different information sources regarding SSIs (climate change, nuclear energy, and organ donation and transplantation). Additionally, their criteria for evaluating these sources were explored. In order to achieve above purposes, a survey design was used. In a survey research, a researcher is generally interested in how and how much of the responses vary – their variability, how closely some responses are related to others and how responses differ within specific demographic variables or with measures of social, political or psychological variables (Krathwohl, 1998). Most surveys contain three basic characteristics: (1) the collection of information, (2) from a sample, (3) by asking questions in order to describe some aspects of the population of which the sample is a part (Fraenkel, & Wallen, 2009).

Correlational and causal-comparative researches are two of the most common tools in analyzing data obtained by using scales in survey analysis (Fraenkel, & Wallen, 2009). With the data obtained through survey, correlational and causal comparative analyses were used to address the research questions of this study.

### **3.2. Sample**

A convenience sample of 630 PSTs from all of the four grade levels of education faculties of four public universities: University 1 in Kırşehir, University 2 in İzmir, University 3 in Kayseri, and University 4 in Ankara participated in the study. Since they are convenient for us, these universities were selected. These universities except University 2 mostly represents Central Anatolia Region. The target population of the study was all PSTs enrolled in Faculties of Education in these four universities in the spring semester of 2012-2013. The target population of this study constituted 1086 PSTs. Of this population 630 PSTs were enrolled to the study voluntarily. Thus, the sample of the study constitutes 58% of the target population. Of the sample 127 PSTs were males and 503 were females. The mean age of the sample was calculated as 20.89 years. Demographic information for the participants was presented in Table 3.1.

Table 3.1 Demographic information for participants

| Grade                                  | Gender |      |        |      | Total  |      |
|--|--------|------|--------|------|--------|------|
|  | Male   |      | Female |      | Number | %    |
|  | Number | %    | Number | %    |        |      |
| 1                                      | 33     | 22,8 | 112    | 77,2 | 145    | 23,0 |
| 2                                      | 19     | 14,6 | 111    | 85,4 | 130    | 20,6 |
| 3                                      | 38     | 18,4 | 168    | 81,6 | 206    | 32,7 |
| 4                                      | 37     | 24,8 | 112    | 75,2 | 149    | 23,7 |
| Total                                  | 127    | 20,2 | 503    | 79,8 | 630    | 100  |
| Graduated high school                  |        |      | Number | %    |        |      |
| General high school                    |        |      | 335    | 53,3 |        |      |
| Vocational high school                 |        |      | 10     | 1,6  |        |      |
| Super high school                      |        |      | 12     | 1,9  |        |      |
| Science high school                    |        |      | 1      | 0,2  |        |      |
| Anatolian high school                  |        |      | 230    | 36,6 |        |      |
| Anatolian teacher training high school |        |      | 39     | 6,2  |        |      |
| Other                                  |        |      | 2      | 0,3  |        |      |
| Mother's education                     |        |      | Number | %    |        |      |
| Unschoolled                            |        |      | 8      | 1,3  |        |      |
| Primary school                         |        |      | 327    | 52,4 |        |      |
| Secondary school                       |        |      | 114    | 18,3 |        |      |
| High school                            |        |      | 112    | 17,9 |        |      |
| University                             |        |      | 62     | 9,9  |        |      |
| Graduate education                     |        |      | 1      | 0,2  |        |      |
| Total                                  |        |      | 624    | 100  |        |      |
| Father's education                     |        |      | Number | %    |        |      |
| Unschoolled                            |        |      | 0      | 0,0  |        |      |
| Primary school                         |        |      | 179    | 28,5 |        |      |
| Secondary school                       |        |      | 110    | 17,5 |        |      |
| High school                            |        |      | 173    | 27,6 |        |      |
| University                             |        |      | 157    | 25,0 |        |      |
| Graduate education                     |        |      | 8      | 1,3  |        |      |
| Total                                  |        |      | 624    | 100  |        |      |
| Number of taken courses include SSI    |        |      | Number | %    |        |      |
| 0                                      |        |      | 143    | 22,8 |        |      |
| 1                                      |        |      | 224    | 35,7 |        |      |
| 2                                      |        |      | 241    | 38,4 |        |      |
| 3                                      |        |      | 20     | 3,2  |        |      |
| Total                                  |        |      | 628    | 100  |        |      |

### **3.3. Instrumentation**

In this study, four instruments were applied to the participants: 1. Schommer's Epistemological Questionnaire (SEQ) developed by Schommer (1990), 2. Knowledge Test assessing content knowledge regarding three SSIs developed for the purpose of this study, 3. Texts from different information sources compiled by the researcher, 4. Trustworthiness questionnaire developed by Bråten et al. (2011).

First, in order to assess PSTs' epistemological beliefs, quantitative data were collected through the Likert-type Schommer's Epistemological Questionnaire (SEQ). Second, a 42-item multiple-choice knowledge test was developed and applied to evaluate PSTs' knowledge levels about three SSI. Third, to measure the participants' trustworthiness and determine their criteria, 10-point Likert-type trustworthiness questionnaire developed by Bråten et al. (2011) was applied soon after the texts from different information sources compiled by the researcher. Last, a relationships among PSTs' epistemological beliefs, knowledge level and the way of evaluating of trustworthiness on different sources regarding SSIs was explored.

#### **3.3.1. Schommer's Epistemological Questionnaire (SEQ)**

In this study, SEQ, the first quantitative measurement tool for epistemological beliefs developed by Schommer (1990), was used to determine PSTs' epistemological beliefs. The questionnaire consists of 63 items that use a 5-point Likert scale (1= strongly disagree; 5= strongly agree). Items with negative statement were reverse coded so that higher scores indicated less developed epistemological

beliefs. SEQ includes five hypothetical dimensions and 12 subscales within these dimensions (see Table 3.2).

Table 3.2 Hypothetical Dimensions and Subscales of SEQ

| Hypothetical dimensions | Subscales                              | Number of items |
|-------------------------|--|-----------------|
| Simple knowledge        | Seek single answers                    | 11              |
|                         | Avoid integration                      | 8               |
| Certain knowledge       | Avoid ambiguity                        | 5               |
|                         | Knowledge is certain                   | 6               |
| Omniscient authority    | Do not criticize authority             | 6               |
|                         | Depend on authority                    | 4               |
|                         | Cannot learn how to learn              | 5               |
| Innate ability          | Success is unrelated to hard work      | 4               |
|                         | Ability to learn is innate             | 4               |
|                         | Learning is quick                      | 5               |
| Quick learning          | Learn the first time                   | 3               |
|                         | Concentrated effort is a waste of time | 2               |

Adapted from Schommer's (1990) "Effects of beliefs about the nature of knowledge on comprehension" (p. 500).

Topçu and Yılmaz-Tüzün (2006) translated and validated SEQ into Turkish (see Appendix B). Throughout validation of the instrument, a pilot study was conducted with 94 PSTs and factor analysis was computed. Factor analysis structures showed parallel structure with Schommer's (1990) study.

### 3.3.1.1. Factor Structure of SEQ

In the present study, in order to validate and define the factor structure of 12 subscales of items exploratory factor analysis (EFA) was used rather than confirmatory factor analysis (CFA) since many other studies conducted in Turkey found different factor structures. As Finch and West (1997) stated, EFA should be used when there is no a priori hypothesis regarding the factors of measured variables. Before starting the analyses, certain assumptions were checked:

1. Sample size: Factor analysis is a large sample size technique. Recommendations on appropriate sample sizes for factor analysis vary considerably (Fabrigar et al., 1999). Comrey and Lee (1992) thought that the samples of 100 = poor, 200 = fair, 300 = good, 500 = very good, 1000 or more = excellent for factor analysis. Similarly, Tabachnick and Fidell (2007) stated that there should be at least 300 participants to perform the analysis. Pallant (2007) put forward that it is necessary to have at least five cases for each variables. Since there are 630 cases to 63 items, this study met the sample size assumption.
2. Factorability of the correlation matrix: In order to conduct a suitable factor analysis, the correlation  $r$  should be .3 or greater (Tabachnick & Fidell, 2007). If the correlation coefficients .3 and above do not find in the correlation matrix, it should be reconsidered to use factor analysis (Pallant, 2007). Additionally, Bartlett's test of Sphericity should be statistically significant at  $p < .05$  and the Kaiser-Meyer-Olkin value should be .6 or greater (Pallant, 2007). In this study, all the correlation

coefficients in correlational matrix table are .3 and above. In addition to this, Barlett's test of Sphericity was statistically significant at  $p < .05$  with the p value of .00. Lastly, Kaiser-Meyer-Olkin value was .824. Hence, factorability of the correlation matrix assumption was met in the study.

3. Linearity: Due to factor analysis is based on correlation, it is assumed that the relationship between the variables is linear (Pallant, 2007). Pallant (2007) stated that if the sample size and ratio of cases to variables are adequate, this assumption is met. In this study, the sample size and ration of cases to variables were adequate so that this assumption was also met.
4. Outliers among cases: Factor analysis may be sensitive to outliers. Thus, to make this assumption met, these outliers were checked and removed from the data before conducting the analyses.

Soon after checking assumptions above, reliability analysis and factor analysis were conducted. The reliability of total scale including 63 items was found to be .82 as measured by the Cronbach's alpha coefficient. The results of analyses revealed four factors that account for 55.9 % of the variance. Similar with Schommer's (1990) analyses, descriptive titles were given to each factor based on the subscales having factor loadings of .50 and higher. Factor 1 was named "Quick Learning" including the subscale dimensions of "Learn the first time" and "Concentrated effort is a waste of time" with the Cronbach's alpha of .70. Factor 2 was named "Certain Knowledge" including the subscale dimension of "Avoid ambiguity" with the Cronbach's alpha of .49. Factor 3 was named "Simple Knowledge" including the subscale dimension of "Seek single answers" with the

Cronbach’s alpha of .48. Factor 4 was named “Omniscient Authority” including the subscales of “Depend on authority” and “Do not criticize authority” with the Cronbach’s alpha of .68. Factor structure, variances related to the factors and eigenvalues of them are showed in Table 3.3.

Table 3.3 Factor Loadings of Principal Component Factor Analysis with Varimax Rotation of SEQ Items

| Subscales                                 | Factor loading |             |             |              |
|---|----------------|-------------|-------------|--------------|
|   | 1              | 2           | 3           | 4            |
| 1. Cannot learn how to learn              | <b>.713</b>    | .052        | -.069       | .286         |
| 2. Learn the first time                   | <b>.702</b>    | -.211       | .123        | .006         |
| 3. Success is unrelated to hard work      | <b>.676</b>    | .170        | .037        | -.023        |
| 4. Concentrated effort is a waste of time | <b>.614</b>    | .145        | .135        | .033         |
| 5. Avoid integration                      | <b>.578</b>    | .339        | .214        | -.061        |
| 6. Avoid ambiguity                        | -.108          | <b>.786</b> | -.054       | -.127        |
| 7. Learning is quick                      | .397           | <b>.573</b> | .114        | .018         |
| 8. Ability to learn is innate             | .217           | <b>.493</b> | .337        | .161         |
| 9. Seek single answers                    | -.015          | -.026       | <b>.822</b> | -.177        |
| 10. Knowledge is certain                  | .227           | .179        | <b>.599</b> | .224         |
| 11. Depend on authority                   | .108           | .160        | .113        | <b>-.856</b> |
| 12. Do not criticize authority            | .390           | .185        | .244        | <b>.588</b>  |
| Eigenvalue                                | 3.279          | 1.419       | 1.026       | .982         |
| % of variances                            | 27.322         | 11.827      | 8.551       | 8.184        |

*Note.* Major loadings for each item are bolded.

Inter-item reliabilities for items of each factor were range from .48 to .70. Those were lower than Schommer’s findings ranging from .51 to .78. According to

Pallant (2007), the recommended optimal range for the inter-item correlation mean is .2 to .4. According to Clark and Watson (1995), the average inter-item correlation should fall somewhere between .15 and .50. Yılmaz-Tüzün and Topçu (2008) explained two reasons for this lower reliability. Firstly, some subscale dimensions may not load into their hypothesized dimensions. Instead of this, they may be loaded highly to other factors. This indicates that Turkish context participants might not successfully differentiate subscale items because of their close meanings. Secondly, Turkish participants might not understand the items in a way the original questionnaire indicated if the Turkish version can not captured the full and literal meaning of the original questionnaire. Since our values are in the acceptable range and close to the values of Schommer's study, we continued our analysis. In the present study, Table 3.3 showed the subscale dimensions loaded highly to other factors instead of their hypothesized ones. Pallant (2007) stated that if there are factors composed of maximum 10 items, it is possible to obtain lower correlations. Thus because of the unique characteristics of the SEQ and lower reliabilities reported earlier we decided to use this scale in our further analysis.

### **3.3.2. Knowledge Test Assessing Content Knowledge Regarding three SSIs**

For the present study, a knowledge test including 47-item multiple-choice questions with four answer choices –15 items for nuclear energy, 15 items for organ donation and transplantation, and 17 items for climate change topic, were developed in order to assess PSTs' knowledge level about the topics (see Appendix C).

The questions were at knowledge level mostly. Using this test, it was aimed to differentiate between participants who hold little or no understanding regarding the three topics. While questions were formed, science curriculum, elementary science education textbooks prepared by the Ministry of National Education, and course contents of the four universities were examined carefully. These courses were namely Sustainable Energy, Special Topics in Chemistry, Environmental Science, Special Topics in Biology, Electrochemistry and Nuclear Chemistry, Environmental Chemistry, Environmental Consciousness, Contemporary World Problems, Natural Energy Resources, Radiation and Environment Interactions (see Table 3.4). Five content experts (three academicians –one of them is expert on Environmental Education, and two of them are from the department of Elementary Science Education with a minimum 10 years teaching experience; and two elementary science teachers with a minimum 5 years teaching experience) reviewed the knowledge test for content, accuracy and clarity. The instrument was finalized before pilot study after making necessary changes in the light of suggestions of the experts.

Table 3.4 The Four Universities' Course Names With Contents

| <b>Course</b>                          | <b>Course type</b> | <b>Containing topic</b>               | <b>University</b> | <b>Grade</b> |
|--|--------------------|---------------------------------------|-------------------|--------------|
| Contemporary World Problems            | Elective           | climate change                        | 3                 | 4            |
| Electrochemistry and Nuclear Chemistry | Elective           | nuclear energy                        | 1                 | 4            |
| Environmental Chemistry                | Elective           | climate change<br>nuclear energy      | 1                 | 4            |
| Environmental Consciousness            | Elective           | climate change                        | 1                 | 2            |
| Environmental Science                  | Must               | climate change<br>nuclear energy      | 1<br>3<br>4       | 3            |
| Natural Energy Resources               | Elective           | nuclear energy                        | 3                 | 2            |
| Radiation and Environment Interactions | Elective           |                                       | 1                 | 4            |
| Special Topics in Chemistry            | Must               | climate change<br>nuclear energy      | 1<br>3<br>4       | 3            |
| Special Topics in Biology              | Must               | organ donation<br>and transplantation | 1<br>3<br>4       | 4            |
| Sustainable Development                | Elective           |                                       | 2                 | 3            |

### 3.3.2.1. Pilot Study

A pilot study is conducted in order to understand the appropriateness of the content, instructions, questions, and scale items (Pallant, 2007). Pilot test of a newly developed instrument should be conducted with respondents selected from population of the original study (Lackey & Wingate, 1998). Kline (1994) stated that the larger the sample size, the more reliable the analysis. Additionally, the sample for a pilot study of an instrument is recommended to be at least one tenth the size of the sample for the primary study (Baker, 1994; Pett, Lackey, & Sullivan, 2003). Considering all of these, the knowledge test was pilot tested with 120 PSTs from

various grades of the four public universities. Below analyses were done for reliability and validity purposes.

First, reliability of the knowledge test items was measured by Cronbach's alpha. Field (2009) described the acceptable range of alpha value to be from .70 to .80 and values lower than .70 indicating an unreliable scale. In the present study, the reliability of 47 items was found as .75. This value is acceptable (Pallant, 2007). By examining each item's Cronbach's alpha if item deleted value in item-total statistics table, it was decided to remove five items having lower values. One item from nuclear energy, two items from organ donation and transplantation, and two items from climate change test were removed from the instrument. In this case, the knowledge test had 42 items. After removing these five items, reliability of the knowledge test was reexamined. This time, Cronbach's alpha coefficient was found as 0.77 and it was seen that there was no need to remove another item.

Second, knowledge test in the present study was composed of dichotomously scored items; hence it would be better to calculate the Kuder-Richardson 20 ( $KR_{20}$ ) value. The results obtained by pilot test were used to assess the instrument's internal consistency using  $KR_{20}$  estimate. The  $KR_{20}$  formula is:

$$KR_{20} = \frac{k}{k-1} \left( 1 - \frac{\sum pq}{\sigma^2_X} \right)$$

where  $k$  is the number of items  $\sigma^2_X$  is the total test variance, and  $pq$  is the variance of item  $i$ . Given the conservative nature of Kuder-Richardson estimates (Mehrens & Lehmann, 1991), internal consistency was calculated as  $r_{xx}=0.76$ . This suggested that

the instrument was reliable. Pilot study enabled us to use this knowledge test for the main study. The below analysis was obtained for the main study.

### **ITEMAN Analysis:**

Item analysis process was conducted with 120 PSTs in the pilot study. The analysis included 42 items of the knowledge test. The proportion of respondents for any question correctly ( $p$ -value) ranged from .87 indicating very easy question to .09 indicating a very difficult question. The average  $p$  value was .52. Suen and McClellan (2003) suggested that when  $p$  is equal to 0.5, the item variance is maximized for the best reliability. Hence,  $p$ -value of this study supported reliability and there is no need to remove any other item from the knowledge test. In conclusion, as a result of reliability and validity checking, a knowledge test including 42-item multiple-choice questions with four answer choices regarding the three SSIs was developed to assess PSTs' knowledge level about the topics.

According to the analysis, raw scores ranged from 8 (19.1%) to 37 (88.1%) items answered correctly out of 42 items. The distribution of scores approximated a normal distribution (skewness =  $-.525$ ; kurtosis =  $.318$ ) with a mean of 27.15 and standard deviation of 5.963. The alpha value was 0.680 which suggested that the test was reliable. The proportion of respondents of a particular question correctly ( $p$ -value) which shows the difficulty of the item, ranged from 0.91 indicating a very easy question to 0.20 indicating a very difficult question. Average  $p$ -value was found 0.62 which suggested that the test was appropriately challenging for the sample (Osterlind, 1989).

Point-biserial correlation coefficients varied from 0.112 to 0.534. All of the correlations among items were positive. There were 10 items which have point biserial values less than .19. In terms of discrimination index, .40 and greater are very good items, .30 to .39 are reasonably good but possibly subject to improvement, .20 to .29 are marginal items and need some revision, below .19 are considered poor items and need major revision or should be eliminated (Ebel & Frisbie, 1986). Although these 10 items have low discrimination values, since some of them assess the misconceptions these items remained on the test. As Engelhardt and Beichner (2004) stated that the low average discrimination values may indicate that the test is indeed uncovering students' misconceptions.

### **3.3.2.2. Main Study**

For the present study validity and reliability analyses of the knowledge test and item analysis regarding the three SSIs were conducted, and Cronbach's alpha coefficient and KR 20 values were calculated.

The Cronbach's alpha value was calculated by using reliability analysis in Statistical Package for Social Sciences (SPSS) 20. The alpha value was 0.77 which suggested that reliability of the knowledge test was acceptable (Cronbach, 1951). This value was same as the Cronbach's alpha value of the pilot study and ITEMAN analysis.

Since the knowledge test in the present study was composed of dichotomously scored items, it is better to calculate the KR<sub>20</sub> value. KR 20 was preferred to KR 21 since when item difficulties vary as stated in the results of

ITEMAN analysis, the reliability estimate from the KR 21 is systematically lower than the KR 20 (Crocker & Algina, 1986). The KR<sub>20</sub> value also found as 0.77 which is consistent with the alpha value obtained from SPSS.

### **ITEMAN Analysis:**

Nunnally (1967, as cited in Crocker & Algina, 1986) stated that it is necessary to have 5 to 10 times as many subjects as items to run the item analysis. In addition, Crocker and Algina (1986) recommended a minimum number of 200. Accordingly, there should be at least 420 participants, since we have 42 items. Hence, item analysis process was also conducted in the main study with 630 PSTs. The proportion of the respondents for any question correctly (*p*-value) ranged from .90 indicating very easy question to .08 indicating a very difficult question. The average *p* value was .56. Suen and McClellan (2003) suggested that “Generally, look for  $p = 0.5$ , where half the examinees know the correct answer and half do not, because when  $p = 0.5$ , the item variance is maximized for the best reliability. However, based on the random guessing model, the target *p*-value for a multiple-choice item would be 0.75 for a 2-option item, 0.67 for a 3-option item, 0.62 for a 4-option item, and 0.60 for a 5-option item.” Hence, being a 4-option item, *p*-value of this study supported reliability.

According to the analysis, raw scores ranged from 7 (16.7%) to 39 (92.9%) items answered correctly out of 42 items. The distribution of scores approximated a normal distribution (skewness = -.612; kurtosis = -.073) with a mean of 25.90 and standard deviation of 6.337. The alpha value was 0.690 which suggested that the test

was reliable. The proportion of respondents of a particular question correctly ( $p$ -value) which shows the difficulty of the item, ranged from 0.93 indicating a very easy question to 0.22 indicating a very difficult question. Average  $p$ -value was found 0.64 which suggested that the test was appropriately challenging for the sample (Osterlind, 1989).

Point-biserial correlation coefficients varied from 0.106 to 0.542. All of the correlations among items were positive. Similar to the pilot study, in the main study there were also 10 items which have point biserial values less than .19. Although these items have low discrimination values, since some of them assess the misconceptions they remained on the test. In conclusion, the results of these analyses made us sure about the appropriateness of 42-item knowledge test without removing any other items.

### **3.3.3. Texts From Different Information Sources**

There is a large number of written sources about the three SSIs. For this study nine separate Turkish texts about the three SSIs from different information sources were used. For each SSI topic, there were three texts including the information about the primary and secondary information sources, and publication dates. While determining the sources, we paid attention to the followings:

1. Having different mediums such as newspaper, journal, online journal, scientific journal. As Kolstø (2001) stated, to guide evaluation of sources, knowledge of the characteristics of different kinds of sources of science-based information should be included. Additionally, in a similar study

Bråten et al. (2011) also paid attention to the texts' representing different kinds of authentic source materials that educated adult readers typically encounter.

Authors were determined based on some features in that they mostly are academicians or member of leading institutions like Greenpeace, TÜBİTAK who gain public acceptance, have important studies on the selected subjects and play an active role on different groups. Besides this characteristics, as Harris (2013) stated that the author or source of the information should show some evidence of being knowledgeable, reliable, and truthful. Some tips which were considered while selecting the authors and information sources of this study are as follows:

- “Author's education, training, experience in a field relevant to the information. Look for biographical information, the author's title or position of employment
  - Author provides contact information (email or snail mail address, phone number)
  - Organizational authorship from a known and respected organization (corporate, governmental, or non-profit)
  - Author's reputation or standing among peers.
  - Author's position (job function, title)” (Harris, 2013).
2. Texts were determined based on some features in that they are easily accessible, widely acclaimed hence the participants may have a tendency to read them. In addition, the texts are up-to-date which means they

contain the latest information about the topics. Also they provide reliable information on the subject and this information was based upon various sources,

3. Having different publication dates since it is one of the six criteria that needs to be rated by PSTs,
4. Having different contents – e.g., texts about climate change presented different views on the causes of climate change, and the texts about nuclear energy presented different views regarding nuclear power plant construction in Turkey. Lastly, texts about organ donation and transplantation presented different problems, deficiencies and misconceptions with respect to the topic. Similarly, in their study, Strømsøet al. (2008) selected the texts contained partly conflicting information presenting different views on the causes, consequences, and solutions of global warming instead of using texts including more neutral information.
5. Being short and fluent.

The first three texts were about climate change topic. The first text was a 211-word text about climate change was obtain from an online newspaper website and written by an author who is a member of the climate change working group of a public university in İstanbul. This text (Text 1) discussed human activity is the major cause for global warming. The article was published in 2012. The second text was a 138-word text about climate change from an online newspaper written by an academicians professor who is the president of the Environmental Issues Research

and Implementation Center of a university in Antalya. This text (Text 2) was published in 2011 and discussed solar energy is the primary factor for climate change. The last text about climate change was a 169-word text written by an author in a scientific journal in 2005. This text (Text 3) included the information about how both natural causes and human activities contribute to climate change. This one dealt with the topic in a relatively neutral way.

The second three texts were about nuclear energy. The first text was a 243-word online newspaper article written by an academician professor in 2013. In this text (Text 4), the author promoted the idea of Turkey should start to use nuclear energy by taking precautions. The second text (Text 5) was a 228-word text written in the website of a non governmental environmental organization in 2008. This text mentioned the drawbacks of nuclear energy and defended Turkey should not build any nuclear power plant. The third text (Text 6) was a 217-word text published by an online newspaper including the phrases of academician professor about nuclear energy usage in Turkey. The article was published in 2007. He stated Turkey need to have nuclear power plant(s) and people who against nuclear power plant construction in Turkey are the ones who do not want Turkey's development.

The last three texts were about organ donation and transplantation. The first text was a 205-word text quoted from a professor of medicine. This (Text 7) is a public information text published by an online newspaper in 2012. The professor stated that there is no favouritism in organ transplantation and pointed out there is a lack of knowledge about the importance of organ donation. The second text was a 222-word text published by a newspaper in 2013. This (Text 8) is also a public

information text quoted from the president of Turkish Kidney Foundation. He stated that there are many people who want to sell their kidneys; however this is forbidden and result in adverse outcomes. He also stated that transplantation of organs from human cadavers remains insufficient. The last text (Text 9) was a 199-word text was published in 2001 and retrieved from a scientific journal. The author mentioned the main reasons of insufficiency of organ transplantation from human cadavers and misconceptions about organ transplantation.

In implementation process of the study, it was expected that PSTs having an adequate knowledge about the topics will evaluate each information source easily. It was also expected that PSTs' judging information of a specific source to be more trustworthy than other sources will show they compare scientific knowledge based on different sources. Since PSTs' range of trustworthiness on sources and their criteria may vary by topic, this was also explored in this study. Additionally, it was expected that PSTs will make a comparison between their own opinion and content of the text written about the topic. It is important that they should decide for which topic their own opinion will become prominent, and for which topic the content of the text will become prominent.

Each text was printed on one separate sheet of paper respectively, and date of publication, name of the information source and author were presented at the top of each page.

### 3.3.4. Trustworthiness Questionnaire

In order to measure the participants' judgments of trustworthiness and determine their criteria they put on while judging text trustworthiness, 10-point Likert-type trustworthiness questionnaire developed by Bråten et al. (2011) was applied. This questionnaire originally has 56 items for seven texts. That means for each text there is one item ranging from *to a very little extent* (1) to *to a very large extent* (10) about trustworthiness on the text, there are six items ranging from *to a very little extent* (1) to *to a very large extent* (10) for each criterion, and there is one item ranging from *to very easy* (1) to *very difficult* (10) about comprehensibility of the text. However, since there are 9 texts in this study, the items were replicated and a 72-item questionnaire conducted. The questionnaire was translated into Turkish language and validated (see Appendix E). Also the translation was checked by a bilingual expert. Soon after translation was completed, the questionnaire was pilot tested with 120 PSTs. First, reliability of the Likert-type 72-item questionnaire was measured by Cronbach's alpha. For a Likert scale, the value of Cronbach's alpha should be larger than .70 for a reliable scale (Nunnally, 1967). In the pilot study, the reliability was .95 indicated a very strong internal consistency (Pallant, 2007). In the present study conducted with 630 PSTs, reliability was found as .97 indicating very strong internal consistency.

The trustworthiness questionnaire included three parts mainly: 1. Trustworthiness on the text including one item, 2. Trustworthiness on each criterion including six items, and 3. Comprehensibility of the text including one item. More information about each part was given below.

#### **3.3.4.1. Trustworthiness on the Text**

At the beginning, the respondents were given a written instruction for the questionnaire ‘In the following, we list all the nine texts that you have now read. In connection with each text, we ask you some questions about how you judge the trustworthiness of the text. Do not turn back to the texts when you answer these questions. You will get a brief description of each text before you answer the questions.’ (Bråten et al., 2011). After these instructions, PSTs were asked to indicate the extent to which they trusted the information in the text using the 10-point Likert-type scale. This is the only item in the first part of the questionnaire.

#### **3.3.4.2. Trustworthiness on Each Criterion**

In this part, PSTs were given six different justification criteria (author, publisher, type of text, content of text, own opinion about topic, and publication date of text, respectively) and asked to indicate to what extent they had based their rating of the text’s trustworthiness on each criteria using the 10-point Likert-type scale. Bråten et al. (2011) stated that the justification criteria were based on the study of Rouet et al. (1996), and Britt and Aglinskas’ (2002) reanalysis of data from that study, with the addition of the publisher category.

#### **3.3.4.3. Comprehensibility of the Text**

This last part of the questionnaire involved the assessment of perceived comprehensibility of each text. Therefore, PSTs were asked to rate how difficult they thought each text was to understand using the 10-point Likert-type scale.

### **3.4. Data Collection**

Data collection procedure took one semester, 2012-2013 Spring. Before starting data collection, the necessary permissions from four universities in order to conduct the research and the ethical permission from Ethical Committee were obtained. The questionnaires were conducted within two months – May and June. PSTs were given approximately 45 minutes to complete all the three questionnaires and read the texts. The questionnaires were distributed right after the participant information sheet (see Appendix A). The questionnaires were answered in the same class hour in the order of SEQ, knowledge test, trustworthiness questionnaire. After the knowledge test, nine texts were given PSTs and then trustworthiness questionnaire were given them. The questionnaires were administered only by the researcher in order to be sure about consistency of procedure of data collection. The researcher explained aim of the study and asked the participants not to leave any part unanswered. Before the administration of the questionnaires, all the participants signed a consent form about they were participated the research study voluntarily.

### **3.5. Data Analysis**

Statistical Package for Social Sciences (SPSS) 20 was used to analyze the data. There were three major variables involved in this study; PSTs' epistemological beliefs, content knowledge levels about three SSI topics, and the way of evaluating of trustworthiness on different information sources. First, PSTs' epistemological beliefs were assessed quantitatively by through a 63-item close-ended questionnaire. The answers were coded and interpreted based on the Schommer's (1990) five

epistemological dimensions. Second, participants' answers to the knowledge test were coded based on the answer key. Each correct answer was coded as "1" and each incorrect answer was coded as "0". Their total scores for 42-item knowledge test were also calculated. Last, answers for the trustworthiness questionnaire of Bråten et al. (2011) were assessed. In order to explore the relationship between the three variables, PSTs' epistemological beliefs, content knowledge levels about three SSI topics, and the way of evaluating of trustworthiness on different information sources, some statistical analyses were conducted. Also factor analysis was used to define the factor structure of items. In order to describe PSTs' content knowledge levels (third research question), descriptive statistics was used.

For the trustworthiness questionnaire, descriptive statistics were used. A mixed-ANOVA was conducted to answer the first and second research questions. To find out a relationship between three variables (fifth research question) correlational analysis were conducted.

### **3.6. Validity of the Study**

In this part, internal and external validity of the study are discussed.

#### **3.6.1. Internal Validity**

Internal validity means that any relationship observed between the dependent variables should be directly related to the independent variable, not caused by any other unintended variables (Fraenkel & Wallen, 2009). In this part, the possible threats to the internal validity of the present study were discussed.

### **3.6.1.1. Subject Characteristics**

Some characteristics of the subjects like gender, age, maturity, ethnicity, intelligence, attitude, reading ability, socioeconomic status, and political or religious beliefs may have an effect on the study and this may result in subject characteristics threat (Fraenkel & Wallen, 2009). To minimize this threat, participants were selected based on some characteristics in the present study. Since participants were at the same grade levels their ages were close to each other. The number of students is not exactly same but close among the grade levels. Additionally, all the participants were public university students from the same department –elementary science education and the educational levels of their parents nearly similar. These may be indicators for their socioeconomic status are nearly similar. Hence, subject characteristics threat is not a problem for this study except that some subject characteristics such as motivation, intelligence or reading ability could not be controlled.

### **3.6.1.2. Mortality**

Even if the subjects were carefully selected, it is common to lose some of the subjects during the study. This threat known as mortality threat or loss of subjects (Fraenkel & Wallen, 2009). Loss of subjects limits generalizability. In this study, the sample constituted 58% of the target population. Since this is a high percentage to represent the target population, mortality could not be a threat for this study.

### **3.6.1.3. Location**

The locations in which data are collected may create alternative explanations for the results and this named as location threat (Fraenkel & Wallen, 2009). The location could not be threat in the current study because data collection instruments were administrated in subjects' own classrooms under similar conditions. Also the location sites and classroom environments of four universities in different countries were very similar. Hence, location threat could not be a threat for this study.

### **3.6.1.4. Instrumentation**

If there are instrument decay, influence of data collector characteristics and/or data collector bias in a study, the instrumentation threat may occur (Fraenkel & Wallen, 2009). Firstly, since the data collection and scoring were scheduled, instrument decay could not be a threat in this study. Secondly, since all the data were collected by the same researcher, data collector characteristics could not be an internal validity threat. Lastly, the researcher behaved in a standard way during the data collection procedure, for instance the necessary information about the study was made. Hence, data collector bias was not a threat for the current study.

### **3.6.1.5. Testing**

In intervention studies, it is common to test subjects at the beginning of the intervention. The use of a pretest in these studies sometimes result in a substantial improvement in posttest scores. However, researchers may think that this is because of the intervention. This is called as testing threat (Fraenkel & Wallen, 2009). In this

study, testing is not a threat since the instruments were used only once. Also, the study includes three instruments which were not related to each other, so that none of them might be caused a clue for the other two instruments.

#### **3.6.1.6. History**

Occasionally, one or more unanticipated and unplanned events occur and affect the responses of subjects. This is known as history threat (Fraenkel & Wallen, 2009). In this study, all the conditions tried to be controlled by the data collector and unexpected events did not occurred during the study. Hence history is not a threat for the current study.

#### **3.6.1.7. Maturation**

On occasion, changes occurred during an intervention may be due to factors associated with the passing of time rather than to the intervention itself. This is known as maturation threat (Fraenkel & Wallen, 2009). This is a serious threat for studies with pretest-posttest or studies that span a number of years. In this study, there could not be a maturation threat in since the data were collected over the same period of time.

#### **3.6.1.8 Attitude of Subjects**

The way subjects view the study and participate in it may cause a threat named as attitude of subjects (Fraenkel & Wallen, 2009). This threat was tried to be controlled by the explanations written in the consent form which the participants signed.

### **3.6.1.9. Regression**

Regression threat may occur when the change is studied in a group that is comprised of extremely low or high in its pre-intervention performance (Fraenkel & Wallen, 2009). Since there was no intervention in this study, regression could not be a threat.

### **3.6.1.10. Implementation**

In an experimental study, the experimental group may be treated in ways that are unintended or not a necessary part of the method which may give advantage to this group of one sort or another. This is known as implementation threat (Fraenkel & Wallen, 2009). Since there were no intervention and experimental group in this study, there could not occur occur any implementation threat.

## **3.6.2. External Validity**

External validity is extending to which the results of a study can be generalized (Fraenkel & Wallen, 2009).

### **3.6.2.1. Population Validity**

In this study, convenience sampling was used and sample size was large. Hence, generalizations were done to the target population cautiously.

### **3.6.2.2. Ecological Validity**

Ecological validity is the degree to which results of a study can be extended to other setting or conditions (Fraenkel & Wallen, 2009). The measuring instruments were used in regular classroom settings. The study is on PSTs. Thus, the results of the study can be generalized similar settings to this study.

## **3.7. Assumptions and Limitations**

In this section, assumptions and limitations of this study are presented.

### **3.7.1. Assumptions**

For the present study, the following assumptions were made by the researcher:

1. The sample size represented the population.
2. The three instruments were administered under standard conditions.
3. The implementation process of the study instrument was the same for all participants.
4. There was no interaction between the respondents during the administration of the instruments.
5. The sample of the study gave answers to all the three instruments accurately and truthfully.

### **3.7.2. Limitations**

The present study was subject to the following limitations:

1. There are some limitations for generalizability since convenience sampling was used in this study.
2. In this study, there were 32 senior students enrolled in evening education of University 3. However, there was not a statistically significant difference between senior students from daytime and evening education.
3. The study was limited to the four public universities in Turkey.
4. Completion time of the instruments took almost one hour and this might cause boredom and tiredness for some respondents.
5. This study only covered the three SSIs: Climate change, nuclear energy, and organ donation and transplantation
6. This study included students from four grade levels but the results were generalized to all PSTs since there was no statistically significant difference among the three variables – PSTs' epistemological beliefs, knowledge levels, and evaluation of trustworthiness on different information sources regarding each SSI based on their grades, university and gender.

## **CHAPTER 4**

### **RESULTS**

In this chapter, descriptive statistics about PSTs' epistemological beliefs, content knowledge levels, trustworthiness on different information sources were given. Lastly, the results regarding each research question were given respectively.

#### **4.1. Descriptive Statistics**

##### **4.1.1. PSTs' Epistemological Beliefs**

**Research Question 4:** What are the PSTs' epistemological beliefs?

Table 4.1 shows PSTs' average scores and standard deviations on the subdimensions of SEQ. Results revealed that PSTs scored from highest to lowest: Certain Knowledge with an average of 3.28, Simple Knowledge with an average of 3.02, Omniscient Authority with an average of 2.77, Quick Learning with an average of 2.55. According to the results, while PSTs scored highest on certain knowledge, they scored lowest on other subdimensions of SEQ. Majority of PSTs' scores were around the absolute mean of the 1-5 Likert-type scale. Therefore, it can be concluded that PSTs have a relatively sophisticated epistemological beliefs towards science.

Table 4.1 PSTs' Scores on Subdimensions of SEQ

| Dimension                              | Mean | SD   | Range     |
|--|------|------|-----------|
| Quick Learning                         | 2.55 |      |           |
| Learn the first time                   | 2.66 | 0.67 | 1-6       |
| Concentrated effort is a waste of time | 2.43 | 0.73 | 1-4.50    |
| Certain Knowledge                      | 3.28 |      |           |
| Avoid ambiguity                        | 3.28 | 0.57 | 1-4.75    |
| Simple Knowledge                       | 3.02 |      |           |
| Seek single answers                    | 3.02 | 0.31 | 2.18-5.55 |
| Omniscient Authority                   | 2.77 |      |           |
| Depend on authority                    | 3.22 | 0.55 | 1-5       |
| Do not criticize authority             | 2.32 | 0.49 | 1-5       |

#### 4.1.2. PSTs' Knowledge Levels Regarding Climate Change, Nuclear Energy, and Organ Donation and Transplantation

**Research Question 3:** What is the knowledge level of PSTs on climate change, nuclear energy, and organ donation and transplantation topics?

In order to investigate PSTs' knowledge on the knowledge test, descriptive statistics were used. Table 4.2 presents the findings of descriptive statistics on each topic. Results showed that PSTs scored on climate change test with an average of 9.30, nuclear energy test with an average of 8.76, and organ donation and transplantation test with an average of 7.99. Scores were given in percentages and 70% were taken to be representative of adequate knowledge (Leeming, Dwyer, & Bracken, 1995). In more detail, there were 282 PSTs, 44.8% of the sample, having a

score over 70% on climate change test. Hence, 282 PSTs had an adequate knowledge of climate change test. Regarding nuclear energy, 261 (41.4%) PSTs had an adequate knowledge of nuclear energy test. There were only 148 (%23.5) PSTs having a score over 70% on organ donation and transplantation test. The scores of all the three tests showed negatively-skewed distributions as shown in Figures 4.1, 4.2, and 4.3 indicating average knowledge levels about the three concepts. Since these negative skewnesses are in an acceptable range, the analyses were continued. PSTs obtained generally high mean scores from the knowledge test (Table 4.3). According to Table 4.3, the easiest question for PSTs was question-7 on organ donation and transplantation test with the highest mean score and the highest response rate. The most difficult question was question-9, focused on organ donation and transplantation law on the same test with a mean score of 0.22:

Question 7 on Organ Donation and Transplantation Test:

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*Ülkemizde organ ve doku nakli hizmetleri, 1979 yılında yürürlüğe giren hangi kanun ile yürütülmektedir?*

- A) Organ Bağıışı ve Nakli Kanunu  
B) Organ ve Doku Alınması, Saklanması, Aşılması ve Nakli hakkında kanun  
C) Organ ve Doku Bağıışı ile Nakli Hakkındaki Kanun  
D) Organ ve Doku Alınması ve Nakli Kanunu
- 

Question 9 on Organ Donation and Transplantation Test:

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*Aşağıdakilerden hangisinin naklinin kesinlikle kadavradan yapılması gerekmektedir?*

- A) El                      B) İnce bağırsak                      C) Pankreas                      D) Deri
-

According to Table 4.3, the easiest question on climate change test for PSTs was question-2, focused on the definition of greenhouse and question-11, focused on consequences of climate change with a mean score of 0.78. The most difficult question on climate change test was question-1, focused on the definition of climate change with a mean score of 0.41. These questions were given below:

Question 2 on Climate Change Test:

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*“Dünya atmosferi çeşitli gazlardan oluşur. Güneşten gelen ışınlar, atmosferi geçerek yeryüzünü ısıtır. Atmosferdeki gazlar, yeryüzündeki ısının bir kısmını tutar ve yeryüzünün ısı kaybına engel olur. Atmosferin, ışığı geçirme ve ısıyı tutma özelliği vardır. Isıyı tutma yeteneği sayesinde suların sıcaklığı dengede kalır. Böylece nehirlerin ve okyanusların donması engellenmiş olur. Bu şekilde oluşan, atmosferin ısıtma ve yalıtma etkisine ..... etkisi denir.”*

*Yukarıdaki paragrafta boşbırakılan yere aşağıdakilerden hangisi yazılmalıdır?*

- A) doppler                      B) coriolis                      C) sera                      D) plasebo*
- 

Question 11 on Climate Change Test:

---

*Aşağıdakilerden hangisi iklim değişikliğinin olası bir sonucu olamaz?*

- A) Nüfus artışı                      C) Kuraklık*  
*B) Seller                      D) Yağışın bazı bölgelerde artarken bazı bölgelerde azalması*
-

Question 1 on Climate Change Test:

---

*İklim deęişiklięinin tanımı ařaęıdaki Őıkların hangisinde doęru verilmiřtir?*

- A) *Karřılařtırılabilir zaman dilimlerinde gözlenen doęal ve doęrudan veya dolaylı olarak küresel atmosferin bileřimini bozan insan faaliyetleri sonucunda iklimde oluřan deęiřiklidir.*
- B) *Atmosfere salınan gazların miktarındaki artış nedeniyle, dünya üzerinde yıl boyunca kara, deniz ve havada ölçülen ortalama sıcaklıklarda görülen artıřtır.*
- C) *Bir yerde uzun bir süre boyunca gözlemlenen sıcaklık, nem, hava basıncı, rüzgar, yaęıř, yaęıř řekli gibi meteorolojik olayların ortalamasına verilen addır.*
- D) *Yařam ve insan aktiviteleri üzerindeki etkisini de göz önüne almak kořuluyla atmosferin belirli bir anda, belirli bir bölgedeki haline denir.*
- 

Table 4.3 shows that the easiest question on nuclear energy test for PSTs was question-2, focused on the definition of nuclear energy with a mean score of 0.85. The most difficult question on this test was question-12, focused on the the areas of usage nuclear energy with a mean score of 0.29:

Question 2 on Nuclear Energy Test:

---

*Nükleer enerji nedir?*

- A) *Aęır radyoaktif atomların bir nötronun çarpmasıyla daha küçük atomlara bölünmesi veya hafif radyoaktif atomların birleřerek daha aęır atomları oluřturmasıyla ortaya çıkan çok büyük miktardaki enerjidir.*
- B) *Yer kabuęunun çeřitli derinliklerinde birikmiř olan ısının oluřturduęu, kimyasallar içeren sıcak su, buhar ve gazlardan kaynaklanan enerjidir.*
- C) *Kimyasal tepkime sonucu ortaya çıkan enerjiye denir.*
- D) *Bir maddenin moleküllerinin bařka bir madde molekülleri ile yaptıęı reaksiyon sonucu ortaya çıkan ısı enerjisine denir.*
-

Question 12 on Nuclear Energy Test:

---

*Ülkemizde nükleer teknoloji hangi alanda henüz kullanılmamaktadır?*

*A) Endüstri*

*B) Tıp*

*C) Araştırma ve eğitim*

*D) Elektrik*

*üretimi*

---

After conducting descriptive statistics for knowledge test, the means of each item in the 42-item test were calculated. The average mean of the knowledge test was found as 8.68 (Figure 4.4). On the basis of studies of Bråten et al. (2011), PSTs whose knowledge test mean scores were below 8.68 were accepted as low achievers and PSTs whose knowledge test mean scores were above or equal to 8.68 were accepted as high achievers. We coded 1 for low achiever PSTs and 2 for high achiever PSTs. There were 317 high achievers, and 301 low achievers in the sample of this study. This categorization was used in further analysis.

Considering above mentioned questions formed to identify PSTs' misconceptions, question-6 on climate change test has a very low mean score (0.42) which means that the participants had a confusion about which phenomenon results from global warming. When examining PSTs' misconceptions about nuclear energy topic, it was reported questions 1, 2 and 4 on nuclear energy test had mean scores of 0.68, 0.85, and 0.82 respectively. And that means PSTs did not have a difficulty to answer these three questions. Similarly, question-1 on organ donation and transplantation test that was formed to identify a misconception had a high mean of 0.81. It can be concluded that our sample has a misconception about global warming topic.

Table 4.2 PSTs' Knowledge Levels on Climate Change, Nuclear Energy, and Organ Donation and Transplantation

| Knowledge Test Parts               | Mean | SD   | Range |
|------------------------------------|------|------|-------|
| Climate Change                     | 9.30 | 3.50 | 0-15  |
| Nuclear Energy                     | 8.76 | 2.49 | 1-14  |
| Organ Donation and Transplantation | 7.99 | 2.13 | 1-13  |

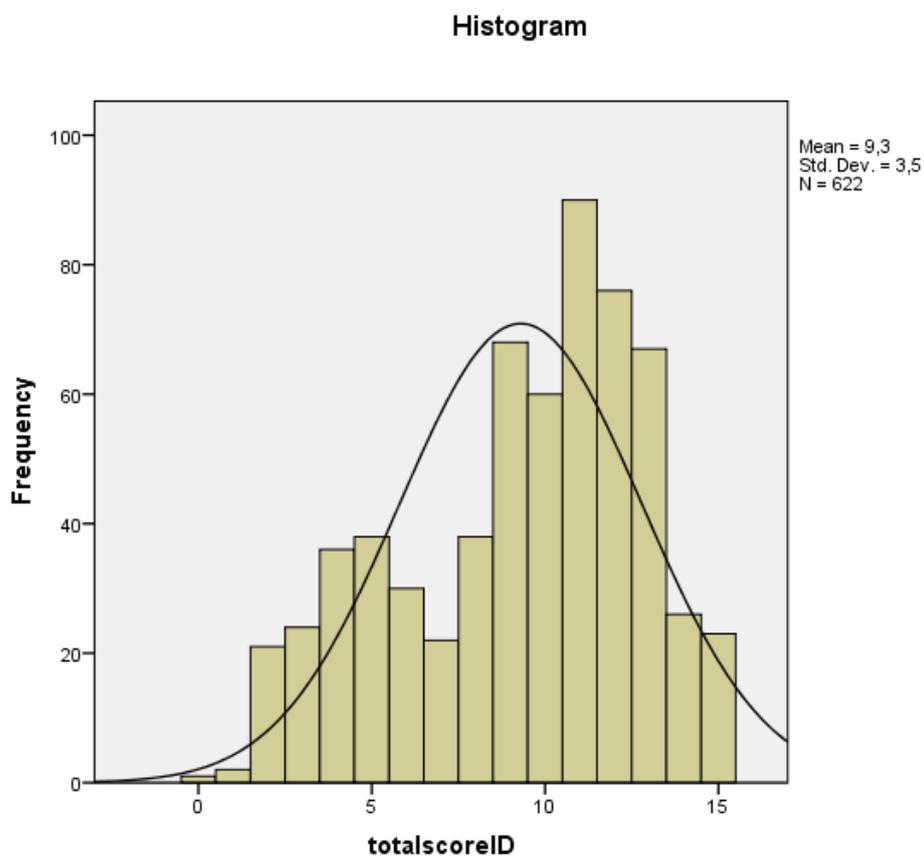


Figure 4.1 Range of Climate Change Test

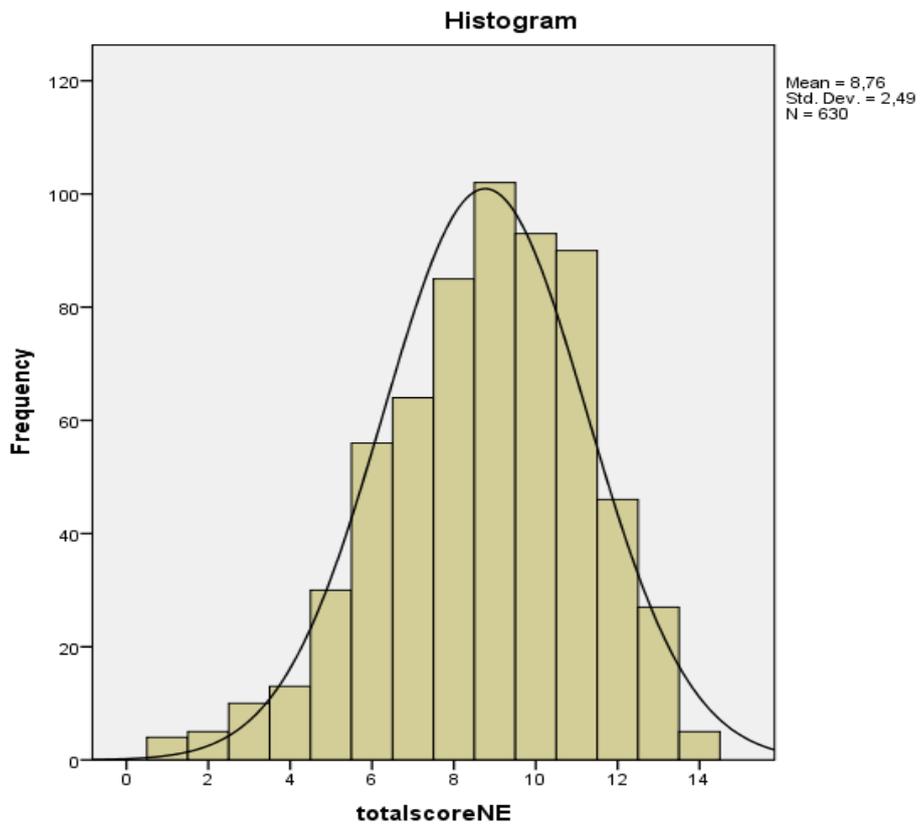


Figure 4.2 Range of Nuclear Energy Test

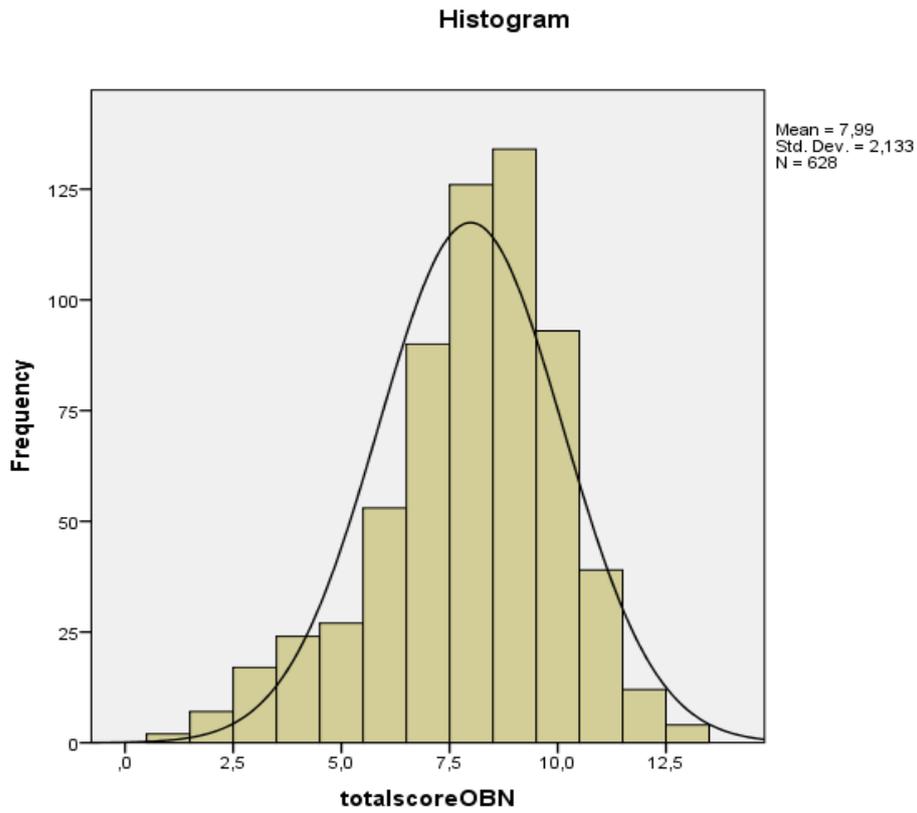


Figure 4.3 Range of Organ Donation and Transplantation Test

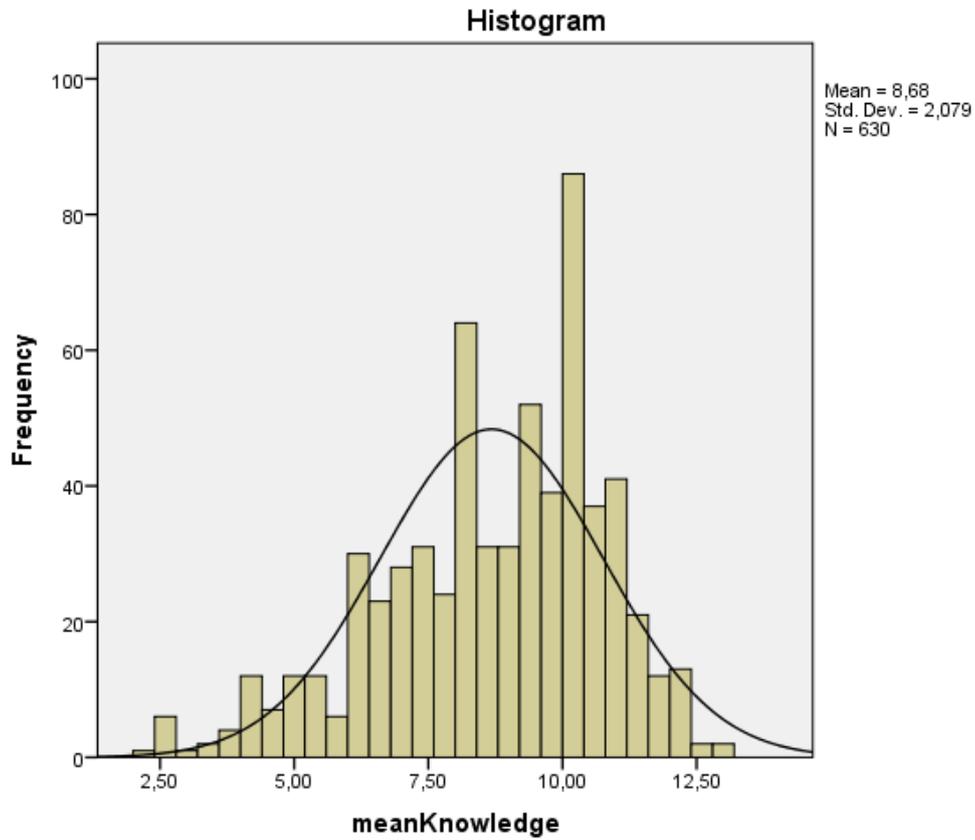


Figure 4.4 Average Mean of the Knowledge Test

Table 4.3 Descriptive Statistics on PSTs' Scores on the Knowledge Test

| Item                  | PSTs |      | Test | Mean | SD   | N   |
|-----------------------|------|------|------|------|------|-----|
|                       | Min. | Max. | Max. |      |      |     |
| <b>Climate Change</b> |      |      |      |      |      |     |
| Question 1            | 0    | 1    | 1    | 0.41 | 0.49 | 554 |
| Question 2            | 0    | 1    | 1    | 0.78 | 0.42 | 568 |
| Question 3            | 0    | 1    | 1    | 0.72 | 0.45 | 581 |
| Question 4            | 0    | 1    | 1    | 0.55 | 0.50 | 607 |
| Question 5            | 0    | 1    | 1    | 0.75 | 0.43 | 593 |
| Question 6            | 0    | 1    | 1    | 0.42 | 0.49 | 606 |
| Question 7            | 0    | 1    | 1    | 0.57 | 0.50 | 605 |
| Question 8            | 0    | 1    | 1    | 0.43 | 0.50 | 576 |
| Question 9            | 0    | 1    | 1    | 0.72 | 0.45 | 605 |

Table 4.3 Descriptive Statistics on PSTs' Scores on the Knowledge Test  
(continued)

|                                    |   |   |   |      |      |     |
|------------------------------------|---|---|---|------|------|-----|
| Question 10                        | 0 | 1 | 1 | 0.71 | 0.45 | 610 |
| Question 11                        | 0 | 1 | 1 | 0.78 | 0.42 | 604 |
| Question 12                        | 0 | 1 | 1 | 0.74 | 0.44 | 600 |
| Question 13                        | 0 | 1 | 1 | 0.73 | 0.45 | 598 |
| Question 14                        | 0 | 1 | 1 | 0.71 | 0.46 | 588 |
| Question 15                        | 0 | 1 | 1 | 0.73 | 0.44 | 599 |
| <hr/>                              |   |   |   |      |      |     |
| Nuclear Energy                     |   |   |   |      |      |     |
| Question 1                         | 1 | 1 | 1 | 0.68 | 0.47 | 620 |
| Question 2                         | 1 | 1 | 1 | 0.85 | 0.36 | 603 |
| Question 3                         | 1 | 1 | 1 | 0.79 | 0.41 | 621 |
| Question 4                         | 1 | 1 | 1 | 0.82 | 0.38 | 619 |
| Question 5                         | 1 | 1 | 1 | 0.82 | 0.39 | 619 |
| Question 6                         | 1 | 1 | 1 | 0.56 | 0.50 | 611 |
| Question 7                         | 1 | 1 | 1 | 0.81 | 0.39 | 619 |
| Question 8                         | 1 | 1 | 1 | 0.43 | 0.50 | 622 |
| Question 9                         | 1 | 1 | 1 | 0.42 | 0.49 | 544 |
| Question 10                        | 1 | 1 | 1 | 0.67 | 0.47 | 600 |
| Question 11                        | 1 | 1 | 1 | 0.64 | 0.48 | 599 |
| Question 12                        | 1 | 1 | 1 | 0.29 | 0.46 | 617 |
| Question 13                        | 1 | 1 | 1 | 0.77 | 0.42 | 568 |
| Question 14                        | 1 | 1 | 1 | 0.56 | 0.50 | 607 |
| <hr/>                              |   |   |   |      |      |     |
| Organ Donation and Transplantation |   |   |   |      |      |     |
| Question 1                         | 1 | 1 | 1 | 0.81 | 0.40 | 621 |
| Question 2                         | 1 | 1 | 1 | 0.53 | 0.50 | 621 |
| Question 3                         | 1 | 1 | 1 | 0.46 | 0.50 | 616 |
| Question 4                         | 1 | 1 | 1 | 0.68 | 0.47 | 563 |
| Question 5                         | 1 | 1 | 1 | 0.30 | 0.46 | 607 |
| Question 6                         | 1 | 1 | 1 | 0.43 | 0.50 | 562 |
| Question 7                         | 1 | 1 | 1 | 0.93 | 0.25 | 624 |

Table 4.3 Descriptive Statistics on PSTs' Scores on the Knowledge Test  
(continued)

|             |   |   |   |      |      |     |
|-------------|---|---|---|------|------|-----|
| Question 8  | 1 | 1 | 1 | 0.43 | 0.50 | 577 |
| Question 9  | 1 | 1 | 1 | 0.22 | 0.42 | 605 |
| Question 10 | 1 | 1 | 1 | 0.88 | 0.33 | 607 |
| Question 11 | 1 | 1 | 1 | 0.80 | 0.40 | 587 |
| Question 12 | 1 | 1 | 1 | 0.82 | 0.39 | 613 |
| Question 13 | 1 | 1 | 1 | 0.66 | 0.47 | 605 |
| Question 14 | 1 | 1 | 1 | 0.38 | 0.49 | 593 |

#### 4.1.3. Text Difficulty for Each SSI

In order to evaluate the perceived comprehensibility of nine texts, the PSTs were asked to rate how difficult they thought each text was to understand. To investigate this, descriptive statistics were used. Based on the analyses, the average difficulty of the nine texts was found as 4.23 which means PSTs had some difficulty in comprehension of the texts. Table 4.4 presents the findings of descriptive statistics on each text. According to the Table 4.4, the PSTs found 8<sup>th</sup> text written about organ donation and transplantation (4.06) more difficult to understand while they found 3<sup>rd</sup> text written about climate change (4.39) less difficult. However, there is not a statistically significant difference among the difficulties of the nine texts.

Table 4.4 Descriptive Statistics on PSTs' Rating Text Difficulty for Each Text

| <b>Text No</b> | <b>Topic / Source / Date of Publication</b>                           | <b>M</b> | <b>SD</b> |
|----------------|---|----------|-----------|
| 1              | climate change / an online newspaper / 2012                           | 4.24     | 2.09      |
| 2              | climate change / an online newspaper / 2011                           | 4.25     | 2.17      |
| 3              | climate change / a scientific journal / 2005                          | 4.39     | 2.25      |
| 4              | nuclear energy / an online newspaper / 2013                           | 4.35     | 2.23      |
| 5              | nuclear energy / a non governmental environmental organization / 2008 | 4.25     | 2.21      |
| 6              | nuclear energy / an online newspaper / 2007                           | 4.18     | 2.22      |
| 7              | organ donation and transplantation / an online newspaper / 2012       | 4.21     | 2.36      |
| 8              | organ donation and transplantation / a newspaper / 2013               | 4.06     | 2.24      |
| 9              | organ donation and transplantation / a scientific journal / 2001      | 4.10     | 2.20      |

*The scale is ranging from very easy (1) to very difficult (10).*

#### **4.1.4. PSTs' Evaluation of Trustworthiness on Different Information Sources**

In order to evaluate PSTs' judgments of trustworthiness on nine texts from different information sources, they were asked to rate how much they trusted each text. The descriptive statistics was run to determine how much PSTs trusted the texts. Table 4.5 presents the findings of descriptive statistics on each text. According to the table, the PSTs found 6<sup>th</sup> text (6.13) and 4<sup>th</sup> text (6.16) written about nuclear energy and transplantation less trustworthy while they found 3<sup>rd</sup> text written about climate change (6.61) more trustworthy. However, there is not a statistically significant difference among the trustworthiness of the nine texts.

Table 4.5 Descriptive Statistics on PSTs' Rating Trustworthiness on Each Text

| <b>Text No</b> | <b>Topic / Source / Date of Publication</b>                           | <b>M</b>    | <b>SD</b> |
|----------------|---|-------------|-----------|
| 1              | climate change / an online newspaper / 2012                           | 6.38        | 1.87      |
| 2              | climate change / an online newspaper / 2011                           | 6.33        | 1.92      |
| 3              | climate change / a scientific journal / 2005                          | <b>6.61</b> | 1.96      |
| 4              | nuclear energy / an online newspaper / 2013                           | 6.16        | 2.36      |
| 5              | nuclear energy / a non governmental environmental organization / 2008 | 6.47        | 2.12      |
| 6              | nuclear energy / an online newspaper / 2007                           | <b>6.13</b> | 2.30      |
| 7              | organ donation and transplantation / an online newspaper / 2012       | 6.27        | 2.13      |
| 8              | organ donation and transplantation / a newspaper / 2013               | 6.40        | 2.03      |
| 9              | organ donation and transplantation / a scientific journal / 2001      | 6.39        | 2.18      |

*The scale is ranging from to a very little extent (1) to to a very large extent (10).*

#### **4.1.5. PSTs' Criteria When Evaluating Trustworthiness Across Texts**

**Research Question 2:** What kind of criteria do PSTs emphasize when evaluating trustworthiness across texts regarding the three SSI?

To determine PSTs' criteria on which they put more emphasize while evaluating trustworthiness of the texts, they were asked to rate how much they trusted each criteria. The descriptive statistics was run to determine their criteria. Table 4.6 presents the findings of descriptive statistics on each text. Based on these results, while PSTs generally put more emphasis on content of the text for climate change topic, they put more emphasis on their own opinion for nuclear energy, and

organ donation and transplantation texts. On the average, the participants put less emphasis on author while reading climate change and nuclear energy texts. However, they put less emphasis on the publication date of the texts written about organ donation and transplantation.

Table 4.6 Descriptive Statistics on PSTs’ Criteria When Evaluating Trustworthiness Across Texts

| Criterion        | Climate Change |      |      | Nuclear Energy |      |      | Organ Donation & Transplantation |      |      |
|------------------|----------------|------|------|----------------|------|------|----------------------------------|------|------|
|                  | 1              | 2    | 3    | 4              | 5    | 6    | 7                                | 8    | 9    |
| Author           | 6.09           | 6.00 | 6.00 | 6.07           | 6.08 | 6.11 | 6.12                             | 6.25 | 6.19 |
| Publisher        | 6.02           | 6.23 | 6.92 | 6.01           | 6.65 | 6.18 | 6.05                             | 6.19 | 6.91 |
| Text type        | 5.92           | 6.11 | 6.64 | 6.13           | 6.43 | 6.26 | 5.98                             | 6.29 | 6.56 |
| Content          | 7.35           | 7.19 | 7.24 | 6.94           | 6.97 | 6.79 | 6.89                             | 6.91 | 7.05 |
| Own opinion      | 7.24           | 7.01 | 7.10 | 6.96           | 7.04 | 7.05 | 6.93                             | 7.04 | 7.12 |
| Publication date | 6.16           | 6.13 | 6.17 | 6.37           | 6.08 | 6.02 | 6.25                             | 6.18 | 6.03 |

## 4.2. Correlational Analyses

**Research Question 5:** Is there a relationship between PSTs’ knowledge level on three SSIs, epistemological beliefs, and evaluation of trustworthiness?

In the analyses conducted for the fifth research question, a relationship was not found between PSTs’ knowledge level and epistemological beliefs. Hence, in this part whether there is a relationship between PSTs’ knowledge level and evaluation of

trustworthiness and a relationship between PSTs' epistemological beliefs and evaluation of trustworthiness were investigated.

#### **4.2.1. Correlational Analyses to Investigate Relationship Between PSTs' Knowledge Level and Evaluation of Trustworthiness**

Before examining the correlation between PSTs' knowledge level on three SSIs and evaluation of trustworthiness, preliminary analyses were conducted to check the assumptions of correlational analyses. Normality, homoscedasticity, linearity and outliers assumptions were checked with the help of means of bivariate plots (Pallant, 2007). There was no assumptions were violated. Then, Pearson product moment correlation coefficients were calculated.

According to the results, high achievers found all nine texts about three SSIs more difficult to comprehend than low achievers. Also the high achievers gave more importance to the content of a text while evaluating the trustworthiness of sources than the low achivers did (Table 4.7). For a deeper knowledge about this relationship, a mixed-ANOVA was also conducted and graphs were given in Part 4.4.

Table 4.7 High and Low Achievers' Mean Values on Trustworthiness Questionnaire

| Criterion      | Text No              | Climate Change |      |      | Nuclear Energy |      |      | Organ Donation & Transplantation |      |      | M    |
|----------------|----------------------|----------------|------|------|----------------|------|------|----------------------------------|------|------|------|
|                |                      | 1              | 2    | 3    | 4              | 5    | 6    | 7                                | 8    | 9    |      |
| Low achievers  | Text trustworthiness | 6,30           | 6,31 | 6,36 | 6,06           | 6,24 | 6,15 | 6,24                             | 6,20 | 6,07 | 6,21 |
|                | Author               | 6,30           | 6,06 | 6,13 | 6,14           | 6,17 | 6,31 | 6,20                             | 6,31 | 6,25 | 6,21 |
|                | Publisher            | 6,10           | 6,39 | 6,91 | 6,07           | 6,69 | 6,40 | 6,16                             | 6,30 | 6,80 | 6,42 |
|                | Text type            | 6,03           | 6,23 | 6,59 | 6,28           | 6,51 | 6,57 | 6,09                             | 6,38 | 6,44 | 6,35 |
|                | Content              | 7,06           | 6,95 | 7,04 | 6,84           | 6,84 | 6,79 | 6,72                             | 6,71 | 6,82 | 6,86 |
|                | Own opinion          | 7,01           | 6,89 | 7,01 | 6,90           | 6,81 | 6,97 | 6,85                             | 6,86 | 7,02 | 6,92 |
|                | Publication date     | 6,20           | 6,16 | 6,24 | 6,31           | 6,03 | 6,08 | 6,12                             | 6,07 | 6,04 | 6,14 |
|                | Text difficulty      | 4,61           | 4,50 | 4,70 | 4,55           | 4,49 | 4,50 | 4,72                             | 4,32 | 4,51 | 4,54 |
| High achievers | Text trustworthiness | 6,47           | 6,35 | 6,87 | 6,27           | 6,71 | 6,10 | 6,30                             | 6,60 | 6,72 | 6,49 |
|                | Author               | 5,88           | 5,95 | 5,88 | 6,00           | 6,00 | 6,91 | 6,03                             | 6,20 | 6,13 | 6,11 |
|                | Publisher            | 5,93           | 6,06 | 6,92 | 5,95           | 6,60 | 5,96 | 5,95                             | 6,08 | 7,02 | 6,27 |
|                | Text type            | 5,80           | 5,99 | 6,69 | 5,98           | 6,35 | 5,94 | 5,86                             | 6,20 | 6,69 | 6,17 |
|                | Content              | 7,65           | 7,45 | 7,44 | 7,03           | 7,10 | 6,79 | 7,06                             | 7,12 | 7,28 | 7,21 |
|                | Own opinion          | 7,48           | 7,12 | 7,19 | 7,02           | 7,27 | 7,13 | 7,01                             | 7,23 | 7,22 | 7,19 |
|                | Publication date     | 6,11           | 6,11 | 6,11 | 6,43           | 6,12 | 5,95 | 6,39                             | 6,30 | 6,02 | 6,17 |
|                | Text difficulty      | 3,87           | 3,99 | 4,08 | 4,15           | 4,01 | 3,87 | 3,68                             | 3,80 | 3,70 | 3,91 |

#### **4.2.2. Correlational Analyses to Investigate Relationship Between PSTs' Epistemological Beliefs and Evaluation of Trustworthiness**

Before examining the correlation between PSTs' epistemological beliefs and evaluation of trustworthiness, preliminary analyses were conducted to check the assumptions of correlational analyses. Normality, homoscedasticity, linearity and outliers assumptions were checked with the help of means of bivariate plots (Pallant, 2007). There was no assumptions were violated. Then, first the relationship between PSTs' epistemological beliefs and their trustworthiness on each text was investigated using Pearson product-moment correlation coefficient and the details can be seen in Table 4.8. Second, the relationship between PSTs' epistemological beliefs and their evaluation of trustworthiness on different criteria was investigated using Pearson product-moment correlation coefficient and the details can be seen in Table 4.9. Last, the relationship between PSTs' epistemological beliefs and their evaluation of difficulty of each text was investigated using Pearson product-moment correlation coefficient and the details can be seen in Table 4.10.

##### **4.2.2.1. The Relationship Between PSTs' Epistemological Beliefs and Evaluation of Difficulty of Each Text**

According to the results of correlational analyses, there is a small, positive correlation between PSTs' certain knowledge and their trustworthiness on Text 4 written about nuclear energy,  $r = .10$ ,  $n = 519$ ,  $p = .03$ . That means, as PSTs believe the certainty of knowledge, they find Text 4 more trustworthy. Also there is a small, positive correlation between PSTs' simple knowledge and their trustworthiness on

Text 9 written about organ donation and transplantation,  $r = .11$ ,  $n = 521$ ,  $p = .02$ . That means, as PSTs believe the simplicity of knowledge, they find Text 9 more trustworthy.

Table 4.8 Correlation between PSTs' Epistemological Beliefs and Evaluation of Trustworthiness

|                                     | Text 4 | Text 9 |
|-------------------------------------|--------|--------|
| Trustworthiness / Certain Knowledge | .099*  |        |
| Trustworthiness / Simple Knowledge  |        | .114** |

\*Correlation is significant at the 0.05 level (2-tailed).

\*\*Correlation is significant at the 0.01 level (2-tailed).

#### 4.2.2.2. The Relationship Between PSTs' Epistemological Beliefs and Evaluation of Trustworthiness on Different Criteria

Correlational analyses revealed that there is a small, positive correlation between PSTs' simple knowledge and their trustworthiness on author criterion while reading Text 1 written about climate change,  $r = .10$ ,  $n = 524$ ,  $p = .02$ . That means, as PSTs believe the simplicity of knowledge, they put more emphasis on author while reading Text 1.

According to the results of correlational analyses, there is a small, negative correlation between PSTs' omniscient authority and their trustworthiness on text type criterion when reading Text 1 written about climate change,  $r = -.11$ ,  $n = 522$ ,  $p = .01$ . That means, as PSTs believe the omniscience of authority, they put less emphasis on text type while reading Text 1.

A small, negative correlation was found between PSTs' quick learning and their trustworthiness on author criterion while reading Text 2 written about climate change,  $r = -.10$ ,  $n = 520$ ,  $p = .02$ . That means, as PSTs believe learning is quick, they put less emphasis on author while reading Text 2.

A small, positive correlation was found between PSTs' simple knowledge and their trustworthiness on author criterion when reading Text 7 written about organ donation and transplantation,  $r = .12$ ,  $n = 531$ ,  $p = .00$ . That means, as PSTs believe the simplicity of knowledge, they put more emphasis on author while reading Text 7. Also there is a small, positive correlation between PSTs' simple knowledge and their trustworthiness on publisher criterion when reading Text 7 written about organ donation and transplantation,  $r = .10$ ,  $n = 527$ ,  $p = .02$ . That means, as PSTs believe the simplicity of knowledge, they put more emphasis on publisher while reading Text 7.

A small, negative correlation was found between PSTs' certain knowledge and their trustworthiness on content criterion when reading Text 7 written about organ donation and transplantation,  $r = -.10$ ,  $n = 530$ ,  $p = .03$ . That means, as PSTs believe the certainty of knowledge, they put less emphasis on content while reading Text 7.

Table 4.9 Correlation between PSTs' Epistemological Beliefs and Their Criteria When Reading Texts

|                                  | Text 1 | Text 2 | Text 7 |
|----------------------------------|--------|--------|--------|
| Innate Ability / author          |        | -.102* |        |
| Certain Knowledge / content      |        |        | -.097* |
| Simple Knowledge / author        | .104*  |        | .121** |
| Simple Knowledge / Publisher     |        |        | .101*  |
| Omniscient Authority / text type | -.108  |        |        |

\*Correlation is significant at the 0.05 level (2-tailed).

\*\*Correlation is significant at the 0.01 level (2-tailed).

#### 4.2.2.3. The Relationship Between PSTs' Epistemological Beliefs and Difficulty of Texts

The results of correlational analyses revealed that there is a small, positive correlation between PSTs' quick learning and difficulty of Text 1,  $r = -.10$ ,  $n = 519$ ,  $p = .02$ . That means, as PSTs believe learning is quick, they find Text 1 more difficult.

The results revealed that there is a small, negative correlation between PSTs' omniscient authority and difficulty of Text 2 written about climate change,  $r = -.11$ ,  $n = 517$ ,  $p = .02$ . That means, as PSTs believe omniscience of authority, they find Text 2 less difficult.

The results of correlational analyses revealed that there is a small, negative correlation between PSTs' omniscient authority and difficulty of Text 3 written about

climate change,  $r = -.13$ ,  $n = 516$ ,  $p = .00$ . That means, as PSTs believe omniscience of authority, they find Text 3 less difficult.

A small, positive correlation was found between PSTs' simple knowledge and difficulty of Text 4 written about nuclear energy,  $r = -.10$ ,  $n = 516$ ,  $p = .03$ . That means, as PSTs believe knowledge is simple, they find Text 4 more difficult.

A small, positive correlation was found between PSTs' quick learning and difficulty of Text 5 written about nuclear energy,  $r = .13$ ,  $n = 516$ ,  $p = .00$ . That means, as PSTs believe learning is quick, they find Text 5 more difficult.

Lastly, the results showed that there is a small, positive correlation between PSTs' quick learning and difficulty of Text 9 written about organ donation and transplantation,  $r = -.14$ ,  $n = 513$ ,  $p = .00$ . That means, as PSTs believe learning is quick, they find Text 9 more difficult.

Table 4.10 Correlation between PSTs' Epistemological Beliefs and Difficulty of Texts

|                                   | Text 1 | Text 2 | Text 3 | Text 4 | Text 5 | Text 9 |
|-----------------------------------|--------|--------|--------|--------|--------|--------|
| Quick Learning / difficulty       | .104*  |        |        |        | .131** | .135** |
| Simple Knowledge / difficulty     |        |        |        | .099*  |        |        |
| Omniscient Authority / difficulty |        | -.106* | -      |        |        |        |
|                                   |        |        | .131** |        |        |        |

\*Correlation is significant at the 0.05 level (2-tailed).

\*\*Correlation is significant at the 0.01 level (2-tailed).

### **4.3. Mixed Analysis of Variance**

#### **4.3.1. A Mixed Analysis of Variance to Investigate a Relationship Between PSTs' Trustworthiness on Each Source and Topic Knowledge**

**Research Question 1:** How do PSTs evaluate the trustworthiness of different information sources given about three different SSIs: climate change, nuclear energy, organ donation and transplantation?

**Research Question 5:** Is there a relationship between PSTs' knowledge level on three SSI, epistemological beliefs, and evaluation of trustworthiness?

To address the first and fifth research questions, a mixed ANOVA was conducted. Topic knowledge (high versus low) was the between subjects independent variable and the trustworthiness on nine texts was the within subject variable. Some assumptions were checked before conducting the analyses:

1. Level of measurement: The dependent variable should be assessed on an interval or ratio level of measurement. The independent variable should be a categorical variable that includes two or more categories (Pallant, 2007). In this study, the dependent variable was trustworthiness on each text and the independent variable is the topic knowledge level of PSTs (coded 1 and 2), which is a categorical variable. Hence, this assumption was met.
2. Random sampling: The scores are obtained using a random sample from the population was assumed for ANOVA; however, this is often not the case in

researches (Pallant, 2007). Therefore, there is not a problem to violate this assumption.

3. Independence of observations: Each observation or measurement must not be influenced by any other one (Pallant, 2007). This assumption was also met since large groups were given answers to the questionnaires in their classrooms and there was no interaction between the respondents during the administration of the instruments.
4. Normal distribution: The distribution of observed values for the dependent variable should approximate normal distributions. In this study, the assumption was checked by using histograms and this assumption was met.
5. Homogeneity of variances: Levene's Test were conducted for dependent variables to examine this assumption. For each of the nine texts, the homogeneity of variances assumption was not violated.

After checked the assumptions, the mixed-ANOVA was conducted for each nine texts. Figure 4.5 graphically displays the mean trustworthiness ratings of the texts by the topic knowledge groups.

The mixed ANOVA indicated there was no significant main effect of text, Wilk's Lambda = .97,  $F(8, 365) = 1.25$ ,  $p = .27$ , partial eta squared = .027. According to the Post hoc comparisons, high achievers had generally higher means of trustworthiness ratings of the texts than low achievers ( $p < .05$ ). Additionally, both high and low achievers judged Text 3 (scientific journal) more trustworthy than other texts.

Looking on topic basis, all of the PSTs judged Text 3 more trustworthy for climate change topic ( $p < .05$ ). High achiever PSTs judged Text 5 (a non governmental environmental organization) more trustworthy for nuclear energy topic whereas low achievers judged Text 5 and Text 6 (online newspaper) almost equally trustworthy ( $p < .05$ ). About organ donation and transplantation, while high achievers found Text 9 (scientific journal) more trustworthy, low achievers found Text 7 (newspaper) and Text 8 (online newspaper) equally trustworthy ( $p < .05$ ).

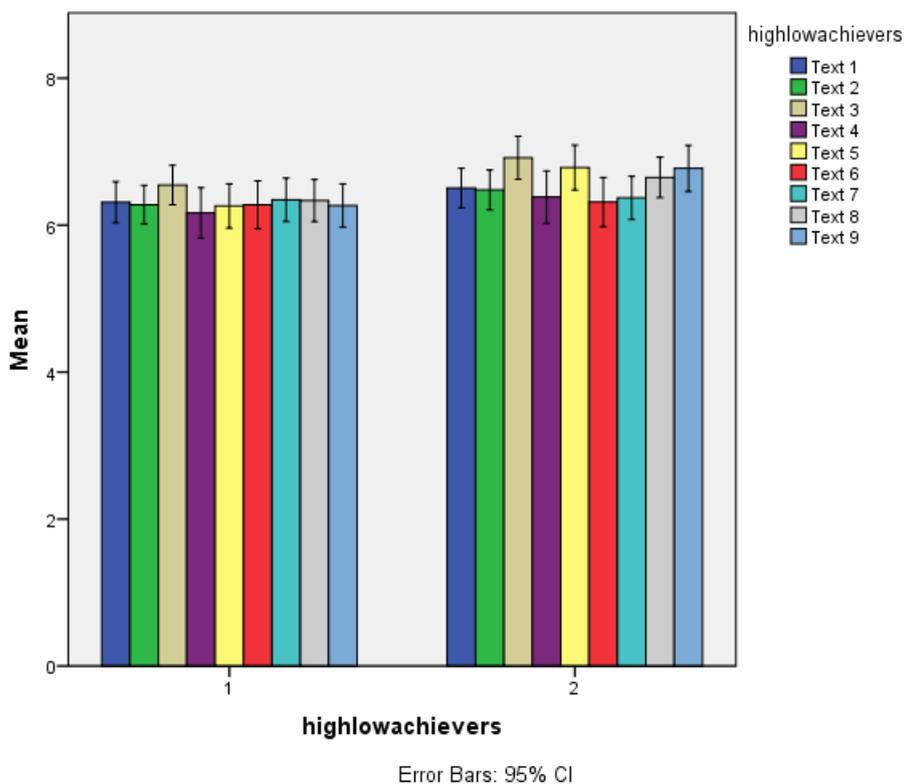


Figure 4.5 Reported trustworthiness across the nine texts by high and low achiever PSTs. Error bars represent standard errors of the means. Above colors indicate the number of texts (navy blue for Text 1, green for Text 2, beige for Text 3, purple for Text 4, yellow for Text 5, red for Text 6, aqua for Text 7, grey for Text 8, and blue for Text 9). Above numbers indicate the knowledge level of PSTs (1 for low achievers and 2 for high achievers).

#### **4.3.2. A Mixed Analysis of Variance to Investigate a Relationship Between PSTs' Justification Criteria and Topic Knowledge**

**Research Question 1:** How do PSTs evaluate the trustworthiness of different information sources given about three different SSIs: climate change, nuclear energy, organ donation and transplantation?

**Research Question 2:** What kind of criteria do PSTs emphasize when evaluating trustworthiness across texts?

**Research Question 5:** Is there a relationship between PSTs' knowledge level on three SSI, epistemological beliefs, and evaluation of trustworthiness?

To address the first, second and fifth research questions, a mixed ANOVA on use of criteria was conducted. Topic knowledge (high versus low) was the between subjects independent variable and the six justification criteria defining the within subject variable. Some assumptions were checked before conducting the analyses:

1. Level of measurement: The dependent variable should be assessed on an interval or ratio level of measurement. The independent variable should be a categorical variable that includes two or more categories (Pallant, 2007). In this study, the dependent variables were the six justification criteria and the independent variable is the topic knowledge level of PSTs (coded 1 and 2), which is a categorical variable. Hence, this assumption was met.
2. Random sampling: The scores are obtained using a random sampline from the population was assumed for ANOVA; however, this is often not the case in

researches (Pallant, 2007). Therefore, there is not a problem to violate this assumption.

3. Independence of observations: Each observation or measurement must not be influenced by any other one (Pallant, 2007). This assumption was also met since large groups were given answers to questionnaires in their classrooms and there was no interaction between the respondents during the administration of the instruments.
4. Normal distribution: The distribution of observed values for the dependent variable should approximate normal distributions. In this study, the assumption was checked by using histograms and this assumption was met.
5. Homogeneity of variances: Levene's Test were conducted for dependent variables to examine this assumption. For each of the nine texts, the homogeneity of variances assumption was not violated.

After checked the assumptions, the mixed-ANOVA was conducted for each nine texts and for each six criteria one by one. Figure 4.6 in Appendix F graphically represents the reported use of the criteria by the two knowledge groups for Text 1. The mixed ANOVA indicated an overall main effect of justification category for Text 1, Wilk's Lambda = .95,  $F(5, 522) = 5.05$ ,  $p < .0005$ , partial eta squared = .05 suggesting a small effect size. According to the Post hoc comparisons, both high and low knowledge PSTs reported basing their judgments of trustworthiness significantly more on content and their own opinion than all other justification criteria ( $p < .05$ ). Also text type was used less than author, publisher, and publication date criteria ( $p < .05$ ). Additionally, whereas high knowledge PSTs put more emphasis on content and

own opinion than low knowledge PSTs, low knowledge PSTs put more emphasis on other four criteria than high knowledge PSTs.

Figure 4.7 in Appendix F graphically represents the reported use of the criteria by the two knowledge groups for Text 2. The mixed ANOVA indicated there was no significant main effect of justification category for Text 2, Wilk's Lambda = .97,  $F(5, 519) = 3.45$ ,  $p = .005$ , partial eta squared = .032. Based on Post hoc comparisons, both high and low knowledge PSTs reported basing their judgments of trustworthiness significantly more on content and their own opinion than all other justification criteria ( $p < .05$ ). Also author was used less than text type, publisher, and publication date criteria ( $p < .05$ ). In addition to these, high knowledge PSTs put more emphasis on content and own opinion than low knowledge PSTs whereas low knowledge PSTs put more emphasis on other four criteria than high knowledge PSTs.

Figure 4.8 in Appendix F graphically represents the reported use of the criteria by the two knowledge groups for Text 3. The mixed ANOVA indicated there was no significant main effect of justification category for Text 3, Wilk's Lambda = .98,  $F(5, 516) = 1.81$ ,  $p = .11$ , partial eta squared = .017. Post hoc comparisons showed that both high and low knowledge PSTs reported basing their judgments of trustworthiness significantly more on publisher, content and their own opinion than other three justification criteria ( $p < .05$ ). Also whereas high knowledge PSTs put more emphasis on text type, content and own opinion than low knowledge PSTs, low knowledge PSTs put more emphasis on author, publisher and publication date than high knowledge PSTs.

Figure 4.9 in Appendix F graphically represents the reported use of the criteria by the two knowledge groups for Text 4. The mixed ANOVA indicated there was no significant main effect of justification category for Text 4, Wilk's Lambda = .99,  $F(5, 517) = 1.15$ ,  $p = .33$ , partial eta squared = .011. Post hoc comparisons showed that both high and low knowledge PSTs reported basing their judgments of trustworthiness significantly more on content and their own opinion than other four justification criteria ( $p < .05$ ). Additionally, PSTs reportedly used publication date criteria more than author, publisher, and text type criteria ( $p < .05$ ). Also while high knowledge PSTs put more emphasis on content, own opinion, and publication date than low knowledge PSTs, low knowledge PSTs put more emphasis on author, publisher and text type than high knowledge PSTs.

Figure 4.10 in Appendix F graphically represents the reported use of the criteria by the two knowledge groups for Text 5. The mixed ANOVA indicated there was no significant main effect of justification category for Text 5, Wilk's Lambda = .98,  $F(5, 515) = 2.26$ ,  $p = .047$ , partial eta squared = .021. Post hoc comparisons showed that both high and low knowledge PSTs reported basing their judgments of trustworthiness significantly more on content and their own opinion than other four justification criteria ( $p < .05$ ). Additionally, PSTs reportedly used publisher and text type criteria more than author and publication date criteria ( $p < .05$ ). Besides while high knowledge PSTs put more emphasis on content, own opinion, and publication date than low knowledge PSTs, low knowledge PSTs put more emphasis on author, publisher and text type than high knowledge PSTs.

Figure 4.11 in Appendix F graphically represents the reported use of the criteria by the two knowledge groups for Text 6. The mixed ANOVA indicated there was no significant main effect of justification category for Text 6, Wilk's Lambda = .97,  $F(5, 513) = 3.30$ ,  $p = .006$ , partial eta squared = .031. Post hoc comparisons revealed that both high and low knowledge PSTs reported basing their judgments of trustworthiness significantly more on content and their own opinion than other four justification criteria ( $p < .05$ ). Additionally, PSTs reportedly used publication date criteria less than author, publisher and text type criteria ( $p < .05$ ). Besides while high knowledge PSTs put more emphasis on content and own opinion than low knowledge PSTs, low knowledge PSTs put more emphasis on other four criteria than high knowledge PSTs.

Figure 4.12 in Appendix F graphically represents the reported use of the criteria by the two knowledge groups for Text 7. The mixed ANOVA indicated there was no significant main effect of justification category for Text 7, Wilk's Lambda = .98,  $F(5, 518) = 1.80$ ,  $p = .11$ , partial eta squared = .017. Post hoc comparisons suggested that both high and low knowledge PSTs reported basing their judgments of trustworthiness significantly more on content and their own opinion than other four justification criteria ( $p < .05$ ). In addition to this, while high knowledge PSTs put more emphasis on content, own opinion and publication date than low knowledge PSTs, low knowledge PSTs put more emphasis on author, publisher, and text type criteria than high knowledge PSTs.

Figure 4.13 in Appendix F graphically represents the reported use of the criteria by the two knowledge groups for Text 8. The mixed ANOVA indicated there

was no significant main effect of justification category for Text 8, Wilk's Lambda = .97,  $F(5, 509) = 2.77$ ,  $p = .018$ , partial eta squared = .026. Post hoc comparisons showed that both high and low knowledge PSTs reported basing their judgments of trustworthiness significantly more on content and their own opinion than other four justification criteria ( $p < .05$ ). Additionally, PSTs reportedly used publication date criteria less than author, publisher and text type criteria ( $p < .05$ ). Also whereas high knowledge PSTs put more emphasis on content, own opinion and publication date than low knowledge PSTs, low knowledge PSTs put more emphasis on author, publisher, and text type criteria than high knowledge PSTs.

Figure 4.14 in Appendix F graphically represents the reported use of the criteria by the two knowledge groups for Text 9. The mixed ANOVA indicated there was no significant main effect of justification category for Text 9, Wilk's Lambda = .99,  $F(5, 512) = 1.31$ ,  $p = .26$ , partial eta squared = .013. Post hoc comparisons showed that both high and low knowledge PSTs reported basing their judgments of trustworthiness significantly more on content and their own opinion than other four justification criteria ( $p < .05$ ). Additionally, PSTs reportedly used publication date criteria less than author, publisher and text type criteria ( $p < .05$ ). Also whereas high knowledge PSTs put more emphasis on publisher, text type, content, own opinion and publication date than low knowledge PSTs, low knowledge PSTs put more emphasis on author than high knowledge PSTs.

In conclusion, for all nine texts, the participants reported basing their judgments of trustworthiness significantly more on content and their own opinion than all other justification criteria ( $p < .05$ ).

#### 4.4. Summary of the Results

In the results section, firstly descriptive statistics were presented. According to the descriptive statistics, PSTs in this study displayed a relatively sophisticated epistemological beliefs towards science. Besides, according to the results, 282 of the participants (44.8%) had an adequate knowledge of climate change test, 261 of the (41.4%) PSTs had an adequate knowledge of nuclear energy test, and only 148 (23.5%) PSTs had an adequate knowledge of organ donation and transplantation test. With the mean score of 8.68, there was 317 high achiever PSTs and 301 low achiever PSTs on the 42-item knowledge test. Additionally, PSTs found 6<sup>th</sup> text (6.13) and 4<sup>th</sup> text (6.16) written about nuclear energy and transplantation less trustworthy while they found 3<sup>rd</sup> text written about climate change (6.61) more trustworthy. Lastly, while reading texts about climate change, PSTs put more emphasis on content. However, while reading texts about nuclear energy or organ donation and transplantation, they put more emphasis on their own opinion. Averagely, PSTs put less emphasis on author while reading texts about climate change and nuclear energy, whereas they put less emphasis on publication date of the texts written about organ donation and transplantation.

According to the correlational analyses results, high achiever PSTs found all nine texts more difficult to comprehend than low achiever PSTs. Also high achievers gave more importance to the content of each text while evaluating the trustworthiness of sources than low achievers did.

Correlational analyses revealed that there is a small, positive correlation between PSTs' simple knowledge and their trustworthiness on author while reading Text 1; between PSTs' quick learning and difficulty of Text 1; between PSTs' certain knowledge and their trustworthiness on Text 4; PSTs' simple knowledge and difficulty of Text 4; PSTs' quick learning and difficulty of Text 5; between PSTs' simple knowledge and their trustworthiness on author criterion when reading Text 7; between PSTs' simple knowledge and their trustworthiness on publisher criterion when reading Text 7; PSTs' simple knowledge and their trustworthiness on author criterion when reading Text 9; between PSTs' quick learning and difficulty of Text 9. Also, correlational analyses revealed that there is a small, negative correlation between PSTs' omniscient authority and their trustworthiness on text type when reading Text 1; between PSTs' quick learning and their trustworthiness on author while reading Text 2; between PSTs' omniscient authority and difficulty of Text 2; between PSTs' omniscient authority and difficulty of Text 3; between PSTs' certain knowledge and their trustworthiness on content criterion when reading Text 7.

The mixed ANOVA results indicated that there was no significant main effect of text. According to the Post hoc comparisons, high achievers had generally higher means of trustworthiness ratings of the texts than low achievers. In addition, both high and low achievers judged Text 3 more trustworthy than other eight texts. Also, PSTs judged Text 3 more trustworthy for climate change topic. While high achievers judged Text 5 more trustworthy for nuclear energy topic, low achievers judged Text 5 and 6 almost equally trustworthy. About organ donation and transplantation, while high achievers found Text 9 more trustworthy, low achievers found Text 7 and 8

equally trustworthy. Although there was an overall main effect of justification category for Text 1, the mixed ANOVA results indicated that PSTs did not differ in justification category for other eight texts. Lastly, for all nine texts, PSTs reported basing their judgments of trustworthiness significantly more on content and their own opinion than all other justification criteria.

## **CHAPTER 5**

### **DISCUSSION**

In this chapter, summary of the study, conclusions and discussions of findings of the study, implications and recommendations for further research were presented respectively.

#### **5.1. Summary of the Study**

A survey study with a sample of 630 PSTs who enrolled in four public universities in Turkey was conducted in the study. The main purpose of the study is to investigate whether there is a relationship between PSTs' epistemological beliefs, knowledge levels about three SSIs and evaluation of trustworthiness on different information sources or not. Data were collected through four instruments: 1. Schommer's Epistemological Questionnaire (SEQ) developed in 1990, 2. Knowledge Test for assessing PSTs' content knowledge levels regarding three socio-scientific issues (climate change, nuclear energy, and organ donation and transplantation) developed by the researcher (2013), 3. Texts from different information sources compiled by the researcher, 4. Trustworthiness questionnaire developed by Bråten et al. (2011).

Data collection was carried out during 2012-2013 Spring semester. PSTs' epistemological beliefs and content knowledge levels about three SSIs, and the way of evaluating of trustworthiness on different information sources were analyzed quantitatively. Statistical analyses were performed to explore the relationship among PSTs' epistemological beliefs, content knowledge levels about three SSI topics, and the way of evaluating of trustworthiness on different information sources.

Results revealed that PSTs displayed a relatively sophisticated epistemological beliefs towards science. As another finding, PSTs put more emphasis on content while reading texts about climate change. However, they put more emphasis on their own opinion while reading texts about nuclear energy or organ donation and transplantation. Also PSTs put less emphasis on author while reading texts about climate change and nuclear energy, whereas they put less emphasis on publication date of the texts written about organ donation and transplantation. Lastly, it was found that high achievers found all nine texts more difficult to comprehend than low achievers.

## **5.2. Discussions**

In this discussion section first, the discussion of the results of the factor structure of the epistemological beliefs of PSTs was presented. Second, the discussion of the results with respect to PSTs' knowledge levels regarding climate change, nuclear energy, and organ donation and transplantation was presented. Third, the discussion of the results regarding to PSTs' evaluation of trustworthiness on different information sources was presented in three parts. Last, the relationship

between PSTs' knowledge level and evaluation of trustworthiness, in following, the relationship between PSTs' knowledge level and justification criteria, and finally the relationship between PSTs' epistemological beliefs and evaluation of trustworthiness on different information sources were discussed.

### **5.2.1. Results of the Factor Structure of PSTs' Epistemological Beliefs**

Factor analysis revealed that four factors which are Innate Ability, Certain Knowledge, Simple Knowledge and Omniscient Authority were found in the present study. This factor structure supported the multidimensional structure of epistemological beliefs. That means, PSTs develop a set of more or less independent beliefs about knowledge and knowing. The result of the present study is consistent with some other studies revealing four factors (e.g. Öztürk, 2011; Schommer, 1990; Schommer et al., 1992; Yılmaz-Tüzün & Topçu, 2007, 2008, 2013). Schommer's two studies revealed four factors which are Quick learning, Certain knowledge, Simple knowledge and Innate ability. Omniscient Authority factor have not been found in her studies conducted with North American college and university students. However, this factor mostly included in the studies conducted in Turkey (e.g. G. Öztürk, 2009; N. Öztürk, 2011; Topçu & Yılmaz-Tüzün, 2006; Yılmaz-Tüzün & Topçu, 2008; Yılmaz-Tüzün & Topçu, 2013). In some other studies it was stated that the dimension of Omniscient Authority especially has emerged as a factor in the countries that eastern culture has been dominant such as China, Japan, Taiwan and Turkey (Chan & Elliott, 2002, 2004; Elliott, & Chan, 1998; Lee, 1995; Wang, Zhang, Zhang, & Hou, 2013). In addition, Yılmaz-Tüzün and Topçu (2008) also explained this difference based on the cultural differences. They stated that PSTs'

previous learning experiences regarding traditional teaching strategies of previous science curriculum might have led PSTs to comprehend that science is a body of knowledge discovered by scientists and teachers deliver this knowledge. All these situations might be the reason for the Omniscient Authority found in the analyses of studies conducted in Turkish context.

Descriptive statistics results revealed that PSTs' scores on subdimensions of Schommer's Epistemological Questionnaire from highest to lowest: Certain Knowledge with an average of 3.28, Simple Knowledge with an average of 3.02, Omniscient Authority with an average of 2.77, Quick Learning with an average of 2.55. Based on the results, PSTs scored highest on "Certain Knowledge" while they scored lowest on "Quick Learning" subdimension of SEQ. Similarly, the findings of the master thesis of Eroğlu (2009) revealed that pre-service teachers have higher mean in "Certain Knowledge" dimension compared with other ones. Perry (1968) studied university students' personal epistemological beliefs and reported that students entered the university with less sophisticated epistemological beliefs for instance they believe knowledge is simple, certain, and handed down by authority, but throughout their education they developed more sophisticated epistemological beliefs i.e. they believe knowledge is complex, tentative, and acquired through reason and empirical evidence. However, in this study the average values of the four dimensions showed a medium level (undecided) which means the participants generally have a developing epistemological belief rather than having a more sophisticated epistemological belief.

### **5.2.2. Results Regarding To PSTs' Knowledge Levels about Climate Change, Nuclear Energy, and Organ Donation and Transplantation**

Descriptive statistics results revealed that PSTs scored on climate change test with an average of 9.30, nuclear energy test with an average of 8.76, and organ donation and transplantation test with an average of 7.99. There were 282 PSTs, 44.5% of the sample, had an adequate knowledge on climate change test. 261 (41.3%) PSTs had an adequate knowledge on nuclear energy test while there were only 148 (%23.4) PSTs had an adequate knowledge on organ donation and transplantation test. The results showed that the easiest question for PSTs was question-7 on organ transplantation and donation test with the highest mean score and the highest response rate and the most difficult question was question-9 on this test with a mean score of 0.22.

The results revealed that PSTs had a confusion that they did not exactly know which phenomenon results from global warming. This finding is consistent with the findings of some other studies which stated that there is a common misconception that ozone layer depletion is due to the global warming (Bahar & Aydın, 2002; Bozdoğan & Yanar, 2010; Khalid, 2001, 2003; Matkins & Bell, 2007; Pekel, 2005). Kahraman et al. (2008) also reported that Turkish prospective teachers had some misunderstandings about global warming. Nowadays, environmental problems has greatly increased due to the global warming and people's using natural sources more intensively. Discussion of environmental problems started to remain on the agenda due to increasingly deterioration of the relationship between human and nature. Climate change which is one of the main environmental problems causes an anxiety

in society (APA, 2009). Therefore, the necessity of environmental education in schools gained importance in order to overcome the problems, provide permanent solutions, and raise environmentally-conscious generations. Hence, SSI education including the three SSIs in this study take part in new Science and Technology Education Program which was restructured by Ministry of Education Head Council of Education and Morality in 2013. Since if PSTs have misconceptions related with SSIs, the students would have some misconceptions in the future, being practitioners of the new program, PSTs' opinions and knowledge about these topics are very important. The literature showed that elementary and middle school students had some misconceptions about global warming and greenhouse effect (Lester, Ma, Lee & Lambert, 2006; Boyes, Stanisstreet, & Papantoniou, 1999). One reason for these misconceptions may be the misconceptions that their teachers had. Hence, more and more studies need to be conducted to identify PSTs' misconceptions about SSIs like climate change and these misconceptions should be overcome by the help of appropriate courses related with SSIs, and teaching and learning activities in the program.

### **5.2.3. Results Regarding To PSTs' Evaluation of Trustworthiness on Different Information Sources**

Descriptive study results revealed that the participants found Text-4 with a mean score of 6.16 and Text-6 with a mean score of 6.13 written about nuclear energy less trustworthy while they found Text-3 written about climate change (6.61) more trustworthy. But, there is not a statistically significant difference among the trustworthiness on the nine texts. Text-4 was written about Turkey should start to use

nuclear energy by taking precautions. This text was written by an academician professor and published on an online newspaper in 2013. Text-6 was written about Turkey need to have nuclear power plant(s) and people who against nuclear power plant construction in Turkey are the ones who do not want Turkey's development. This text was written by an academician professor and published by an online newspaper in 2007. Text-3 was written about how both natural causes and human activities contribute to climate change. It was written by the author of a scientific journal and published in this journal in 2005. Looking at the Table 4.5 in results chapter, it can be concluded that PSTs found the information obtained from five online newspapers less trustworthy with an average mean of 6.25 while they found the information obtained from the newspaper, the scientific journal, and the non governmental environmental organization more trustworthy with an average mean of 6.47. Supporting this finding, Grace (2012) stated that books are generally considered more trustworthy than the Internet since books are stable and unchanging. She additionally suggested that an online article may be edited at any given moment; however, a book is published as a whole at a specific, identifiable time and date. There is a general idea about evaluating the trustworthiness on information sources found on the Internet is vital since there is no regulating body that monitors the reliability of the information on the Internet. However, an Internet article which is published by a reputable research organization or a respected professor at a reputable university is found usually more trustworthy than an unknown author. This may be a result of PSTs' epistemological beliefs in that students holding strong beliefs in certain or simple knowledge tend to use more surface-level strategies while students who hold beliefs in uncertainty and complexity of knowledge tend to use deep-level

strategies to learn (Schommer, & Hutter, 1995). In this study, PSTs hold stronger beliefs in certain or simple knowledge so that they may primarily and superficially compare the authors.

#### **5.2.3.1. Text Difficulty for Each SSI**

To investigate how difficult PSTs thought each text was to understand, descriptive statistics were used. The analyses revealed that the average difficulty of the nine texts was found as 4.23, in other words PSTs had some difficulty in comprehension of the texts. PSTs found Text-8 written about organ donation and transplantation (4.06) more difficult to understand while they found Text-3 written about climate change (4.39) less difficult. However, there is not a statistically significant difference among the difficulties of the nine texts. The reason for this finding may be due to PSTs' being familiar to the popular climate change concept and terminologies while they are probably not so familiar to organ donation and transplantation context. Being another reason, the texts about organ donation and transplantation contain some medical terms and PSTs may have a difficulty in comprehension of them due to their lower level of epistemological beliefs. There is an evidence that epistemological beliefs of people may affect the depth to which students learn (Schommer, 1990).

#### **5.2.3.2. PSTs' Criteria When Evaluating Trustworthiness Across Texts**

To determine PSTs' criteria on which they put more emphasize while evaluating trustworthiness on the texts, the descriptive statistics was run. The results revealed that PSTs generally put more emphasis on text content for texts written

about climate change topic, they put more emphasis on their own opinion for nuclear energy, and organ donation and transplantation texts. PSTs' putting more emphasis on their own knowledge while reading texts written about climate change. According to the results, the participants put less emphasis on author on the average while reading climate change and nuclear energy texts. However, they put less emphasis on the publication date of the texts written about organ donation and transplantation. Similar with these findings of this study, Bråten et al. (2011) trustworthiness on different information sources was evaluated more according to content and text type than according to author. Moreover, the participants used date of publication least when rating text trustworthiness. Bråten et al. (2011) made this finding reasoning in that since there was very little variation in date of publication among the documents, the date of publication may be the least relevant criterion when judging text trustworthiness. In their study, Bråten et al. (2009) also found that the participants used content as a basis for judging texts' trustworthiness. They explained this result in that "given that one's experience and skill in handling multiple documents are limited, it may actually be a wise strategy to carefully consider the contents of documents when evaluating their trustworthiness" (p. 22). In their study, participants used publisher and text type similarly more than author and date of publication and they used own opinion significantly more than date of publication. Additionally, Rouet et al. (1996) found that undergraduates evaluated the trustworthiness on documents mostly according to the characteristics of the content. Again, this may be due to PSTs' epistemological beliefs in that people holding strong beliefs in certain or simple knowledge tend to use more surface-level strategies while people holding beliefs in uncertainty and complexity of knowledge tend to use deep-level strategies

to learn (Schommer, & Hutter, 1995). In this study, PSTs hold stronger beliefs in certain or simple knowledge so that they may primarily and superficially compare the contents rather than other criteria.

#### **5.2.4. The Relationship Between PSTs' Knowledge Level and Evaluation of Trustworthiness on Different Information Sources**

According to the correlational analyses, no relationships were found among PSTs' knowledge level and epistemological beliefs. However, relationships were found between PSTs' knowledge level and evaluation of trustworthiness. High achiever PSTs found all nine texts about three SSIs more difficult to comprehend than low achievers. This is an interesting finding, but may be explained by low achievers' skimming the texts while high achievers made an intensive reading by trying to understand every word. Skimming is generally used to quickly identify the main ideas of a text while intensive reading is used in finding appropriate information in the text which is a key for a successful reading comprehension. As Shamsudin (2009) stated that the aims of science education are to provide students with basic understanding and accessing materials on science, to make students to obtain information by reading and understanding different types of text in science, reading texts on science from different sources, accessing and understanding information on the media. "Reading science texts is an interactive-constructive process which involves making meaning by negotiating understanding between the text and the reader's concurrent experiences and memories of the topic within a sociocultural context" (Yore, & Shymansky, 1991). Yore et al. (1998) suggested that

to gain knowledge in science, learners need to learn and read; and science reading should be a detailed process of getting input from the text or taking meanings.

Being another finding, high achievers gave more importance to the content of a text while evaluating the trustworthiness on sources than the low achievers did. The mixed ANOVA results indicated that high achievers had generally higher means of trustworthiness ratings of the texts than low achievers. Having high knowledge level about a content plays a crucial role when individuals judge the trustworthiness on different information sources (e.g. Bråten et al., 2011; Klemm, Iding, & Speitel, 2001; Rieh & Hilligoss, 2008). Bråten et. al. (2011). This may be due to high content knowledge allows for greater representational flexibility which means to the ability to coordinate multiple mental representations in order to read skillfully (Hynd-Shanahan & Shanahan, 2008, p. 209). Naturally, having an adequate knowledge about a topic causes to be familiar with various types of documents and information sources used in the domain. Hence, high achievers' finding the texts more trustworthy by giving importance to their content is an acceptable finding.

Correlational analyses revealed that both high and low achievers judged Text 3 more trustworthy than other eight texts. This text includes the information about how both natural causes and human activities contribute to climate change. This finding imply that PSTs are in a neutral about causes of climate change. While high achievers judged Text 5 more trustworthy for nuclear energy topic, low achievers judged Text 5 and 6 almost equally trustworthy. Text 5 mentioned the drawbacks of nuclear energy and defended Turkey should not build any nuclear power plant. The content of this text is probably the reason for its being trustworthy. PSTs may

generally be against to construct a nuclear power plant in Turkey. In contrast, Text 6 stated that Turkey need to have nuclear power plant(s) and people who against nuclear power plant construction in Turkey are the ones who do not want Turkey's development. The findings therefore may imply that while high achiever PSTs are against the nuclear power plant construction, low achiever PSTs are more moderate. About organ donation and transplantation, while high achievers found Text 9 more trustworthy, low achievers found Text 7 and 8 equally trustworthy. Text 7 stated that there is no favouritism in organ transplantation and pointed out there is a lack of knowledge about the importance of organ donation. Text 8 stated that there are many people who want to sell their kidneys; however this is forbidden and result in adverse outcomes, and transplantation of organs from human cadavers remains insufficient. Text 9 is includes the main reasons of insufficiency of organ transplantation from human cadavers and misconceptions about organ transplantation. Due to the close ratios and diversity of texts, to make an implication about this issue is difficult. However, Text 9 is more complex than other two texts about organ donation and transplantation that it question the reasons of insufficiency in organ transplantation and debating the misconceptions and high achievers may think hard on these issues than low achievers.

#### **5.2.5. Relationship Between PSTs' Epistemological Beliefs and Evaluation of Trustworthiness on Different Information Sources**

Correlational analyses revealed that there is a small, positive correlation between PSTs' simple knowledge and their trustworthiness on author criterion while reading Text 1 written about climate change. Additionally, a small, positive

correlation was found between PSTs' simple knowledge and their trustworthiness on author criterion when reading Text 7 written about organ donation and transplantation. Similar with these findings, a small, positive correlation was found between PSTs' simple knowledge and their trustworthiness on author criterion when reading Text 9 written about organ donation and transplantation. A small, positive correlation was found between PSTs' simple knowledge and difficulty of Text 4 written about nuclear energy. There is a small, positive correlation between PSTs' simple knowledge and their trustworthiness on publisher criterion when reading Text 7 written about organ donation and transplantation. These means, as PSTs believe the simplicity of knowledge, they find Text 4 more difficult, and put more emphasis on author while reading Text 1, and on publisher while reading Text 7. Schommer-Aikins (2004) suggested that the students with naive beliefs about knowledge such as simple knowledge hardly understand complex texts and easily give up on complex tasks. Thus PSTs' finding a text more difficult is normal. It is interesting that PSTs' putting emphasis on both primary source (author) and secondary source (publisher) since in a similar study it was found that the participants put less emphasis on author and publisher when judging the trustworthiness on textbook information (Bråten et al., 2011).

The results of correlational analyses indicated that there is a small, negative correlation between PSTs' omniscient authority and their trustworthiness on text type criterion when reading Text 1 written about climate change which means, as PSTs believe in omniscient authority, they put less emphasis on text type while reading Text 1. They would probably put more emphasis on author since they accept the

author as authority. The results also revealed that there is a small, negative correlation between PSTs' omniscient authority and difficulty of Text 2 written about climate change. Similarly, the results revealed that there is a small, negative correlation between PSTs' omniscient authority and difficulty of Text 3 written about climate change which means as PSTs believe omniscience of authority, they find texts less difficult. Schommer-Aikins (2004) suggested that the students with naive beliefs about knowledge (in innate ability, quick learning, simple knowledge and certain knowledge) hardly understand complex texts and easily give up on complex tasks. Thus, it is acceptable that PSTs who believe omniscience of the authority found texts less difficult.

The results of correlational analyses revealed that there is a small, positive correlation between PSTs' quick learning and difficulty of Text 1. That means, as PSTs believe learning is quick, they find Text 1 more difficult. Similarly, A small, positive correlation was found between PSTs' quick learning and difficulty of Text 5 written about nuclear energy. That means, as PSTs believe learning is quick, they find Text 5 more difficult. Additionally, the results showed that there is a small, positive correlation between PSTs' quick learning and difficulty of Text 9 written about organ donation and transplantation which means, as PSTs believe learning is quick, they find Text 9 more difficult. A small, negative correlation was found between PSTs' quick learning and their trustworthiness on author criterion while reading Text 2 written about climate change. That means, as PSTs believe learning is quick, they put less emphasis on author while reading Text 2. The students with naive beliefs about knowledge (in innate ability, quick learning, simple knowledge

and certain knowledge) hardly understand complex texts and easily give up on complex tasks (Schommer-Aikins, 2004). These students usually accept the first information they obtained and do not explore any other sources (Tolhurst, 2007). On the basis of these statements, PSTs who believe learning is quick may put less emphasis on many criteria such as author. Thus, this is an acceptable result.

According to the results of correlational analyses, there is a small, positive correlation between PSTs' certain knowledge and their trustworthiness on Text 4 written about nuclear energy. That means, as PSTs believe the certainty of knowledge, they find Text 4 more trustworthy. A small, negative correlation was found between PSTs' certain knowledge and their trustworthiness on content criterion when reading Text 7 written about organ donation and transplantation. That means, as PSTs believe the certainty of knowledge, they put less emphasis on content while reading Text 7. Öztürk (2011) stated that as PSTs believe the certainty of knowledge, they construct less counterarguments regarding SSI. This statement supports our finding in that PSTs find a text more trustworthy which means they construct less counterarguments about nuclear energy issue. Also Schommer-Aikins and Hutter (2002) stated that the more individuals believe the changing nature of the knowledge which shows the sophisticated view of certain knowledge, the more they were likely to accept the multidimensional nature of an issue which in turn ease individuals' generation of reasons from different perspectives.

### **5.3. Implications of the Study**

The present study has some important implications that should be taken into consideration by policy makers of PST education, preservice teachers, curriculum developers and the researchers interested in SSI education, epistemological beliefs, and the way of evaluation of trustworthiness on different information sources. Many researchers stated that SSI is a very suitable context to teach and learn science content, and increase PSTs' scientific literacy, hence it should be incorporated into PST education. (e.g., Albe, 2008; Holbrook & Rannikmae, 2009; Kolstø et al., 2006; Sadler, Barab, & Scott, 2007; Sadler et al., 2004; Topçu, Sadler, & Yılmaz-Tüzün, 2010; Zeidler et al., 2002). Barab and Scott (2006) also stated that students gain conceptual knowledge and an understanding of the nature of science when working with SSI. Inclusion of SSI into science curriculum necessitates some changes and modifications in science teacher education programs such as including courses which aims to improve PSTs' using SSI in classroom and managing discussions of SSI. Teachers play a major role in implementing of SSI into science curriculum and curriculum changes should be consistent with teachers' beliefs, values, philosophies, and their understanding of science (Lee & Witz, 2009). Simmons and Zeidler (2003) stated that for a teacher's implementing SSI into science courses, s/he should be educated as qualified for the using of SSI in science classrooms effectively, s/he should know the issue well, and s/he should possess the required skills to guide the classroom during the discussion process. Therefore, universities' PST education programs should raise teachers with awareness, theoretical background, and the application of using SSI in science classes through method courses (Öztürk, 2011).

Students' epistemological beliefs are significantly related with their level of use of science content knowledge in daily problems (Evcim et al., 2011). Epistemological beliefs are important in SSI education and for development of more sophisticated epistemological beliefs it is important to design a PST education based on these beliefs (Baltacı, 2013). Additionally, by adding SSI to science and PST education curriculum and establishing active learning environments, more sophisticated epistemological beliefs may be formed. These sophisticated beliefs may provide a more effective SSI education. PSTs' epistemological beliefs should be found out and their reflection on this issue should be provided (Baltacı, 2013). To make PSTs discuss their epistemological belief systems and learn their point of views about SSIs, proper classroom environments should be constituted in some courses such as special teaching methods and teaching practice.

Teachers should know about the content they are going to teach and how the nature of knowledge is different for various content areas (Schmidt, Baran, Thompson, Koehler, Mishra, & Shin, 2009). The students require a sophisticated and well-organized content knowledge to have meaningful effects on their practices relative to SSI (e.g., Dawson & Schibeci, 2003; Patronis et al., 1999; Sadler, & Fowler, 2006; Yang & Anderson, 2003). PSTs gain content knowledge about science-related issues using various information sources such as textbooks, newspapers, scientific magazines, online newspapers etc. Undoubtedly that every information source cannot be reliable. Hence, teaching students to evaluate the sources they read considering relevant criteria becomes a highly worthwhile but difficult educational activity (Bråten et al., 2011). PSTs, being future teachers, need

to become critical readers not only of climate change, nuclear energy, and organ donation and transplantation texts but of other various of texts they encounter in all areas, and so that their sourcing skills in multiple-text comprehension needs to be developed by making regulations in the PST education program.

In summary, epistemological beliefs, evaluation of trustworthiness on different information sources, and SSI education together have an important role in PST education. Incorporation of a learning environment feeding these three main factors into PST education programs would improve SSI education in Turkey.

#### **5.4. Recommendations for Further Research**

According to the findings of this study, the following recommendations can be offered. First, further researches on students' source evaluation and the role played by prior knowledge in this process should be conducted. In selecting the texts for trustworthiness questionnaire, some changes can be made as follows:

- different texts about same SSIs,
- texts about different SSIs,
- texts about other science topics,
- number of the texts for each SSI

can be used to replicate this study to reveal PSTs' trustworthiness on different information sources, and the correlations among PSTs' epistemological beliefs and evaluation of trustworthiness on different information sources. In addition, trustworthiness questionnaire can be developed by adding some other criteria to

investigate that to which criteria PSTs put more emphasis while reading the texts. Also this study showed that high achiever PSTs found all the texts more difficult to comprehend than low achievers. To investigate the reason of this, further research, may be a mixed method or qualitative study, can be done.

Second, to have a deeper knowledge about the knowledge levels of PSTs regarding climate change, nuclear energy, and organ donation and transplantation regarding, a qualitative study can also be conducted.

Third, this study revealed that PSTs mostly had inadequate knowledge about organ donation and transplantation while their knowledge levels regarding climate change and nuclear energy are adequate. Thus, PST education should give more importance to this topic.

Finally, research studies exploring the correlation among PSTs' epistemological beliefs, knowledge levels about selected SSIs and their evaluation of trustworthiness on different information sources are needed. In this way, the findings can be utilized while designing an SSI-based science curriculum for PSTs.

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## APPENDICES

### APPENDIX A

#### PARTICIPANT PERSONAL INFORMATION SHEET

Sevgili Öğrenciler,

Bu ankete vereceğiniz yanıtlar, yapılacak olan çalışmaya önemli katkıda bulunacaktır. Yanıtlarınızı daha kapsamlı değerlendirebilmek için size bir kaç kişisel soru sormak istiyoruz. Bu bölümde vereceğiniz yanıtlar kesinlikle gizli tutulacaktır.

|  |
|--|
| 1. Cinsiyetiniz:<br><input type="radio"/> Erkek <input type="radio"/> Bayan  |
| 2. Yaşınız:  |
| 3. Sınıfınız:<br><input type="radio"/> 1 <input checked="" type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4  |
| 4. Mezun olduğunuz lise türü:<br><input type="radio"/> Düz Lise <input type="radio"/> Meslek Lisesi <input type="radio"/> Süper Lise<br><input type="radio"/> Fen Lisesi <input type="radio"/> Anadolu Lisesi <input type="radio"/> Anadolu Öğretmen Lisesi <input type="radio"/> Diğer: |
| 5. Annenizin eğitim durumu:<br><input type="radio"/> İlkokul üstü <input type="radio"/> Ortaokul <input type="radio"/> Lise <input type="radio"/> Üniversite <input type="radio"/> Lisans  |
| 6. Babanızın eğitim durumu:<br><input type="radio"/> İlkokul üstü <input type="radio"/> Ortaokul <input type="radio"/> Lise <input type="radio"/> Üniversite <input type="radio"/> Lisans  |
| 7. Lisansta çevre ile ilgili aldığınız dersler nelerdir?<br>.....  |

## APPENDIX B

### TURKISH VERSION OF SCHOMMER'S EPISTEMOLOGICAL QUESTIONNAIRE

|  | Kesinlikle<br>katılmıyorum | Katılmıyorum | Kararsızım | Katılıyorum | Kesinlikle<br>katılıyorum |
|--|----------------------------|--------------|------------|-------------|---------------------------|
| 1. Eğer bir şeyi anlayabileceksen, onu ilk duyduğunda sana anlamlı gelecektir.   |                            |              |            |             |                           |
| 2. Kesin olan tek şey, hiçbir şeyin kesin olmadığıdır.   |                            |              |            |             |                           |
| 3. Okulda başarılı olmak için yapacağın en iyi şey çok soru sormamaktır.   |                            |              |            |             |                           |
| 4. Nasıl çalışman gerektiğini anlatan bir ders faydalı olacaktır.  |                            |              |            |             |                           |
| 5. Bir kişinin okuldaki eğitimden kazanacakları, öğretmenin kalitesine çok bağlıdır.                                   |                            |              |            |             |                           |
| 6. Okuduğun her şeye inanabilirsin.  |                            |              |            |             |                           |
| 7. Öğretmenlerimin gerçekten ne kadar bildiğini çok sık merak ederim.  |                            |              |            |             |                           |
| 8. Öğrenme yeteneği doğuştan gelen bir kabiliyettir.   |                            |              |            |             |                           |
| 9. Neye inandığı konusunda karar verememiş öğretmeni dinlemek rahatsız edicidir.                                       |                            |              |            |             |                           |
| 10. Başarılı öğrenciler her şeyi çok çabuk anlarlar.   |                            |              |            |             |                           |
| 11. İyi bir öğretmenin işi öğrencilerini merak ettiği konulardan uzaklaştırmaktır.                                     |                            |              |            |             |                           |
| 12. Eğer bilim adamları yeterince sıkı çalışırsa, hemen hemen her şeyin doğrusunu bulabilirler.                        |                            |              |            |             |                           |
| 13. Bilim otoritelerini sorgulayan insanlar, kendilerine olması gerektiğinden fazla güvenenlerdir.                     |                            |              |            |             |                           |
| 14. Farklı konu başlıklarından, hatta farklı derslerden öğrendiğim bilgileri birleştirmek için elimden geleni yaparım. |                            |              |            |             |                           |

15. En başarılı insanlar öğrenme yeteneklerinin nasıl geliştiğini keşfeden insanlardır.

16. Profesörlerin size anlattıkları şeyler aslında gerçeklerinden daha basittir.

17. Bilimsel çalışmaların en önemli özelliği çok hassas ölçümler ve dikkatli çalışmalardan oluşmasıdır.

18. Benim için çalışmak; okuduğum şeyden, detaylı bilgiler yerine genel bir fikir elde etmektir.

19. Öğretmenler yeri geldiğinde en iyi öğretim metodunun ne olduğuna karar verebilmelidirler.

20. Zor bir kitabın bölümlerini tekrar tekrar okumak, o bölümleri anlamana yardım etmez.

21. Bilim adamları en sonunda doğruları bulurlar.

22. Yazarın amacını bilmeden, onun kitabının vermek istediği fikri asla bilemezsin.

23. Bilimsel çalışmanın en önemli kısmı, orijinal düşüncesidir.

24. Bir kitabın bölümünü ikinci kez okumaya zaman ayırabilirsem, bu ikinci okumadan çok şey öğrenirim.

25. Öğrencinin bir kitaptan sahip olacağı bilginin miktarı daha çok kendi kontrolündedir.

26. Dahî olmanın %10'u yetenek, %90'ı çalışmaktır.

27. Bilimsel otoritelerin anlaşılmadıkları konular hakkında düşünmeyi ilginç bulurum.

28. Herkesin nasıl öğrenebileceğini öğrenmeye ihtiyacı vardır.

29. Kitapta zor bir kavram ile karşılaştığın zaman yapacağın en iyi şey kendi kendine anlamaya çalışmaktır.

30. Bir cümlenin hangi durum için söylendiğini bilmiyorsan anlaşılması zordur.

31. Genellikle iyi bir öğrenci olmak, bilgileri ezberlemeyi gerektirir.

32. Akıllılık cevapları bilmek değil, cevapların nasıl bulunduğunu bilmektir.

33. Kelimelerin çoğu tek bir anlama sahiptir.

34. Gerçek hiçbir zaman değişmez.

35. Bir insan okuduğu şeyin ayrıntılarını unutsa bile, eğer o konu hakkında yeni fikirler üretebiliyorsa o kişinin oldukça akıllı olduğunu düşünürüm.

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36. Hayatımda zor bir problemle karşılaştığımda aileme danışırım.

37. Tanımları kelime kelime öğrenmek, sınavda başarılı olmak için her zaman gereklidir.

38. Çalışırken belirli (spesifik) gerçekleri ararım.

39. Eğer bir insan bir şeyi kısa bir zaman içerisinde anlayamazsa, onu anlamak için çalışmaya devam etmelidir.

40. Bazen bir öğretmenin verdiği cevapları anlamasan da kabul etmelisin.

41. Eğer üniversitedeki profesörler bilimsel teorilerden çok bilimsel gerçeklere dayanarak eğitim verirlerse, öğrenciler üniversitelerden daha çok şey öğrenirler.

42. Sonu belli olmayan filmleri sevmem.

43. Bir konuda ilerlemek, gelişmek çok çaba gerektirir.

44. Kesin cevabı belli olmayan problemler üzerinde çalışmak tam bir zaman kaybıdır.

45. Eğer bir konuyu iyi biliyorsan, o konu hakkında yazılmış bir kitaptaki bilginin doğruluğunu değerlendirmelisin.

46. Uzmanların tavsiyeleri bile, sık sık sorgulanmalıdır.

47. Bazı insanlar doğuştan öğrenme kapasiteleri yeterli doğarlar, diğerleri ise sınırlı öğrenme kabiliyetine mahkûmdur.

48. Hiçbir şey kesin değildir, ölüm dışında.

49. Gerçekten zeki öğrencilerin okulda başarılı olmaları için çok sıkı çalışmalarına gerek yoktur.

50. Zor bir problem üzerinde uzun zaman çok sıkı çalışmak, sadece gerçekten zeki öğrenciler için iyi bir sonuç verir.

51. Eğer bir insan bir problemi anlamak için çok çalışırsa, kafası karışmış bir şekilde bu işi bırakacaktır.

52. Bir kitaptan öğrenebileceğiniz bilginin hemen hemen hepsini ilk okumada edirsiniz.

53. Genellikle çok zor kavramları; dışarıdan gelebilecek dikkat dağıtıcı şeyleri azalttığında ve iyice konsantre olduğunda öğrenebilirsin.

54. Bir kitabı anlayabilmenin en iyi yolu kitabın içindeki bilgileri kendi anlayacağın şekilde tekrar organize etmendir.

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55. Okulda ortalama bir başarıya sahip olan öğrenci hayatının diğer kısımlarında da ortalama bir başarıya sahiptir.

56. Bilgileri düzenli olan bir insan, kafası boş bir insandır.

57. Bir alanda uzman olan kişi, o alanda doğuştan kazanılmış özel bir yeteneğe sahiptir.

58. Ders planlarına sıkı sıkıya bağlı olan ve özenle ders notlarını organize eden öğretmenleri gerçekten takdir ediyorum.

59. Fen dersindeki en iyi şey, bu dersteki çoğu problemlerin sadece tek bir doğru cevabının olmasıdır.

60. Öğrenmek, bilginin yavaşça üst üste inşa edildiği bir işlemdir.

61. Bugünkü bilimsel gerçekler, gelecekte hayal ürünü veya hikâye olabilir.

62. Kendi kendinize öğrenmenizi sağlayan kitaplar çok fazla yardımcı olmaz.

63. Bir konu hakkında bir kitaptan öğrendiğiniz bilgileri, o konu hakkında sahip olduğunuz bilgilerle birleştireceğiniz zaman kafanız karışacaktır.

## APPENDIX C

### KNOWLEDGE TEST

#### CLIMATE CHANGE

1. İklim değişikliğinin tanımını aşağıdaki şıkların hangisinde doğru verilmiştir?

A) Karşılaştırılabilir zaman dilimlerinde gözlenen doğal ve doğrudan veya dolaylı olarak küresel atmosferin bileşimini bozan insan faaliyetleri sonucunda iklimde oluşan değişiktir.

B) Atmosfere salınan gazların miktarındaki artış nedeniyle, dünya üzerinde yıl boyunca kara, deniz ve havada ölçülen ortalama sıcaklıklarda görülen artıştır.

C) Bir yerde uzun bir süre boyunca gözlemlenen sıcaklık, nem, hava basıncı, rüzgar, yağış, yağış şekli gibi meteorolojik olayların ortalamasına verilen addır.

D) Yaşam ve insan aktiviteleri üzerindeki etkisini de göz önüne almak koşuluyla atmosferin belirli bir anda, belirli bir bölgedeki haline denir.

2. “Dünya atmosferi çeşitli gazlardan oluşur. Güneşten gelen ışınlar, atmosferi geçerek yeryüzünü ısıtır. Atmosferdeki gazlar, yeryüzündeki ısının bir kısmını tutar ve yeryüzünün ısı kaybına engel olur. Atmosferin, ışığı geçirme ve ısıyı tutma özelliği vardır. Isıyı tutma yeteneği sayesinde suların sıcaklığı dengede kalır. Böylece nehirlerin ve okyanusların donması engellenmiş olur. Bu şekilde oluşan, atmosferin ısıtma ve yalıtma etkisine ..... etkisi denir.”

Yukarıdaki paragrafta boş bırakılan yere aşağıdakilerden hangisi yazılmalıdır?

A) Doppler                      B) coriolis                      C) sera                      D) plasebo

3. Küresel ısınma üzerinde etkili olduğu bilinen en önemli gaz aşağıdakilerden hangisidir?

A) Karbondioksit      B) Diazot monoksit      C) Kükürt heksaflorid      D) Oksijen

4. Aşağıdakilerden hangisi bir sera gazı değildir?

- A) Karbondioksit                      **B) Oksijen**                      C) Metan                      D) Ozon

5. Geçmiş dönemde büyük boyutlu iklim değişikliklerinin meydana gelmiş olduğu bilinmektedir. Bu değişimlerin çoğu astronomik ve jeofiziksel olarak izah edilebilmekte ve doğal nedenlere dayanmaktadır. Son yıllarda sıkça gündeme gelen günümüze ait iklim değişiminin ise insan aktivitelerinden kaynaklandığına dair belirtiler mevcuttur.

Aşağıdakilerden hangisi insan aktivitelerinin neden olduğu olaylardan biri değildir?

- A) Fosil yakıtlarının yakılması                      C) Ormanların yok edilmesi  
B) Sanayileşmenin artması                      **D) Volkanik aktiviteler**

6. Küresel ısınma, aşağıdaki olaylardan hangisine sebep olur?

- A) Nüfus artışı                      C) Sera gazı salınımının artması  
B) Ozon tabakasının incilmesi                      **D) İklim değişikliği**

7. Aşağıdaki olaylardan hangisi iklim değişikliğine sebep olan faktörlerden bir tanesi değildir?

- A) Yenilenebilir enerji kaynaklarının kullanılması** B) Yanlış arazi kullanımı  
C) Sera gazlarının normal seviyenin üzerine çıkması D) Ozon tabakasındaki incelme

8. Aşağıdakilerden hangisi iklim değişikliğine neden olan doğal (doğrudan insan kaynaklı olmayan) etmenlerden birisidir?

- A) El Nino olayları**                      B) Fosil yakıtlar                      C) Nüfus artışı                      D) Sera gazları

9. “Birçok ülkede çöplüklerin büyük yer kaplaması sorun yaratmaktadır. Organik çöplerden pek çoğu ayrışarak büyük miktarda ..... salgılamakta, bu gaz da özellikle iyi havalandırması olmayan ve kontrol altında tutulmayan eski çöplüklerde patlamalara ve içten yanmalara neden olmaktadır. Atmosfere salınan bu gazın oranı artmakta ve bunun sonucu olarak da sera etkisi tehlikeli boyutlara varmaktadır.”

Yukarıdaki metinde boş bırakılan yere hangi kelime gelmelidir?

A) karbondioksit      **B) metan**      C) azotoksit      D) su buharı

10. Aşağıdakilerden hangisi iklim değişikliğinin olası bir sonucu olamaz?

A) **Nüfus artışı**      C) Kuraklık  
B) Seller      D) Yağışın bazı bölgelerde artarken bazı bölgelerde azalması

11. Atmosfere verilen gazların sera etkisi yaratması sonucunda, dünya atmosferi ve okyanuslarının ortalama sıcaklıklarında belirlenen artışa verilen isme ne denir?

A) Geri dönüşüm      B) İklim      C) Erozyon      **D) Küresel ısınma**

12. Aşağıdakilerden hangisi iklim değişikliğinin insan sağlığına etkilerinden biri değildir?

A) **AIDS**      C) Deri kanseri riskinin artması  
B) Su ile bulaşan hastalıklar      D) Kalp damar hastalıklarına duyarlılıklar

13. Aşağıdakilerden hangisi atmosferdeki karbondioksit miktarını artırmaya neden olmaz?

A) Orman yangınları      C) Yanlış toprak kullanımı  
**B) Yağmur yağması**      D) Fosil yakıtların yanması

14. Aşağıdakilerden hangisi küresel ısınmanın potansiyel etkilerinden bir tanesi değildir?

A) Doğal yaşam alanlarında kayıplar      C) Su kaynakları için rekabet  
B) Salgın hastalıklar      **D) Tür çeşitliliğinde artış**

15. Küresel ısınma ve iklim değişikliğinin etkilerini azaltmak için aşağıdakilerden hangileri yapılabilir?

- I. Enerji dostu ampuller kullanılmalıdır.
- II. Vantilatör yerine klima kullanılmalıdır.
- III. Evler ısı kaybına karşı yalıtılmalıdır.
- IV. Toplu taşıma araçları tercih edilmelidir.
- V. Bulaşıklar makinede değil elde yıkanmalıdır.
- VI. Geri dönüşüm yapmaya özen gösterilmelidir.

A) I, II ve IV      B) II, IV, V ve VI      C) **I, III, IV ve VI**      D) I, IV ve VI

## NUCLEAR ENERGY

1. Aşağıdakilerden hangisi yenilenebilir bir enerji kaynağıdır?

A) Kömür      B) Petrol      C) Nükleer enerji      D) **Jeotermal enerji**

2. Nükleer enerji nedir?

A) **Ağır radyoaktif atomların bir nötronun çarpmasıyla daha küçük atomlara bölünmesi veya hafif radyoaktif atomların birleşerek daha ağır atomları oluşturmasıyla ortaya çıkan çok büyük miktardaki enerjidir.**

B) Yer kabuğunun çeşitli derinliklerinde birikmiş olan ısının oluşturduğu, kimyasallar içeren sıcak su, buhar ve gazlardan kaynaklanan enerjidir.

C) Kimyasal tepkime sonucu ortaya çıkan enerjiye denir.

D) Bir maddenin moleküllerinin başka bir madde molekülleri ile yaptığı reaksiyon sonucu ortaya çıkan ısı enerjisine denir.

3. Radyoaktif atıklar nasıl saklanır?

A) Denize bırakılır.      B) **Çeşitli işlemlerden geçirilip depolanır.**  
C) Yakılarak gömülür.      D) Çöpe atılır.

4. Aşağıdaki açıklamalardan hangisi radyasyonun tanımıdır?

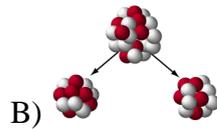
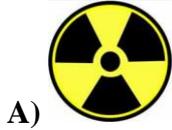
A) Nükleer santrallerin diğer adıdır.

**B) Elektromanyetik dalgalar veya parçacıklar biçimindeki enerji yayılımı veya aktarımıdır.**

C) Sağlığa zararlı, elektronik aletlerde sıkça bulunan radyoaktif ışınların diğer adıdır.

D) Bir enerji türüdür.

5. Aşağıdakilerden hangisi radyoaktif madde sembolüdür?



6. “Nükleer güç santrali ..... enerjiyi ..... enerjiye dönüştürür.” cümlesinde boş bırakılan yerlere aşağıdaki kelime çiftlerinden hangisi getirilmelidir?

A) kimyasal, fiziksel

C) fiziksel, nükleer

**B) nükleer, elektrik**

D) elektrik, kimyasal

7. Aşağıdaki santrallerden hangisinde radyoaktif maddeler yardımı ile elektrik enerjisi elde edilir?

**A) Nükleer santral**

C) Hidroelektrik santrali

B) Termik santral

D) Jeotermal santral

8. Radyoaktif çekirdeklerin kararlı yapıya geçebilmek için dışarı saldıkları hızlı parçacıklar ve elektromanyetik dalga şeklinde taşınan enerjilere ..... denir.

A) Kinetik Enerji

B) Potansiyel Enerji

C) Nükleer Enerji

**D) Radyasyon**

9. Aşağıda verilen nükleer santrallerden hangisinde (henüz) bir felaket yaşanmamıştır?

A) Çernobil Nükleer Santrali

**C) Oldbury Nükleer Santrali**

B) Fukuşima Nükleer Santrali

D) Three Mile Island Nükleer Santrali

10. Aşağıdakilerden hangisi günümüzde nükleer güç santrallerinde kullanılan yakıt türlerinden bir tanesi değildir?

- A) **Sodyum**                      B) Toryum                      C) Uranyum                      D) Plütonyum

11. Bir nükleer güç tesisinin kurulabilmesi için bazı özelliklere dikkat edilmelidir. Aşağıdakilerden hangisi bir yere nükleer güç tesisi kurmak için göz önünde bulundurulması gereken konulardan biri değildir?

- A) Deprem olma ihtimalinin düşük olması      **C) Kurak yer olması**  
B) O yerdeki nüfus yoğunluğunun az olması      D) Meteorolojik şartların uygun olması

12. Ülkemizde nükleer teknoloji hangi alanda henüz kullanılmamaktadır?

- A) Endüstri                      B) Tıp                      C) Araştırma ve eğitim                      **D) Elektrik üretimi**

13. I. Koruma kabuğu

II. Yakıt deposu

III. Elektrik jeneratörü

IV. Buhar tribünü

Kapalı bir nükleer santralde yukarıda verilen yapılardan hangileri bulunur?

- A) I ve III  
B) II ve IV  
**C) I, II, III ve IV**  
D) II, III ve IV

14. Nükleer enerjinin oluşması için üç reaksiyondan biri gereklidir. Aşağıdakilerden hangisi bunlardan biri değildir?

- A) Füzyon reaksiyonu  
B) Fisyon reaksiyonu  
C) Yarılanma reaksiyonu  
**D) Kimyasal reaksiyon**

## ORGAN DONATION AND TRANSPLANTATION

1. Aşağıdakilerden hangisi bir kişinin organ bağışı yapabilmesi için gerekli yasal şartlardan bir tanesi değildir?

- A) 18 yaşını doldurmuş olmak
- B) Akıl sağlığının yerinde olması
- C) İki birinci dereceden akrabayı şahit olarak bulundurmak
- D) Sağlık raporu almak**

2. Organ nakli ile ilgili verilen aşağıdaki bilgilerden hangisi doğrudur?

- A) Nakilden sonra kişi eski işgücüne geri dönemez.
- B) Günümüzde kalp kapağı nakli henüz yapılamamaktadır.
- C) Alıcı ve vericinin kan grupları uyumsuz ise organ nakli gerçekleşemez.
- D) Akraba dışı bir kişiden organ nakli mümkündür.**

3. Organ donörü yaşayan kişi veya kadavra olabilir. Ancak çeşitli nedenlerden dolayı bazı organların nakli yalnızca kadavradan veya yaşayan kişiden yapılmaktadır. Aşağıdaki doku ve organlardan hangisinin naklinin yapılabilmesi için donörün canlı olması şarttır?

- A) Karaciğer
- B) Kalp
- C) Kemik iliği**
- D) Kornea

4. “Bazı böbrek hastaları vericileri olmasına rağmen kan ve doku uyumsuzluğu nedeniyle kendi vericilerinden böbrek alamamaktadırlar. Aynı durumdaki iki çift arasında birinin vericisinden diğerinin alıcısına böbrek nakli yapılmasına ..... denilmektedir.”

- A) çapraz nakil**
- B) değişim
- C) çiftli organ nakli
- D) çaprazlama

5. Organ bağışı işlemi aşağıdaki kurumlardan hangisinde yapılmamaktadır?

- A) **Sağlık Bakanlığı’nda**
- C) Organ nakli yapan merkezlerde
- B) Hastanelerde
- D) Organ nakli ile ilgilenen vakıf, dernek gibi kuruluşlarda

6. Ülkemizde Organ ve Doku Nakli hizmetleri, 1979 yılında yürürlüğe giren hangi kanun ile yürütülmektedir?

A) Organ Bağıışı ve Nakli Kanunu

**B) Organ ve Doku Alınması, Saklanması, Aşılması ve Nakli hakkında Kanun**

C) Organ ve Doku Bağıışı ile Nakli Hakkında Kanunu

D) Organ ve Doku Alınması ve Nakli Kanunu

7. Aşağıdaki organlardan hangisinin nakli günümüzde henüz yapılamamaktadır?

A) Akciğer

**B) Beyin**

C) Karaciğer

D) Böbrek

8. Aşağıdakilerden hangisinin naklinin kesinlikle kadavradan yapılması gerekmektedir?

A) El

B) İnce bağırsak

C) Pankreas

D) Deri

9. Doku ve organ nakli ile ilgili aşağıda verilen bilgilerden hangisi yanlıştır?

A) Alıcı ve verici arasında doku uyumu olmasa bile nakil yapılabilir.

B) Hepatit B olan hastalar da nakil olabilir.

C) Belli koşullarda kanser hastaları da nakil olabilir.

**D) Gönüllü olan her birey verici olabilir.**

10. “Vücudumuzdaki bir organın görevini yapamamasına ..... denir. Bu organlar kalp, karaciğer, böbrek ve pankreas gibi hayati organlar olabilir. Bu bozukluk, sonunda tüm organları etkilemekte ve insanlarımız ölmektedir. Ülkemizde yaklaşık 40 bin kişi bu durum ile yaşam mücadelesi vermektedir.”

A) organ bağıışı

B) organ eksikliği

**C) organ yetmezliği**

D) organ nakli

11. Aşağıdakilerden hangisi, bir naklin başarılı olmasını sağlayan etkenlerden biri değildir?

A) Ameliyata girecek olan ekibin tecrübeli, deneyimli ve bilgili olması

B) Hastanenin fiziki ve tıbbi koşullarının iyi olması

C) Nakil öncesi ve sonrasında hastanın yakın takibi

**D) Ameliyatın özel bir hastanede yapılması**

12. Herkes verici olamaz. Aşağıdakilerden hangisi, verici olmak için gereken kriterlerden birisi değildir?

A) **50 yaşını geçmemiş olmak**

C) Kalp hastası olmamak

B) Gönüllü olmak

D) Şeker hastası olmamak

13. Organ bağıışı ve nakli ile ilgili aşağıda verilen bilgilerden hangisi doğrudur?

A) 90 yaşındaki bir kişinin kalp, karaciğer, böbrek gibi hayati organları bir çocuğa nakledilebilir.

B) Hepatit C hastaları verici olabilir.

C) **18 yaş altı beyin ölümü gerçekleşmiş bir kişinin organ(lar)ı nakil için kullanılabilir.**

D) Bitkisel hayata girmiş bir kişinin organları alınabilir.

## APPENDIX D

### READING TEXTS ABOUT THE THREE SOCIOSCIENTIFIC ISSUES

#### CLIMATE CHANGE TEXTS

**Metin-1:** 11/12/2012; *Belkıs Gökbulut, Boğaziçi Üniversitesi İklim Değişikliği Çalışma Grubu*

Bilim insanlarının küresel ısınma hakkındaki ortak görüşü IPCC 2007 raporunda açıkça ifade edildi: “Günümüzde yaşanmakta olan küresel iklim değişikliğinin sebebi çok yüksek ihtimalle insanların çeşitli işlemler sonucu çevreye yaydıkları sera gazlarıdır.” Küresel ısınmada en önemli etken olan karbondioksitin atmosferdeki oranı, fosil yakıtların kullanılmasıyla, en yüksek seviyeye ulaştı ve yeryüzünden yayılan ısının uzaya kaçmasını engelleyerek son 100 yılda 0,7 C° sıcaklık artışını beraberinde getirdi. Tarih boyunca yaşanmış iklim değişiklikleri tamamen doğal kaynaklıydı. Güneş aktivitelerindeki değişim bunların oluşumunda önemli faktördü. Güneşin manyetik alanındaki değişimler güneş lekelerinin artması veya azalmasına neden olur, bu da güneşin yaydığı enerji miktarını değiştirir. Son 30 yıldır dünyaya ulaşan enerji miktarı uydularla ölçülüyor. Ölçümler güneşten gelen enerjinin azaldığını fakat dünyanın ısınmaya devam ettiğini; daha az enerji almasına rağmen atmosferdeki sera gazlarının artması nedeniyle ısının dünyada daha çok hapsedildiğini gösteriyor. Atmosfere her gün milyarlarca ton karbondioksit saldığımızı ve güneş aktivitelerinin normal döngüsü içinde yeniden artmaya başlayacağını göz önünde bulundurduğumuzda bu artışın katlanarak devam edeceğini unutmamalıyız.

Bilimin açıkça kabul ettiği gerçeğe rağmen, kişisel çıkarlarını insanlığın varlığından üstün tutanlar rahatını bozmamak için küresel ısınma ve ardından gelen felaketlerin nedenini güneşe bağlamaktan çekinmiyor. Hükümetler siyasi menfaatlerini üstün görerek sera gazı salınımını azaltmaktan, enerji verimliliği

politikaları uygulamaktan uzak duruyor. Fakat bilim, insanlığın gerçekte yüzleşmezse kendi sonunu hazırladığını gözler önüne seriyor; küresel ısınmanın sebebi biziz!

**Metin-2:** 05.07.2011; Prof. Dr. Tuncay Neyişçi, Akdeniz Üniversitesi Çevre Sorunları Araştırma ve Uygulama Merkezi Müdürü

Bugüne kadar yaşanmış en sıcak 10 yıl, 90'lı ve 2000'li yıllar. Bu ısınmanın küresel ısınma yani karbondioksit emisyonu ile ilgili olduğu söylendi. Hükümetler arası iklim değişikliği panelinde sunulan raporda da var. Ancak o raporun içinde olup da bilim adamlarına yansıtılmayan başka bir görüş daha var. O da bu ısınmanın Güneş'ten Dünya'ya gelen enerjiyle ilgili olduğu yönünde. Bu sıcaklık belli dönemlere kayıyor, bunun yağışlar üzerinde de etkisi oluyor, orman yangınları üzerinde de. Güneş'teki bu söz konusu patlamaların emisyonla bir ilgisi olmadığı için de hangi mevsimde olacakları belli olmuyor. Emisyona, küresel ısınmaya bağlı olsaydı o zaman neden soğuk kış geçirdik? İklimsel anormallikler söz konusu, bunda en büyük pay güneşten yeryüzüne ulaşan enerjiyle ilgili. İklimlerin kaymasında bu en önemli etken. Yazın ortasında sağanak yağışlar, kışın açan güneşler hep bu yüzden. Bunlar kıyamet alameti değil, söz konusu rapora bakılsın, bize yanlış hedef gösteriliyor.

**Metin-3:** 06.2005; *Bilim ve Teknik dergisi*, Elif Yılmaz

İklimimiz değişiyor! Dünyamız bin yıldan uzun süredir, geçtiğimiz 30 yıl içinde ısındığı kadar hızlı ısınmadı ve en sıcak 3 gün 1998'den sonra kaydedildi. İklim sisteminin dengesi, doğal veya insan etkisiyle ortaya çıkan bazı zorlamalara uğradığında bozulabiliyor. Doğal etmenler, güneş ışınması miktarındaki doğal oynamalar, volkanik patlamalarla atmosfere yayılan tozlar veya okyanus akıntı sistemlerini ve atmosferdeki rüzgarları etkileyen kıta hareketleri gibi, insan etkisiyle ilgili olmayan nedenlerden ortaya çıkıyor. İnsan etkinlikleriyle ortaya çıkan etmenlerse daha çok, sera gazlarının atmosferdeki miktarını artıran ve atmosferin en alt tabakası olan troposfer kimyasının değişimine neden olan etkinlikler. Sanayi devrimiyle birlikte kent nüfuslarının ve fosil yakıt tüketiminin artmasına bağlı olarak,

atmosfere salınan sera gazlarının miktarının da önemli ölçüde arttığına dikkat çeken bilim insanları, bunun küresel ısınmaya yol açabileceğini söylüyorlardı. Atmosferdeki karbondioksit, su buharı, ozon, metan, azotoksit ve kloroflorokarbon gazlarının miktarlarındaki artış, dünyadan atmosfere geri yollanan güneş ışınlarının daha fazla tutularak yeniden atmosfere yayılması ve bu da, ortalama sıcaklığın artması anlamına geliyor. Son yıllarda, insan etkinlikleriyle küresel ısınma arasında doğrudan bir ilişki olduğunu kanıtlamaya yönelik birçok araştırma yapılıyor.

## NUCLEAR ENERGY TEXTS

**Metin-1:** 21.03.2013; Prof. Dr. Deniz Ülke Arıboğan

Enerjide dışa bağımlılığı gittikçe artan Türkiye’de, bağımsızlığın ön koşullarından biri nükleer enerjidir. Yüksek maliyetli yatırım gibi görünse de, kendisini kısa sürede amorti edebilen nükleer reaktörler, elektrik üretiminde ülkelere çağ atlatabilecek verimliliğe sahip. Avrupa’da 2011 yılı itibariyle 195 nükleer reaktör bulunuyor. Petrol kaynağına sahip olmayan ülkeler açısından bu çok avantajlı ve özgürleştirici. Avrupa’da nükleer güvenliği sağlayan önemli hususlar teknoloji ve zeminin deprem güvenliğine sahip olması. Nükleer reaktörler açısından en yüksek riski depremler ve yüksek imha gücüne sahip silahlar oluşturuyor. Terör eylemleri ve savaş ortamları insan eliyle yaratılan tehlikeler arasında. Avrupa artık kendini bunlardan önemli ölçüde muaf sayıyor. Bir işletim hatasına karşı en yüksek güvenlik tedbirleri alınmış durumda. Ancak Japonya’daki deprem, tsunami ve nükleer sızıntıdan sonra Almanya nükleer inşaat süreçlerini durdurdu. Eski reaktörlerin devre dışı bırakılması, yenilerinin daha özenle inşa edilmesi gerektiği konuşuluyor. Bundan sonra nükleer karşıtı lobinin daha da etkin hale gelecek ve nükleer yatırım yapmak isteyen hükümetlerin işi artık daha zor olacak.

Bir ülkede nükleer reaktör olmaması, o ülkenin nükleer kazalara karşı güvende olacağını göstermez. Türkiye sınırlarında reaktörler var. Çernobil’in etkisini

kilometrelerce ötede olmasına rağmen derinden hisseden bir ülke olarak, olası kazalardan nasıl etkileneceğimizi şimdiden tahmin edebiliriz.

Nükleer enerji güvenli bir ortam sağlandığında temiz bir enerji olabilir. Güçlü bir Türkiye için enerji bağımsızlığı çok önemlidir. Lakin konu, bir aksilik halinde koca bir ülkenin yok oluşuna neden olabilecek kadar önemli olduğundan, derinlemesine tartışılması ve risklerle kazançların hesaplanması gereklidir. Doğru teknoloji, doğru yer ve doğru işletmeciliğin bulunduğu bir örnek yaratamazsak, büyük bir tehlike kapımızda demektir.

**Metin-2: 10.2008; Greenpeace**

Nükleer enerji iklim değişikliğine karşı alınacak önlemlerden bizi uzaklaştıracak pahalı ve tehlikeli bir unsurdur. Sera gazı salınımlarını düşürme hedeflerine ancak geçerliliği kanıtlanmış yenilenebilir enerji kaynağı seçenekleri ve enerji verimliliğiyle ulaşmak mümkündür. Uluslararası Enerji Ajansı'nın 2008 senaryosu, yenilenebilir enerji kaynaklarının sera gazı indirimine olan katkısının nükleer enerjiye göre dört kat fazla olduğunu, esas potansiyelinse verimlilikte yattığını göstermektedir.

Nükleer enerji önümüze kabul edilemez sağlık, güvenlik sorunları koymaktadır. İklim değişikliğinin etkileri arttıkça, nükleer enerjiye bağlı riskler de artmaktadır. Örneğin, nükleer enerji santralleri büyük miktarda soğutma suyuna gereksinim duymaktadır. İklimi değiştirmekte olan dünyada daha sık meydana gelecek seller nedeniyle reaktörleri soğutmak için kullanılacak su miktarının azalması santrallerin kapanmasına, bu da elektrik kesintilerine ve güven sorununa yol açacaktır. Nükleer tesislerde kazalar hep olur. Chernobil kazası, 120,000 km<sup>2</sup>'den fazla bir alanı kirletmiş ve kirlilik Lapland ve İskoçya gibi uzak noktalara kadar ulaşmıştır. Kayıp sayısı 100.000'in üzerindedir. Milyarlarca dolara ve yıllardır süren araştırmalara karşın nükleer enerjinin ürettiği tehlikeli radyoaktif atıklarla mücadele etmenin güvenli bir yolu yoktur. Ortalama bir nükleer reaktör her yıl yüksek radyoaktivite içeren 20-30 ton kullanılmış yakıt üretir. Bu yakıtlar yüzbinlerce yıl radyoaktif olmayı sürdürür. Nükleer genişleme nükleer silah yapımı ve terörizm

fırsatlarını önemli ölçüde artırarak küresel güvenliği tehlikeye sokar. Gelişmekte olan ülkelerde kurulan santraller ulusal borcu ciddi şekilde artırmıştır. Filipinler’de hiç devreye alınmayan santral son 20 yılda ülkenin en önemli dış borç kalemi olmuştur. Borcun ödenmesi, iş başladıktan 32 yıl sonra bitmiştir.

**Metin-3:** 01.2007; *Prof. Dr. Sümer Şahin, Gazi Üniversitesi*

Türkiye, nüfusu ve jeopolitik konumu nedeniyle hayati öneme sahiptir. Varlığını ve istiklalini koruyabilmesi için yüksek teknolojiye sahip olmalıdır. Nükleer teknoloji de bilinen en ileri teknoloji olduğu için, Türkiye'nin bu düzeye mutlaka geçiş yapması gerekiyor. Nükleer silah konusundan kesinlikle uzak durarak, elektrik üretimi için ticari maksatlarla nükleer teknolojiye geçilmelidir. Nükleer enerjide, çekirdek parçalanmasıyla açığa çıkan enerji reaksiyonunda, kimyasal enerjinin 100 milyon katını elde ediyorsunuz. Elde ettiğiniz sonuç size alabildiğine geniş imkânlar sunuyor. Şu an uzay teknolojisindeki enerji, kimyasal yollarla sağlanıyor. diğer gezegenlere gitmek, oralara insan göndermek isterseniz, muhakkak nükleer enerjiye ihtiyacınız var. Yani nükleer teknolojiniz olmadan ileri uzay teknolojisine sahip olamazsınız.

Türkiye'nin bağımlılığını isteyenler nükleer enerjiyi istemiyor. Türkiye gibi ülkelerde, bilhassa dış güçler tarafından desteklenen birtakım dernek, kurum ve kuruluşlar, petrol ve kömür kartelleri Türkiye bu ileri teknolojiye geçmesin diye bu propagandayı yapar. Türkiye'nin nükleer enerjiye geçmesinden rahatsız olan grupların adını, bu ülkenin kalkınmasını ve ileriye gitmesini istemeyenler olarak koyabiliriz. Örneğin Rus doğalgaz karteli nükleer enerjiyi istemez çünkü Türkiye doğalgazda Rusya'ya bağımlı hale geldi.

Atığın yeniden değerlendirilmesi bütün reaktörler için geçerli ve mümkün. Güney Afrika'daki üstün teknolojinin hem ucuz olması bekleniyor, hem de yakıt problemini hallettiği görülüyor. Çevre ve emniyet yönünden son derece üstün bir reaktör. General Atomic'in geliştirdiği buna benzer başka bir reaktör türünde de toryumun kullanılması mümkün. Hindistan'a göre Türkiye, toryum rezervlerinde dünyada birinci, onlar ikinci.

## ORGAN DONATION AND TRANSPLANTATION TEXTS

**Metin-1:** 02.06.2012; *Memorial Ataşehir Hastanesi Organ Nakli ve Genel Cerrahi Bölüm Başkanı Prof. Dr. Kamil Yalçın POLAT*

Türkiye, sağlık alanında son 10 yılda önemli yerlere geldi. Karaciğer ve böbrek nakli için hastalarımız artık yurt dışına gitmiyor. Aksine yurt dışından hastalar Türkiye'ye nakil olmaya geliyor. Türkiye özellikle canlı karaciğer naklinde dünya üçüncüsü durumuna geldi. Ama organ nakli sadece bir ameliyat değil sosyal bir olay. İnsanlar ölecek ya da bir şekilde hayatına devam edecek. Onun için organ nakli çok önemseniyor. 21. yüzyılda da organ nakli hep ön planda olacak. Yüz, bağırsak, kol nakilleri yapılmaya başlandı. Türkiye'de böbrek ve karaciğer nakli artık rutin ameliyatlardır. Hastanemizde her hafta iki karaciğer nakli yapılıyor.

Dünyada hasta sayısı sürekli artmakta fakat yeterli organ bulunamamaktadır. Böbrek hastaları için diyaliz şansı var. Ama karaciğer için böyle bir tedavi yöntemi yok. Bu yüzden organ nakli yapmak zorundayız. Organ naklini kadavradan yapmak esastır. Türkiye'de kadavra bulamıyoruz, yılda ölüp organını bağışlayan kişi sayısı 300-400 arasında. Yılda ortalama 1900 hastaya nakil yapılamıyor. Yani yıllık 2500 nakil yapmamız gerekiyor. Organ bağışının önemini anlatamamışız. En çok hasta yakınları organ naklinin önemli olduğunu biliyor.

Organ bağışı ve nakli internetten takip edilebiliyor. Kimsenin torpilli birine organ takma şansı yok. Kadavra sırasına giren her hastanın bakanlıkta puanı ve adı var. Bakanlık bize isim yolluyor. Şu karaciğeri şu 5 hastadan birine takabilirsiniz diyor. Yani kimse kimsenin önüne geçemez, hakkını elinden alamaz.

**Metin-2:** 14.02.2013; *Türk Böbrek Vakfı Başkanı Timur ERK*

Organ bağışı konusunda son derece sistemli çalışmalar yürüterek bir bilinç yaratmayı hedeflese de, organlarını satmak için başvuruların sayısını düşüremiyoruz. Son günlerde TV kanallarında yayınlamaya başlayan ve organ

bağışına dikkat çeken 'Beni Bağışlayın' adlı kamu spotu, organ bağışı konusunda başvuruları arttırdı. Ancak yine de neredeyse her gün gelen 'Böbreklerimi Satmak İstiyorum' başvurularını azaltmadı.

Ülkemizde organ naklinin iki şekilde yapılması yasaldır. Birinci yol, canlı vericiden 4. dereceye kadar kan bağı olan akrabalar arasında yapılan bağış ile akraba dışı ancak Sağlık Bakanlığı etik kurulları tarafından onaylanmış kişiler arasında yapılan bağıştır. İkinci yol, beyin ölümü gerçekleşmiş kadavradan yapılan bağışla yapılan nakildir. Bu yolların dışında organ nakli ve organ ticareti yapılması kesinlikle yasaktır ve suçtur.

Böbreğini satmak isteyen kimselerin ulaştıkları ilk nokta Türk Böbrek Vakfı olmaktadır. Türkiye'de organ nakillerinde en büyük sorun kadavradan çok az nakil yapılmasıdır. Türkiye Cumhuriyeti sınırlarında, sadece Sağlık Bakanlığı tarafından ruhsatlandırılan organ nakil merkezlerinde, belirli yasal ve tıbbi şartların sağlanması halinde organ nakli yapılabilir. Yapılan organ nakillerine ilişkin her türlü veri düzenli olarak Sağlık Bakanlığı'na bildirilmek zorundadır ve tüm işlemler bakanlık tarafından denetlenmektedir. T.C. Sağlık Bakanlığı tarafından ruhsatlanmamış yerlerde yapılan her türlü tıbbi müdahaleler, suç ve insan sağlığı açısından ciddi riskler oluşturur. Size yasadışı yolları önererek sahte vaatler sunan kişiler dolandırıcıdır. Siz, bir böbreğinizi verip karşılığında para kazanıp borçlarınızı kapatma ve ailenize destek olma hayali kurarken, hayatınızı riske atmış ve suç işlemiş oluyorsunuz.

**Metin-3:** 06.05.2001; *Bilim ve Teknik Dergisi* yazarı Ferda ŞENEL

Böbrek yetmezliğinin en çok tercih edilen tedavi şekli olan böbrek nakli, ülkemizde halen gereksinimi karşılayabilecek sayıda yapılmıyor. Bunun en önemli nedeni, yeterli sayıda organ bulunamaması. Ülkemizdeki böbrek nakillerinin ancak %15'i kadavradan alınan böbreklerle gerçekleştiriliyor. Geri kalanlarsa akrabalar arası nakiller. Kadavradan organ bağışı batı ülkelerine göre ülkemizde çok daha az sayıda. Kadavradan organ bağışının yetersizliğinin en önemli nedeni kültürel ve eğitimsel farklılıklar.

Organ sıkıntısı tüm dünyada var olan bir sorun. Akrabalardan ve kadavradan organ bağışını artırmak için ülkeler çeşitli önlemler alıyor. Ekonomik zorluklara bağlı olarak gelişen materyalist yaşam biçiminin sonucunda vurgusu artan “ben” kavramı da bağış azlığının bir nedeni olabilir. Bu ülkelerde canlılar arası nakilleri artırabilmek için yoğun çaba harcanıyor. Akrabalarına veya sevdiklerine böbrek bağışlamak isteyen kişilerin kafalarındaki önemli sorulardan biri “acaba böbreğimin birini bağışlarsam geri kalan böbrek bana yeter mi?” sorusu. Bu konu toplumun bilinçlendirilmesi, canlıdan böbrek nakillerini artırmak açısından çok önemli. İnsan, böbreklerinden birini değil, iki böbreğinin toplam %70 ‘ini bile kaybetse, geri kalan kısım kanı süzmeye yeter. Böbreklerden biri diğerinin yedeği gibidir. Biri alındığında geriye kalan böbrek diğerinin de görevlerini üstlenir ve zaman içerisinde yaklaşık olarak normal boyunun iki katına çıkar. Uzun süreli takiplerde tek böbreğini veren insanların yaşam süre ve kalitesi, iki böbrekli insanlardan farklı değil.

## APPENDIX E

### TURKISH VERSION OF THE TRUSTWORTHINESS QUESTIONNAIRE

Aşağıda, az önce okumuş olduğunuz dokuz metin listelenmiştir. Size, her bir metin ile ilgili olarak metnin güvenilirliğini ve zorluğunu nasıl değerlendirdiğinize dair sorular sorulmaktadır. Soruları cevaplandırırken metinlere geri dönmeyiniz. Soruları cevaplandırmadan önce her bir metnin kısa açıklaması verilecektir.

#### İklim değişikliği

**Metin-1**, bir internet sitesinden (www.yesilgazete.org) alınmıştır. Boğaziçi Üniversitesi İklim Değişikliği Çalışma Grubu üyesi Belkıs Gökbulut tarafından yazılmış, 2012 yılında yayımlanmıştır.

*Metin, küresel ısınmaya insan aktivitelerinin sebep olduğu ile ilgilidir.*

Bu metindeki bilgilere ne ölçüde güveniyorsunuz?

Çok küçük bir ölçüde  
bir ölçüde

Çok büyük

1 2 3 4 5 6 7 8 9 10

Bu metne duyduğunuz güveni  
derecelendirirken, aşağıdaki kriterleri ne  
ölçüde baz aldınız?

Çok küçük  
bir ölçüde

Çok büyük  
Bir ölçüde

1. Metni kimin yazdığı..... 1 2 3 4 5 6 7 8 9 10
2. Metni yayımlayan organ  
(www.yesilgazete.org)..... 1 2 3 4 5 6 7 8 9 10
3. Metnin türü (blog yazısı)..... 1 2 3 4 5 6 7 8 9 10
4. Metnin içeriği..... 1 2 3 4 5 6 7 8 9 10
5. İklim değişikliği konusundaki kendi  
görüşüm..... 1 2 3 4 5 6 7 8 9 10
6. Metnin yayımlandığı tarih..... 1 2 3 4 5 6 7 8 9 10

Bu metni anlamak ne kadar zor oldu?

Çok kolay

1 2 3 4 5 6 7 8 9 10

Çok zor

## İklim deęişikliği

**Metin-2**, bir internet sitesinden (www.haberturk.com) alınmıştır. Akdeniz Üniversitesi Çevre Sorunları Araştırma Merkezi Müdürü Prof. Dr. Tuncay Neyişçi tarafından yazılmış, 2011 yılında yayımlanmıştır.

*Metin, küresel ısınmanın Güneş'ten Dünya'ya gelen enerji ile ilgili olduğundan söz etmektedir.*

Bu metindeki bilgilere ne ölçüde güveniyorsunuz?

Çok küçük bir ölçüde  
bir ölçüde

1 2 3 4 5 6 7 8 9 10

Çok büyük

Bu metne duyduğunuz güveni derecelendirirken,  
aşağıdaki kriterleri ne ölçüde baz aldınız?

|   | Çok küçük<br>bir ölçüde | Çok büyük<br>Bir ölçüde |
|---|-------------------------|-------------------------|
| 1. Metni kimin yazdığı.....                         | 1 2 3 4 5 6 7 8 9 10    |                         |
| 2. Metni yayımlayan organ (www.haberturk.com).....  | 1 2 3 4 5 6 7 8 9 10    |                         |
| 3. Metnin türü (gazete yazısı).....                 | 1 2 3 4 5 6 7 8 9 10    |                         |
| 4. Metnin içerięi.....                              | 1 2 3 4 5 6 7 8 9 10    |                         |
| 5. İklim deęişikliği konusundaki kendi görüşüm..... | 1 2 3 4 5 6 7 8 9 10    |                         |
| 6. Metnin yayımlandığı tarih.....                   | 1 2 3 4 5 6 7 8 9 10    |                         |

Bu metni anlamak ne kadar zor oldu?

Çok kolay

1 2 3 4 5 6 7 8 9 10

Çok zor

## İklim deęişikliği

**Metin-3**, 2005 yılında yayımlanan Bilim ve Teknik Dergisi'nden alınmıştır. Dergi yazarı Elif Yılmaz tarafından yazılmıştır.

*Metin, iklim deęişikliğine doğal olayların ve insan etkinliklerinin sebep olduğunun üzerinde durmaktadır.*

Bu metindeki bilgilere ne ölçüde güveniyorsunuz?

Çok küçük bir ölçüde  
bir ölçüde

1 2 3 4 5 6 7 8 9 10

Çok büyük

Bu metne duyduğunuz güveni derecelendirirken,  
aşağıdaki kriterleri ne ölçüde baz aldınız?

|   | Çok küçük<br>bir ölçüde | Çok büyük<br>Bir ölçüde |
|---|-------------------------|-------------------------|
| 1. Metni kimin yazdığı.....                         | 1 2 3 4 5 6 7 8 9 10    |                         |
| 2. Metni yayımlayan organ (Bilim ve Teknik Dergisi) | 1 2 3 4 5 6 7 8 9 10    |                         |
| 3. Metnin türü (dergi yazısı).....                  | 1 2 3 4 5 6 7 8 9 10    |                         |
| 4. Metnin içeriği.....                              | 1 2 3 4 5 6 7 8 9 10    |                         |
| 5. İklim deęişikliği konusundaki kendi görüşüm..... | 1 2 3 4 5 6 7 8 9 10    |                         |
| 6. Metnin yayımlandığı tarih.....                   | 1 2 3 4 5 6 7 8 9 10    |                         |

Bu metni anlamak ne kadar zor oldu?

Çok kolay

1 2 3 4 5 6 7 8 9 10

Çok zor

## Nükleer enerji

**Metin-4**, 2013 yılında bir internet sitesinde (www.kentselhaber.com) yayımlanmış, Prof. Dr. Deniz Ülke Arıboğan tarafından yazılmıştır.

*Metin, gerekli önlemler alınarak Türkiye'nin nükleer enerjiye geçişinin başlaması gerektiğini savunmaktadır.*

Bu metindeki bilgilere ne ölçüde güveniyorsunuz?

Çok küçük bir ölçüde  
bir ölçüde

1 2 3 4 5 6 7 8 9 10

Çok büyük

Bu metne duyduğunuz güveni derecelendirirken, aşağıdaki kriterleri ne ölçüde baz aldınız?

|   | Çok küçük<br>bir ölçüde | Çok büyük<br>Bir ölçüde |
|---|-------------------------|-------------------------|
| 1. Metni kimin yazdığı.....                         | 1 2 3 4 5 6 7 8 9 10    |                         |
| 2. Metni yayımlayan organ (www.kentselhaber.com)..  | 1 2 3 4 5 6 7 8 9 10    |                         |
| 3. Metnin türü (gazete yazısı).....                 | 1 2 3 4 5 6 7 8 9 10    |                         |
| 4. Metnin içeriği.....                              | 1 2 3 4 5 6 7 8 9 10    |                         |
| 5. İklim değişikliği konusundaki kendi görüşüm..... | 1 2 3 4 5 6 7 8 9 10    |                         |
| 6. Metnin yayımlandığı tarih.....                   | 1 2 3 4 5 6 7 8 9 10    |                         |

Bu metni anlamak ne kadar zor oldu?

Çok kolay

1 2 3 4 5 6 7 8 9 10

Çok zor

## Nükleer enerji

**Metin-5**, 2008 yılında Greenpeace adlı sivil toplum kuruluşu tarafından bir internet sitesinde (www.greenpeace.org) yayımlanmış bir brifingi (açıklama) içermektedir.

*Metin, nükleer enerji reaktörlerinin sakıncalarından söz etmekte olup, Türkiye'nin nükleer enerjiye geçmemesi gerektiğini savunmaktadır.*

Bu metindeki bilgilere ne ölçüde güveniyorsunuz?

Çok küçük bir ölçüde  
bir ölçüde

1 2 3 4 5 6 7 8 9 10

Çok büyük

Bu metne duyduğunuz güveni derecelendirirken,  
aşağıdaki kriterleri ne ölçüde baz aldınız?

|   | Çok küçük<br>bir ölçüde | Çok büyük<br>Bir ölçüde |
|---|-------------------------|-------------------------|
| 1. Metni kimin yazdığı.....                         | 1 2 3 4 5 6 7 8 9 10    |                         |
| 2. Metni yayımlayan organ (www.greenpeace.org)..... | 1 2 3 4 5 6 7 8 9 10    |                         |
| 3. Metnin türü (açıklama).....                      | 1 2 3 4 5 6 7 8 9 10    |                         |
| 4. Metnin içeriği.....                              | 1 2 3 4 5 6 7 8 9 10    |                         |
| 5. İklim değişikliği konusundaki kendi görüşüm..... | 1 2 3 4 5 6 7 8 9 10    |                         |
| 6. Metnin yayımlandığı tarih.....                   | 1 2 3 4 5 6 7 8 9 10    |                         |

Bu metni anlamak ne kadar zor oldu?

Çok kolay

1 2 3 4 5 6 7 8 9 10

Çok zor

## Nükleer enerji

**Metin-6**, 2007 yılında bir internet sitesinde (www.haberajanda.com.tr) yayımlanmış, Gazi Üniversitesi Öğretim Üyesi Prof. Dr. Sümer Şahin tarafından yazılmıştır.

*Metin, nükleer enerjiye kesinlikle geçilmesi gerektiğini, bu enerjiye karşı çıkanların Türkiye'nin gelişmesini istemediğini savunmaktadır.*

Bu metindeki bilgilere ne ölçüde güveniyorsunuz?

Çok küçük bir ölçüde  
bir ölçüde

1 2 3 4 5 6 7 8 9 10

Çok büyük

Bu metne duyduğunuz güveni derecelendirirken,  
aşağıdaki kriterleri ne ölçüde baz aldınız?

|   | Çok küçük<br>bir ölçüde | Çok büyük<br>Bir ölçüde |
|---|-------------------------|-------------------------|
| 1. Metni kimin yazdığı.....                         | 1 2 3 4 5 6 7 8 9 10    |                         |
| 2. Metni yayımlayan organ (www.haberajanda.com.tr)  | 1 2 3 4 5 6 7 8 9 10    |                         |
| 3. Metnin türü (dergi yazısı).....                  | 1 2 3 4 5 6 7 8 9 10    |                         |
| 4. Metnin içeriği.....                              | 1 2 3 4 5 6 7 8 9 10    |                         |
| 5. İklim değişikliği konusundaki kendi görüşüm..... | 1 2 3 4 5 6 7 8 9 10    |                         |
| 6. Metnin yayımlandığı tarih.....                   | 1 2 3 4 5 6 7 8 9 10    |                         |

Bu metni anlamak ne kadar zor oldu?

Çok kolay

1 2 3 4 5 6 7 8 9 10

Çok zor

## Organ Bağıışı ve Nakli

**Metin-7**, 2012 yılında bir internet sitesinde (www.haberler.com) yayımlanmıştır. Memorial Ataşehir Hastanesi Organ Nakli ve Genel Cerrahi Bölüm Başkanı Prof. Dr. Kamil Yalçın Polat'ın konuşmalarını içeren bir röportajdan alınmıştır.

*Metin, organ naklinde torpile yer olmadığına ve organ bağıışının öneminin yeteri kadar anlatılmadığına dikkat çekmektedir.*

Bu metindeki bilgilere ne ölçüde güveniyorsunuz?

Çok küçük bir ölçüde  
bir ölçüde

1 2 3 4 5 6 7 8 9 10

Çok büyük

Bu metne duyduğunuz güveni derecelendirirken,  
aşağıdaki kriterleri ne ölçüde baz aldınız?

|   | Çok küçük<br>bir ölçüde | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9  | 10 | Çok büyük<br>Bir ölçüde |
|---|-------------------------|---|---|---|---|---|---|---|---|----|----|-------------------------|
| 1. Metni kimin yazdığı.....                         | 1                       | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    |                         |
| 2. Metni yayımlayan organ (www.haberler.com).....   | 1                       | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    |                         |
| 3. Metnin türü (röportaj yazısı).....               | 1                       | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    |                         |
| 4. Metnin içeriği.....                              | 1                       | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    |                         |
| 5. İklim değişikliği konusundaki kendi görüşüm..... | 1                       | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    |                         |
| 6. Metnin yayımlandığı tarih.....                   | 1                       | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    |                         |

Bu metni anlamak ne kadar zor oldu?

Çok kolay

1 2 3 4 5 6 7 8 9 10

Çok zor

## Organ Bađışı ve Nakli

**Metin-8**, 2013 yılında Sabah Gazetesi'nde yayımlanmıştır. Türk Böbrek Vakfı Başkanı Timur Erk'in konuşmalarını içeren bir röportajdan alınmıştır.

*Metin, böbreklerini satmak isteyenlerin fazlalığından, bunun yasak olmasından ve olumsuz sonuçlar doğurmasından, ve kadavradan nakillerin yetersizliğinden söz etmektedir.*

Bu metindeki bilgilere ne ölçüde güveniyorsunuz?

Çok küçük bir ölçüde  
bir ölçüde

1 2 3 4 5 6 7 8 9 10

Çok büyük

Bu metne duyduğunuz güveni derecelendirirken,  
aşağıdaki kriterleri ne ölçüde baz aldınız?

|   | Çok küçük<br>bir ölçüde |   |   |   |   | Çok büyük<br>Bir ölçüde |   |   |   |    |
|---|-------------------------|---|---|---|---|-------------------------|---|---|---|----|
|   | 1                       | 2 | 3 | 4 | 5 | 6                       | 7 | 8 | 9 | 10 |
| 1. Metni kimin yazdığı.....                         | 1                       | 2 | 3 | 4 | 5 | 6                       | 7 | 8 | 9 | 10 |
| 2. Metni yayımlayan organ (Sabah Gazetesi).....     | 1                       | 2 | 3 | 4 | 5 | 6                       | 7 | 8 | 9 | 10 |
| 3. Metnin türü (gazete haberi).....                 | 1                       | 2 | 3 | 4 | 5 | 6                       | 7 | 8 | 9 | 10 |
| 4. Metnin içeriđi.....                              | 1                       | 2 | 3 | 4 | 5 | 6                       | 7 | 8 | 9 | 10 |
| 5. İklim deđişikliği konusundaki kendi görüşüm..... | 1                       | 2 | 3 | 4 | 5 | 6                       | 7 | 8 | 9 | 10 |
| 6. Metnin yayımlandığı tarih.....                   | 1                       | 2 | 3 | 4 | 5 | 6                       | 7 | 8 | 9 | 10 |

Bu metni anlamak ne kadar zor oldu?

Çok kolay

1 2 3 4 5 6 7 8 9 10

Çok zor

## Organ Bağıışı ve Nakli

**Metin-9**, 2001 yılında Bilim ve Teknik Dergisi'nde yayımlanmış, dergi yazarı Ferda Şenel tarafından yazılmıştır.

*Metin, kadavradan organ bağıışının yetersizliğinin nedenlerinden ve organ nakli ile ilgili yanlış bilinenlerden bahsetmektedir.*

Bu metindeki bilgilere ne ölçüde güveniyorsunuz?

Çok küçük bir ölçüde  
bir ölçüde

1 2 3 4 5 6 7 8 9 10

Çok büyük

Bu metne duyduğunuz güveni derecelendirirken,  
aşağıdaki kriterleri ne ölçüde baz aldınız?

|   | Çok küçük<br>bir ölçüde | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9  | 10 | Çok büyük<br>Bir ölçüde |
|---|-------------------------|---|---|---|---|---|---|---|---|----|----|-------------------------|
| 1. Metni kimin yazdığı.....                           | 1                       | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    |                         |
| 2. Metni yayımlayan organ (Bilim ve Teknik Dergisi).. | 1                       | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    |                         |
| 3. Metnin türü (dergi yazısı).....                    | 1                       | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    |                         |
| 4. Metnin içeriğı.....                                | 1                       | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    |                         |
| 5. İklim değışikliğı konusundaki kendi görüşüm.....   | 1                       | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    |                         |
| 6. Metnin yayımlandığı tarih.....                     | 1                       | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    |                         |

Bu metni anlamak ne kadar zor oldu?

Çok kolay

1 2 3 4 5 6 7 8 9 10

Çok zor

## APPENDIX F

### REPORTED USE OF JUSTIFICATION CRITERIA ACROSS EACH TEXT

#### BY HIGH AND LOW ACHIEVER PSTS

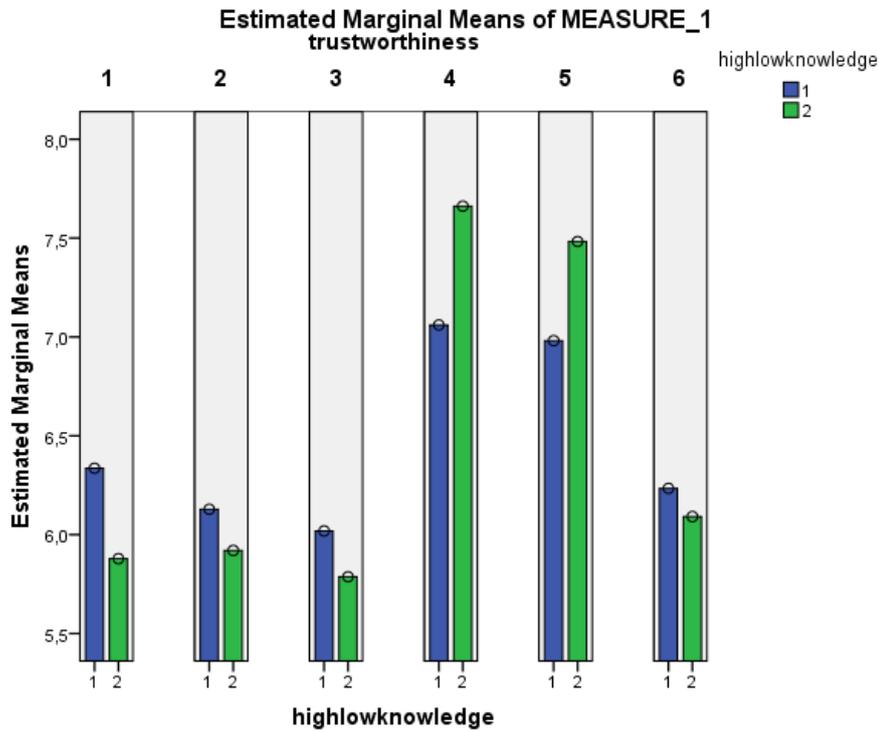


Figure 4.6 Reported use of justification criteria across the Text 1 by high and low achiever PSTs. Error bars represent standard errors of the means. Above numbers indicate the name of criteria (1 for author, 2 for Publisher, 3 for text type, 4 for content, 5 for own opinion, 6 for publication date).

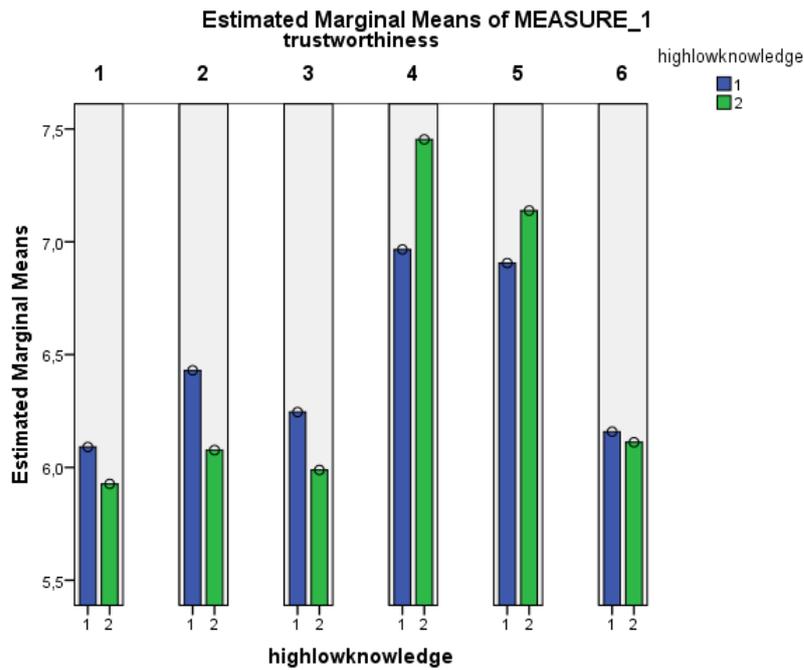


Figure 4.7 Reported use of justification criteria across the Text 2 by high and low achiever PSTs. Error bars represent standard errors of the means. Above numbers indicate the name of criteria (1 for author, 2 for Publisher, 3 for text type, 4 for content, 5 for own opinion, 6 for publication date).

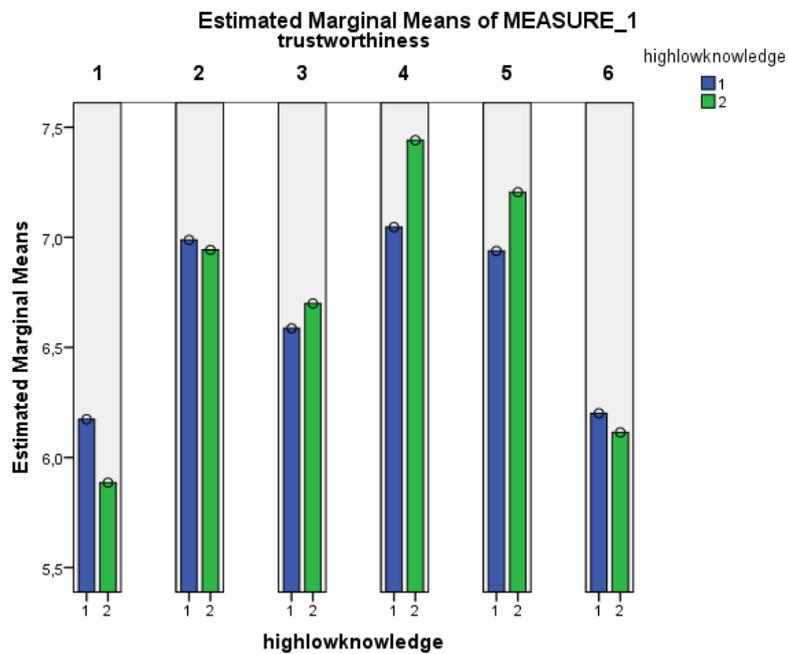


Figure 4.8 Reported use of justification criteria across the Text 3 by high and low achiever PSTs. Error bars represent standard errors of the means. Above numbers indicate the name of criteria (1 for author, 2 for Publisher, 3 for text type, 4 for content, 5 for own opinion, 6 for publication date).

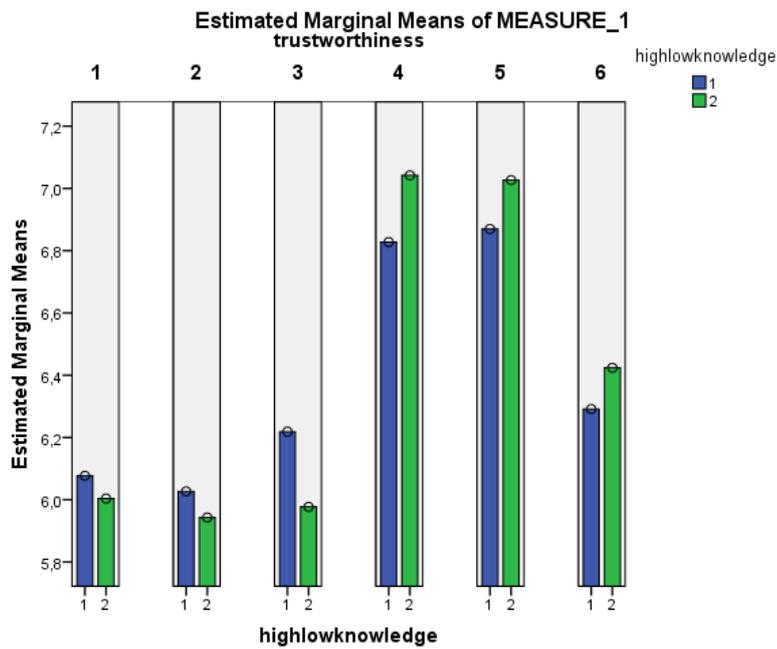


Figure 4.9 Reported use of justification criteria across the Text 4 by high and low achiever PSTs. Error bars represent standard errors of the means. Above numbers indicate the name of criteria (1 for author, 2 for Publisher, 3 for text type, 4 for content, 5 for own opinion, 6 for publication date).

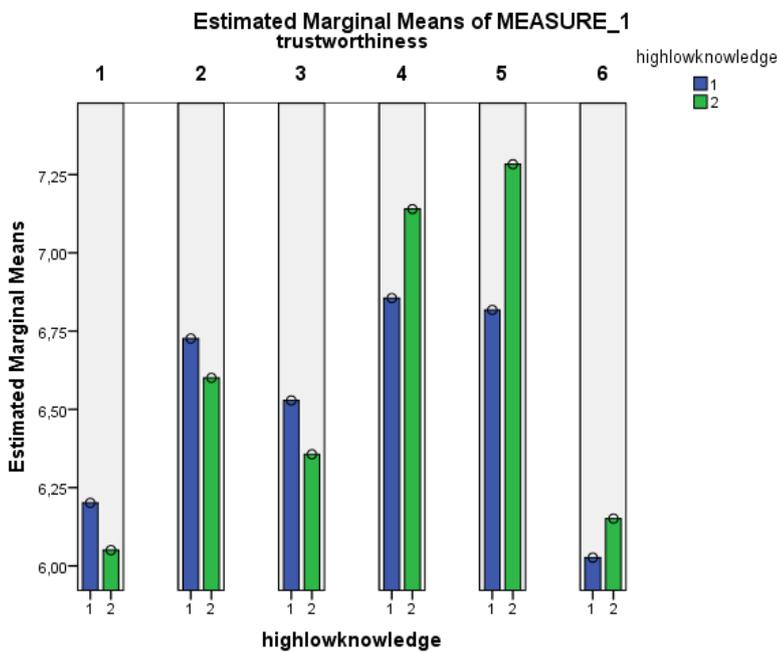


Figure 4.10 Reported use of justification criteria across the Text 5 by high and low achiever PSTs. Error bars represent standard errors of the means. Above numbers indicate the name of criteria (1 for author, 2 for Publisher, 3 for text type, 4 for content, 5 for own opinion, 6 for publication date).

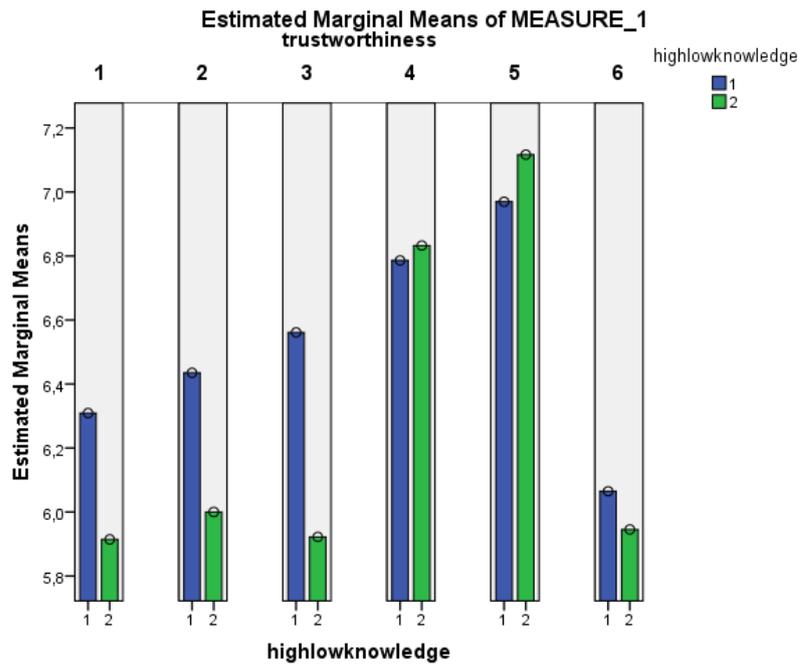


Figure 4.11 Reported use of justification criteria across the Text 6 by high and low achiever PSTs. Error bars represent standard errors of the means. Above numbers indicate the name of criteria (1 for author, 2 for Publisher, 3 for text type, 4 for content, 5 for own opinion, 6 for publication date).

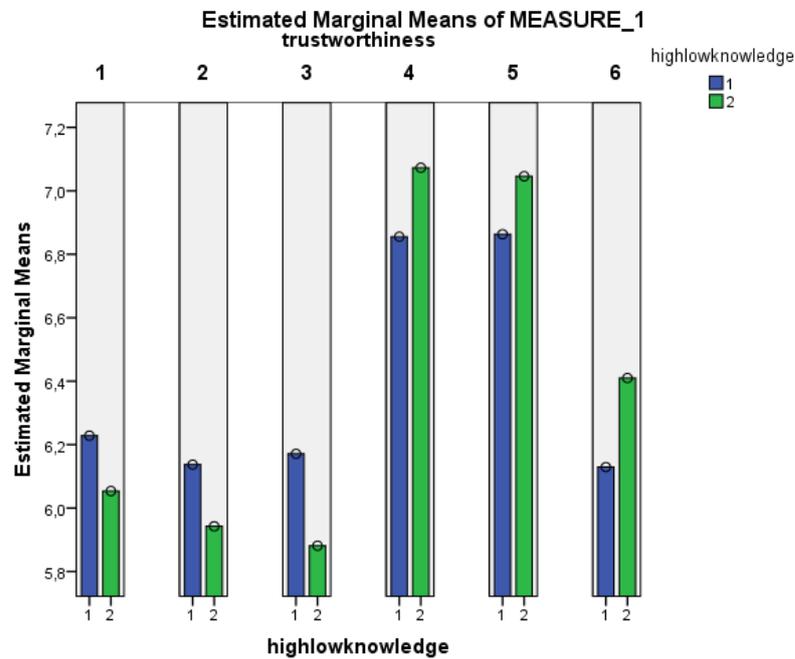


Figure 4.12 Reported use of justification criteria across the Text 7 by high and low achiever PSTs. Error bars represent standard errors of the means. Above numbers indicate the name of criteria (1 for author, 2 for Publisher, 3 for text type, 4 for content, 5 for own opinion, 6 for publication date).

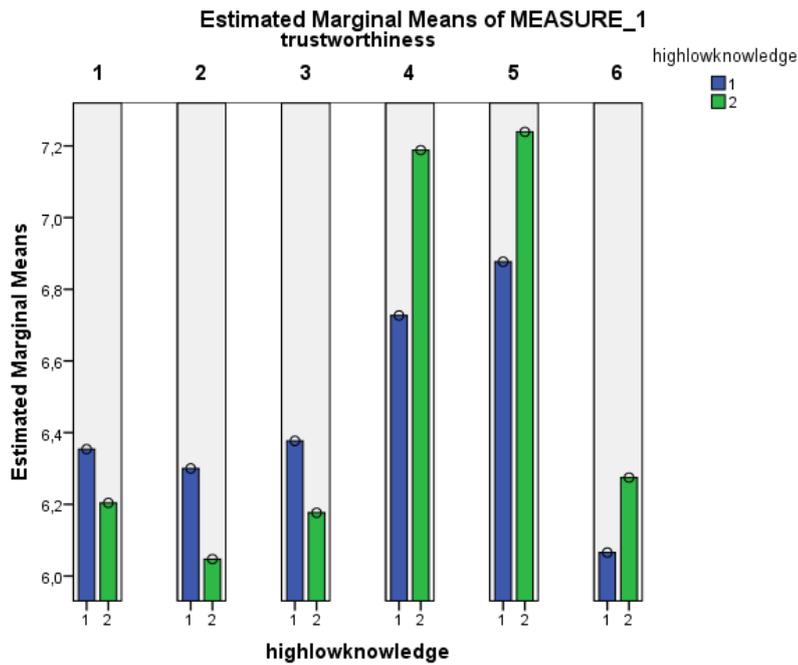


Figure 4.13 Reported use of justification criteria across the Text 8 by high and low achiever PSTs. Error bars represent standard errors of the means. Above numbers indicate the name of criteria (1 for author, 2 for Publisher, 3 for text type, 4 for content, 5 for own opinion, 6 for publication date).

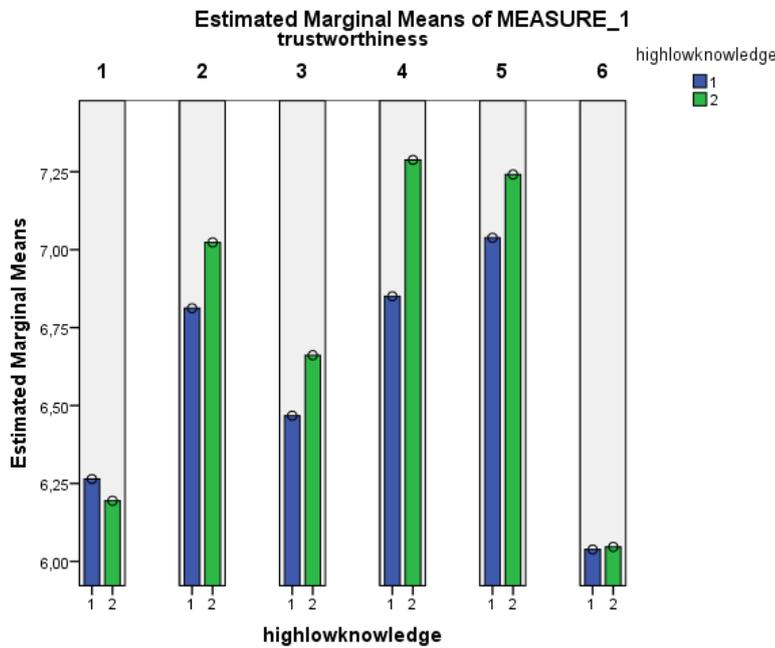


Figure 4.14 Reported use of justification criteria across the Text 9 by high and low achiever PSTs. Error bars represent standard errors of the means. Above numbers indicate the name of criteria (1 for author, 2 for Publisher, 3 for text type, 4 for content, 5 for own opinion, 6 for publication date).

## APPENDIX G

### TURKISH SUMMARY

Fen Bilgisi Öğretmen Adaylarının Epistemolojik İnançları; İklim Değişikliği, Nükleer Enerji, ve Organ Bağışı ve Nakli Hakkındaki Bilgi Düzeyleri ile Bilgi Kaynaklarına Olan Güvenleri Arasındaki İlişkiler

#### 1. Giriş

Bilim ve teknoloji; uçak, otomobil, uydu, bilgisayar ve üç boyutlu televizyon gibi bilimsel ve teknolojik buluşların yaşamımızı kaçınılmaz olarak değiştirmesi yönüyle gündelik yaşamımızın birer parçasıdır. Bu gibi ürünlerin yanı sıra bilimsel ve teknolojik gelişmeler GDO (genetiği değiştirilmiş organizmalar), klonlama, ötanazi ve tedavi amaçlı yapılan hayvan deneyleri gibi bazı konuları ön plana çıkarır. Doğal olarak toplumun farklı kesimleri bu konular hakkında farklı görüşlere sahiptir. Örneğin bilim adamları, politikacılar, çevreciler, ekonomistler, vatandaşlar, müfredat geliştiriciler... vs. farklı bakış açılarına sahiptir. Fen, teknoloji ve topluma yönelik bu tür konular sosyobilimsel konuların araştırma alanında incelenmektedir. Sadler'in (2011) de belirttiği gibi, SBKların fen eğitimi literatüründe daha sıklıkla kullanılır hale gelmesi ve sınıflarda kullanımının da gün geçtikçe artması, bu konuların gün geçtikçe yaygınlaştığını göstermektedir. Bu çizgideki araştırmalar son on yıldır ciddi bir artış göstererek ülkemizdeki öğretim programında da etkili olmaya başlamıştır. Türkiye'de, fen eğitimi müfredatı değişmeye başlamıştır ve SBKlar bu değişimde önemli rol oynamaktadır (Milli Eğitim Bakanlığı, [MEB], 2013).

SBKlar öğrencilerin bilimsel tartışmalara, münazaralara ve diyaloglara katılımını sağlayan, fen bilimleri ile alakalı tartışmalı toplumsal konulardır. Kanıta dayalı karar vermeyi gerektiren bu konular bilimsel bilgiyi anlamak için kaynak sağlamaktadır (Zeidler & Nichols, 2009). İnsanlar SBKlar hakkındaki kararlarını oluştururken etik muhakeme yapmaya veya etik boyutları değerlendirmeye ihtiyaç duyarlar. SBKlar tartışmalı, açık uçlu, birden fazla bakış açısı ve çözüme tabi olan iyi yapılandırılmamış ve tartışılabilir problemlerden oluşması gibi yönleriyle diğer bilimsel konulardan farklıdır ve bu problemlerde çözüm ve uzlaşmayı sağlamak için en iyi yöntem kritik düşünmedir (Sadler & Zeidler, 2005).

SBKlar hakkında bilgi sahibi olmak öğrencileri toplumsal amaçlar hakkındaki politik kararlara ve tartışmalara katılmaya teşvik eder (Barrué & Albe, 2011). Tartışmalı bilimsel konuların öğretimi için başvurulan SBK yaklaşımı fen öğretiminin önemli bir parçasıdır ve bilim okuryazarı bir nesil yetiştirmek için fen derslerinde SBKlara yer verilmelidir (Roth & Barton, 2004). Bunu gerçekleştirmede fen bilgisi öğretmen adaylarına (FBÖA) önemli görevler düşmektedir. FBÖA öncelikle SBKlar hakkında yeterli bilimsel bilgiye sahip olmalıdır. Ayrıca bu konuları sınıflarına nasıl dahil edeceklerini iyi bilmelidirler ki öğrencilerin fen eğitiminin hedeflerini gerçekleştirmelerini sağlayabilsinler. FBÖA sahip oldukları bu bilimsel bilgiyi dergi, gazete, internet, ders kitapları gibi çok çeşitli bilgi kaynakları aracılığıyla edinmektedir. Hangi kaynaklara güvenecekleri ise bilgi kaynaklarının güvenilirliği hakkındaki algılarına bağlıdır (Jackob, 2010). Başarılı bir kritik düşünme süreci, insanların, araştırma yaparak ve başka bilgi kaynaklarına başvurarak kendilerine anlatılanların ötesine, konuya ilişkin diğer bilgilere ulaşmasını gerektirir

(Galott, 1989). Buradan yola çıkarak, bu çalışma FBÖA'nın bazı SBKlar (İklim Değişikliği, Nükleer Enerji, Organ Bağışı ve Nakli) hakkındaki bilgi düzeyleri ile gazete, bilimsel dergi, sivil toplum kuruluşu web sitesi, ve bazı online gazeteler gibi bir takım bilgi kaynaklarından temin edilen dokuz metni ne derecede güvenilir bulduklarını araştırmaktadır.

Son yıllarda SBKlar ile ilgili yapılan çalışmalar hızlı bir şekilde artmaktadır (Baltacı & Kılınç, 2014; Eroğlu, 2009; Koçak vd., 2010; Nuangchalerm, 2009; Oluk & Oluk, 2007; Özdemir ve Çobanoğlu, 2008; Sadler, 2004; Sadler, & Zeidler, 2004; Sander, & Miller, 2005; Şenel, & Güngör, 2008). Bu çalışmaların odağında öğrencilerin farklı SBKlar hakkındaki bilgi düzeyleri (e.g., Eroğlu, 2009; Lewis & Leach, 2006), SBK temelli yaklaşımlar ile bilimsel okuryazarlık arasındaki ilişkiler (örn., Hodson, 2003; Zeidler & Keefer, 2003), epistemolojik inançlar ile SBK'ya ilişkin kritik düşünme arasındaki ilişki (örn., Angeli & Valanides, 2012; Hogan & Maglienti, 2001; Kitchener, 1983; Weinstock & Cronin, 2003; Wu & Tsai, 2010), sosyobilimsel karar verme sürecinde başvuru alan kritik düşünme modelleri (e.g., Bell & Lederman, 2003; Chang & Chiu, 2008; Hogan, 2002; Öztürk, 2011; Sadler & Zeidler, 2005; Yang, 2004; Topçu, Yılmaz-Tüzün & Sadler, 2010) gibi konular bulunmaktadır.

Wu ve Tsai (2010) öğrencilerin bilime yönelik epistemolojik inançları ve bilimsel bilgilerinin, onların kritik düşünme yeteneklerine katkısı olduğunu ifade etmiştir. Her ne kadar bu iki kavram arasında sistematik bir bağ bulunmadığını söyleyen bazı çalışmalar olsa da (Angeli & Valanides, 2012; Topçu, 2011), yapılan çalışmaların çoğu öğrencilerin epistemolojik inançları ile SBK'ya ilişkin kritik

düşünme yetenekleri arasında bir ilişkinin varlığını savunmaktadır (Bendixen & Schraw, 2001; Bendixen, Schraw, & Dunkle, 1994; Bendixen vd., 1998). Bu yüzden, bu çalışmada FBÖA'nın üç SBK hakkındaki bilgi düzeyleri, epistemolojik inançları ve bilgi kaynaklarının güvenilirliğine ilişkin değerlendirmeleri arasında ilişki olup olmadığı araştırılmaktadır.

Epistemoloji, bilginin doğası, kapsamı, kaynağı, yöntemleri ve sınırları ile ilgilenen felsefenin bir dalıdır (Muis, Bendixen, & Haerle, 2006) ve “Bilgi nedir?”, “İnsanlar bilgiyi nereden ve nasıl elde ederler?” gibi soruları irdeler. Epistemolojik inançlar ise bilgi ve öğrenmenin doğasına ilişkin inançlardır (Elby, & Hammer, 2001; Schommer, 1993; Schommer-Aikins, 2004; Schommer-Aikins, Brookhart, Mau & Hutter, 2000). Son yıllarda eğitimciler insanların epistemolojik sorular hakkındaki inançlarını (kişisel epistemolojik inançlar) ve bu inançlarının onların öğrenme ve düşüncelerini etkileyip etkilemediklerini merak etmişlerdir. Kişisel epistemolojik inançları ilk araştıran kişi Perry'dir (1968). Perry'den sonra birçok araştırmacı bu konuda çalışmalar yapmıştır. Bunlardan biri de kişisel epistemolojinin çok yönlü olduğunu ve öğrencilerin bilgiye yönelik inançlarının beş temel boyut ile ilişkili olduğunu ifade eden Schommer'dır (1990). Bu boyutlar bilginin kaynağı, bilginin kesinliği, bilginin organizasyonu, öğrenmenin kontrolü ve öğrenme hızıdır. Başta Schommer olmak üzere birçok araştırmacı, epistemolojik inançların küresel ısınma, klonlama gibi tartışmalı, iyi yapılandırılmamış günlük yaşam problemleri üzerinde etkisi olduğunu belirtmiştir. Ayrıca yapılan birçok araştırma epistemolojik inançların öğrencilerin öğrenmeleri (Chan, 2004; Chan, 2011; Hofer & Pintrich, 1997; Schommer, 1993; Zeidler vd., 2003) ve karar vermeleri (Sadler, Chambers, &

Zeidler, 2004; Schommer-Aikins, & Hutter, 2002; Walker vd., 2000; Liu, Lin, & Tsai, 2010) gibi konularda önemli bir yordayıcı olduğunu ifade etmektedir. Benzer şekilde Bell ve Lederman (2003) da, epistemolojik inançlar ile SBK'lara ilişkin karar verme sürecinin birbiri ile ilişkili olduğunu; fakat bu ilişkinin net ve direkt olmadığını ifade etmiştir. Bu nedenle bu ilişkiyi inceleyecek çalışmalar yapılmasına ihtiyaç vardır. Ayrıca pek çok araştırma öğrencilerin kişisel epistemolojik inançlarının bilimsel bilgi düzeyleri üzerinde önemli bir rolü olduğunu savunmaktadır (Cavallo, Rozman, Blickenstaff, & Walker, 2003; Tsai, 1998; Yang & Tsai, 2012).

Kişisel epistemolojinin, metni iyi anlama (örn., Bråten & Strømsø, 2008) ve online kaynakları değerlendirme üzerinde oldukça etkili olduğu görüşünü savunan araştırmacılar hızla çoğalmaktadır (örn., Barzilai & Zohar, 2012). Diğer taraftan, Tsai (2008) ile Kienhues, Stadtler ve Bromme (2011), tartışmalı, açık uçlu konular üzerinde çalışırken interneti kullanmanın, kişisel epistemolojik inançların düzeyini arttırdığını belirtmiştir.

Sonuç olarak, yukarıda bahsi geçen çalışmalar, FBÖA'nın epistemolojik inançları, SBKlar hakkındaki bilgi düzeyleri, ve farklı bilgi kaynaklarını ne kadar güvenilir bulduklarını değerlendirme yolları arasındaki olası bir ilişkiye dikkat çekmektedir. Bu nedenle, bu çalışmada söz konusu ilişki araştırılmıştır.

### **Araştırmanın Amacı**

Bu çalışmanın ana amacı FBÖA'nın epistemolojik inançları, üç SBK'ya ilişkin bilgi düzeyleri ve farklı bilgi kaynaklarının güvenilirliğine ilişkin

değerlendirmeleri arasında ilişki olup olmadığını araştırmaktır. Ayrıca, çalışmanın alt amaçlarından biri FBÖA'nın epistemolojik inançlarının boyutlarını incelemektir. Çalışmanın diğer bir alt amacı ise FBÖA'nın söz konusu SBK'lar ile ilgili metinlere dayanarak belirledikleri güvenilirlik kriterlerinin neler olduğunun incelenmesidir.

### **Araştırmanın Önemi**

SBK'nın fen eğitimindeki önemine ilişkin çok sayıda çalışma mevcuttur. Fakat, SBK'ya ilişkin karar verme süreci kavramı da fen ve teknoloji eğitiminin önemli bir boyutunu oluşturmaktadır ve öğrencilerin verilen SBKlar hakkında farklı bilgi kaynaklarına olan güvenleri ile ilgili özellikle Türkiye'de yetersiz sayıda çalışma mevcuttur. Türkiye'de hala çoğunlukla uygulanmakta olan ezberci eğitim, öğrencileri daha çok sınav başarısına odaklanmaya yönlendirmektedir. Bu da özellikle fen eğitiminde ciddi problemlere sebep olmaktadır. Bilim, diğer dersler ve günlük hayatla ilişkilendirilememekte, kopuklaştırılmaktadır. Diğer pek çok ülke gibi Türkiye'nin de bilim okuryazarı vatandaşlara ihtiyacı vardır. Bunu gerçekleştirebilmek için öncelikle öğretmen adayları eğitilmelidir. Bu nedendir ki, fen eğitiminin amaçlarından biri öğrencilerin medya, öğretmenler, bilim adamları, reklamcılar, politikacılar ve gazetecilerin iddialarının güvenilirliği ile bunların kanıta dayalı olup olmadığı konusunda değerlendirmelerde bulunabilmelerine yardımcı olmaktır.

Yukarıda bahsedilen çalışmaların temelinde, bu çalışma için çok çeşitli bilgi kaynakları –online gazeteler, bilim ve teknoloji dergisi, alanında uzman öğretim görevlileri, profesörler, doktor, çevreci sivil toplum kuruluşu, Türk Böbrek Vakfı

Başkanı seçilmiştir. Farklı insanlar farklı bakış açılarına sahiptirler ve fikirlerini birbirinden farklı bilgi kaynakları ile topluma ulaştırırlar. Dolayısı ile bu çalışmadaki bilgi kaynaklarının seçilmesindeki nedenlerden birisi, her bir kaynağın konu ile ilgili farklı bir bakış açısına sahip olmasıdır. Buna ek olarak kaynaklar seçilirken, bunların kolayca ulaşılabilir olması ve farklı yayımlanma tarihlerine sahip olması da dikkate alınmıştır. Kullanılan kaynakların örneklemin yaş grubu için oldukça popüler olması da kaynak seçiminde önemli bir noktadır. Son olarak, okuma metinlerinin güvenilir bilgi içeren kaynaklardan toplanmasına özen gösterilmiştir.

Bu üç konunun –iklim değişikliği, nükleer enerji, ve organ bağışi ve nakli seçilme nedeni bunların tartışmalı ve bu günlerde güncel olmasıdır. Örneğin, dünyanın karşı karşıya kaldığı en önemli çevre sorunlarından birisi haline gelen iklim değişikliği kavramı artık günlük hayatımızda kullanılır hale gelmiştir. Bunun yanı sıra, Toplumun birçok kesiminin karşı çıkmasına rağmen bugünlerde Türkiye'nin enerji gündeminde bir nükleer güç reaktörünün kurulması vardır. Ayrıca organ bağışi ve nakli okullarda önem verilmesi gereken, medyada farkındalık yaratmak adına daha fazla vurgulanması gereken ve araştırmalara göre üniversite öğrencilerinin yetersiz bilgiye sahip olduğu (Koçak vd., 2010; Doğan, Toprak, Sunal, & Doğan, 2012) bir başka SBK'dır. Son olarak, pek çok üniversitede sınıfıçi SBK tartışmalarında bu konuların seçimine başvurmaktadır ve bu konuların içeriği fizik, kimya ve biyoloji alanında bazı bilimsel temellere dayanmaktadır.

Kısacası FBÖA'ların epistemolojik inançları, üç SBK hakkındaki bilgi düzeyleri, ve bilgi kaynaklarının güvenilirliğine ilişkin değerlendirmeleri arasındaki olası bir ilişkiyi araştıran hali hazırda ulaşılabilir bir çalışma bulunamamıştır. Bu da

bu çalışmayı farklı kılmaktadır. Ayrıca bu çalışma, Türkiye’de bu üç kavramı içeren çok az sayıdaki çalışmadan birisidir.

## **2. Yöntem**

### **Araştırmanın Deseni**

Bu çalışmada tarama araştırması deseni kullanılmıştır. Tarama araştırmasında, araştırmacı genel olarak verilen cevapların nasıl ve ne kadar çeşitlilik gösterdiği, bazı cevapların birbirine ne kadar ilişkili olduğu ve cevapların belirli demografik değişkenler veya sosyal, politik, psikolojik değişkenler içerisinde nasıl farklılaştığı ile ilgilenir (Krahtwohl, 1998).

Tarama araştırmalarının genel olarak üç temel özelliği vardır: (1) örneklemeden, (2) örneklemin elde edildiği popülasyonun bazı yönlerini tanımlama amacıyla sorular sorarak, (3) bilgi toplama (Fraenkel, & Wallen, 2009).

Korelasyon ve nedensel karşılaştırma araştırmaları, tarama analizinde en sık kullanılan iki yöntemdir (Fraenkel, & Wallen, 2009). Dolayısıyla bu araştırmanın araştırma sorularına yanıt bulmak adına, elde edilen verilerin analizinde korelasyon ve nedensel karşılaştırma analizleri kullanılmıştır.

### **Örneklem**

Bu araştırmaya kolay ulaşılabilir durum örnekleme ile belirlenen, birinci, ikinci, üçüncü ve dördüncü sınıflarda öğrenim görmekte olan, Kırşehir, İzmir, Kayseri ve Ankara’da bulunan dört farklı devlet üniversitesinden toplam 630 (127

erkek, 503 kadın) FBÖA katılmıştır. İzmir dışındaki üniversiteler genel olarak İç Anadolu Bölgesi'ni temsil etmektedir. Araştırma 2012-2013 bahar döneminde gerçekleştirilmiştir. Örneklemin yaş ortalaması 20.89'dur.

Bu çalışmada örneklem olarak FBÖA'nın seçilme nedeni, bilim okuryazarı bir nesil yetiştirmek ancak öğretmen adaylarının bilgili; yalnızca temel fen konularında değil, SBKlar hakkında da kendini sürekli yenileyen ve geliştiren bireyler olması ile mümkün olabilir. Fen eğitimindeki yeni düzenlemeler ile, fen kitapları "İnsan ve Çevre" gibi çevresel problemler ve yaşamımıza etkileri ile iklim değişikliği gibi konulara yönelik üniteler ile "Vücudumuzdaki Sistemler" gibi organ nakli konusuna yönelik üniteler içermektedir. Ayrıca ilköğretim öğrencilerinin nükleer enerji konusu hakkında da ders kitapları ve fen dersleri aracılığıyla temel bir bilgiye sahip olması beklenmektedir. Fen bilgisi öğretmenlerinin ise bu üç SBK hakkında daha derin bir bilgiye sahip olmaları gerekmektedir. Bu nedenlerle bu çalışmada, öğrencilere öğretebilmeleri için SBK hakkında yeterli bilgiye sahip olması gereken FBÖA'nın örneklem olarak seçilmesi daha uygun bulunmuştur.

### **Ölçme Araçları**

Bu çalışmada katılımcılara dört ölçme aracı uygulanmıştır: 1. Schommer'ın (1990) Epistemolojik İnanç Ölçeği, 2. Üç SBK'ya ilişkin bilgi düzeyini ölçmeye yönelik olarak araştırmacı tarafından geliştirilen Bilgi Testi, 3. Araştırmacı tarafından, farklı bilgi kaynaklarından derlenen dokuz okuma metni, 4. Bråten, Strømsø, ve Salmerón (2011) tarafından geliştirilen güvenilirlik anketi.

Öncelikle, FBÖA'nın epistemolojik inançlarını belirlemek için Schommer (1990) tarafından geliştirilen ve bu alandaki ilk nicel veri toplama aracı olan Epistemolojik İnanç Ölçeği kullanılmıştır. Ölçek, 5'li Likert tipindeki (kesinlikle katılmıyorum, katılmıyorum, kararsızım, katılıyorum, kesinlikle katılıyorum) 63 maddeden oluşmaktadır. Ölçek 5 boyut içermektedir. Topçu ve Yılmaz-Tüzün (2006) Schommer'ın Epistemolojik İnanç Ölçeği'ni Türkçe'ye çevirmiş ve geçerlilik çalışmalarını yapmıştır. Faktör analizi sonuçları Schommer'ınki (1990) ile paralellik göstermiştir. İkinci olarak, 42 maddeden oluşan çoktan seçmeli bilgi testi geliştirilmiş ve FBÖA'na, üç SBK hakkındaki bilgi düzeylerini belirlemek amacı ile uygulanmıştır. Üçüncü ve son olarak, FBÖA'nın bilgi kaynaklarına olan güvenleri ile kriterlerini belirlemek için üç SBK hakkında farklı bilgi kaynaklarından derlenmiş olan dokuz okuma metninin hemen ardından 10'lu Likert tipindeki, Bråten vd. (2011) tarafından geliştirilen güvenilirlik anketi uygulanmıştır. Bu anket üç kısımdan oluşmaktadır: 1. Her bir metne olan güveni değerlendirmeye yönelik 1 madde, 2. Her bir kritere olan güveni değerlendirmeye yönelik 6 madde, ve 3. Her bir metnin anlaşılabilirliğini değerlendirmeye yönelik 1 madde.

### **Verilerin Analizi**

Analizlerde SPSS 20 paket programı kullanılmıştır. Epistemolojik İnanç Ölçeği verilerinin analizinde betimleyici istatistikler ve factor analizi kullanılmıştır. Bilgi testine verilen yanıtların cevap anahtarı baz alınarak yapılan kodlanmasında, katılımcıların her bir doğru yanıtı için "1" ve her bir yanlış yanıtı için "0" değerleri girilmiştir. 42 maddelik bilgi testi için katılımcıların toplam puanları belirlenmiştir. Bilgi testinin analizinde betimleyici istatistikler kullanılmıştır. Katılımcıların bilgi

kaynaklarının güvenilirliklerini nasıl değerlendirdiklerini incelemek için de yine betimleyici istatistik analizine başvurulmuştur. Çalışmanın amacına yönelik üç değişken arasındaki ilişkiyi araştırmak için korelasyon analizi ile karışık tasarım varyans analizi yöntemine başvurulmuştur.

### **3. Bulgular ve Tartışma**

Betimsel istatistik sonuçlarına göre FBÖA bilime karşı göreceli olarak gelişmiş epistemolojik inançlara sahiptir. Factor analizi sonuçlarına göre, katılımcıların epistemolojik inançları ortalama değerlerine göre sırasıyla şu dört boyuttan oluşmaktadır: Kesin Bilgi (3.28), Basit Bilgi (3.02), Otorite Bilgisi (2.77) ve Hızlı Öğrenme (2.55). Bu faktör yapısı epistemolojik inançların çok boyutlu yapıya sahip olduğunu destekler niteliktedir. Bu çalışmanın sonuçları, dört boyutu açığa çıkaran diğer bazı çalışmalar ile tutarlıdır (örn., Öztürk, 2011; Schommer, 1990; Schommer, Crouse. & Rhodes, 1992; Yılmaz-Tüzün & Topçu, 2007, 2008, 2013). Benzer şekilde, Schommer'ın da iki çalışmasında dört faktör bulunmuştur fakat bunların içinde otorite bilgisi yoktur. Fakat otorite bilgisi boyutu Türkiye'de uygulanan çoğu çalışmada açığa çıkmıştır (örn. G. Öztürk, 2009; N. Öztürk, 2011; Topçu & Yılmaz-Tüzün, 2006; Yılmaz-Tüzün & Topçu, 2008; Yılmaz-Tüzün & Topçu, 2013). Bu noktada, bazı çalışmalarda otorite bilgisi boyutunun daha çok Çin, Japonya, Tayvan ve Türkiye gibi doğu kültürünün egemen olduğu ülkelerde ortaya çıktığı belirtilmektedir (Chan & Elliott, 2002, 2004; Elliott,& Chan, 1998; Lee, 1995; Wang, Zhang, Zhang, & Hou, 2013). Bu çalışmanın sonuçlarına benzer şekilde, Eroğlu'nun (2009) yüksek lisans tezinde de öğretmen adaylarının "Kesin Bilgi" boyutunda daha yüksek ortalamaya sahip olduğu belirtilmiştir. Perry (1968),

üniversite öğrencilerinin kişisel epistemolojik inançları üzerine çalışmış ve öğrencilerin üniversiteye başladığında daha az gelişmiş epistemolojik inançlara sahip olup (örn. bilginin basit, kesin olduğu ve otorite tarafından belirlendiği gibi görüşlere sahip olmaları), eğitimleri boyunca daha gelişmiş epistemolojik inançlar geliştirdiklerini (örn. bilginin karmaşık ve değişken olduğu gibi görüşlere sahip olmaları) ifade etmiştir. Halbuki bu çalışmada sınıflar bazında bir farklılık bulunamamış olup, bulunan dört boyutun ortalama değerleri orta düzeydedir ki bu da katılımcıların gelişmiş epistemolojik inançlardan ziyade, geliştirmekte olan epistemolojik inançlara sahip olduğunu göstermektedir.

Betimleyici istatistik analizi sonuçlarına göre, katılımcıların iklim değişikliği testi sonuç ortalaması 9.30, nükleer enerji testi sonuç ortalaması 8.76 ve organ bağıışı ve nakli testi sonuç ortalaması ise 7.99 olarak bulunmuştur. Ayrıca analiz sonuçları, katılımcıların 282'sinin (44.8%) iklim değişikliği, 261'inin (41.4%) nükleer enerji ve sadece 148'inin (23.5%) organ bağıışı ve nakli konusunda yeterli bilgiye sahip olduklarını göstermektedir. 42 maddelik bilgi testinde 8.68 olarak bulunan test ortalaması baz alındığında, 317 katılımcı yüksek, 301 katılımcı ise düşük başarı düzeyine sahiptir. Bulguların detayına inildiğinde, FBÖA'nın küresel ısınmanın sebep olduğu olayların neler olduğu konusunda kafa karışıklığına sahip oldukları görülmektedir. Bu bulgu diğer pek çok çalışma tarafından da desteklenmiştir (Bahar & Aydın, 2002; Bozdoğan & Yanar, 2010; Khalid, 2001, 2003; Matkins & Bell, 2007; Pekel, 2005). Ayrıca ilgili literature göre ilkokul ve ortaokul öğrencileri de bu küresel ısınma ve sera etkisi gibi konularda pek çok kavram yanılgısına sahiptir (Lester, Ma, Lee & Lambert, 2006; Boyes, Stanisstreet, & Papantoniou, 1999).

FBÖA'nın, oldukça güncel olan iklim değışikliđi ve küresel ısınma konularında yeterli bilgi düzeyine sahip olmaları beklenmektedir ki öğrencilerine de bu bilgiyi aktarabilsinler. Bu tip SBKlar detaylı olarak üniversitelerin çevre eğitimi dersi kapsamına alınmalı ve FBÖA'nın kavram yanılgıları giderilmelidir.

FBÖA nükleer enerji hakkında yazılmış olan 6. metin (6.13) ile 4. metni (6.16) daha az güvenilir bulurken, iklim değışikliđi hakkında yazılmış olan 3. metni (6.61) daha güvenilir bulmuşlardır. Son olarak, iklim değışikliđi hakkında yazılmış olan metinleri okurken katılımcılar içerik kriterine en fazla önemi vermişler; fakat nükleer enerji ve organ bađışısı ve nakli konuları hakkındaki metinleri okurken en fazla kendi fikirlerine önem vermişlerdir. Tüm metinlerin güvenilirlik değeri analizinin ortalamasına bakıldığında ise, katılımcıların iklim değışikliđi ve nükleer enerji konuları hakkındaki metinleri okurken yazara; organ bađışısı ve nakli hakkında yazılmış olan metinleri okurken ise yayımlanma tarihine en az önemi verdikleri görülmektedir.

Korelasyon analizi sonuçlarına göre, başarı düzeyi yüksek FBÖA, başarı düzeyi düşük FBÖA'na göre dokuz metnin tümünü daha az anlaşılır bulmuşlar ve güvenilirlik değerlendirmesinde içerik konusuna daha fazla önem vermişlerdir. Başarılı öğrencilerin daha az başarılı öğrencilere göre genellikle metinleri daha detaylı, anlamaya çalışarak okudukları bilinen bir gerçektir. Buradan yola çıkarak bu çalışmanın bu bulgusu manidardır. Yine korelasyon analizi sonuçlarına göre FBÖA'nın basit bilgi boyutu ile Metin 1'i okuma sürecinde yazara olan güvenleri arasında; hızlı öğrenme boyutu ile Metin 1'in zorluğu arasında; kesin bilgi boyutu ile Metin 4'e olan güvenleri arasında; basit bilgi boyutu ile Metin 4'ün zorluğu arasında;

hızlı öğrenme boyutu ile Metin 5'in zorluğu arasında; basit bilgi boyutu ile Metin 7'yi okuma sürecinde yazara olan güvenleri arasında; basit bilgi boyutu ile Metin 7'yi okuma sürecinde yayın organına olan güvenleri arasında; basit bilgi boyutu ile Metin 9'u okuma sürecinde yazara olan güvenleri arasında ve hızlı öğrenme boyutu ile Metin 9'un zorluğu arasında zayıf birer pozitif korelasyon bulunmuştur.

Ayrıca, korelasyon analizi sonuçlarına göre, FBÖA'nın otorite bilgisi boyutu ile Metin 1'i okuma sürecinde metin türüne olan güvenleri arasında; hızlı öğrenme boyutu ile Metin 2'yi okuma sürecinde yazara olan güvenleri arasında; otorite bilgisi boyutu ile Metin 2'nin zorluğu arasında; otorite bilgisi boyutu ile Metin 3'ün zorluğu arasında ve kesin bilgi boyutu ile Metin 7'yi okuma sürecinde metnin içeriğine olan güvenleri arasında zayıf birer negatif korelasyon bulunmuştur.

Korelasyon analizlerine bakıldığında FBÖA'nın bilgi düzeyleri ve epistemolojik inançları arasında herhangi bir ilişkinin bulunamadığı görülmektedir.

Karışık tasarım varyans analizi sonuçlarına göre, yüksek başarı düzeyine sahip olan FBÖA, düşük başarı düzeyindekilere göre genel olarak daha yüksek metin güvenilirliği ortalamasına sahiptir. Buna ek olarak, ortalamalar baz alındığında, genel olarak hem yüksek hem de düşük başarı düzeyine sahip FBÖA'nın Metin 3'ü diğer sekiz metne oranla daha güvenilir buldukları görülmektedir. Bu metin bilimsel bir dergide yayınlanmıştır ve içeriğine bakıldığında iklim değişikliğine hem insan aktivitelerinin hem de doğal süreçlerin neden olduğunu savunduğu görülmektedir. Buradan yola çıkarak, FBÖA'nın iklim değişikliğinin nedenlerine ilişkin olarak görüşlerinin daha nötr olduğu düşünülebilir. Genel olarak bakıldığında FBÖA'nın

online gazetelerden ziyade gazete ve bilimsel dergileri daha güvenilir buldukları sonucuna varılmıştır. Grace'in (2012) bulguları da bunu destekler niteliktedir. Son olarak, dokuz testin tümü için FBÖA'nın güvenilirlik hakkındaki hükümlerini en çok kendi fikirleri ve içerik kriterlerine bakarak verdikleri görülmektedir ki bu da yapılan diğer çalışmalar tarafından da desteklenmektedir (Bråten vd., 2009; Bråten vd., 2011).

#### **4. Öneriler**

Pek çok araştırmacı fen öğretiminde SBK kullanımının çok uygun olduğu ve FBÖA'nın fen okuryazarlığı üzerinde olumlu etkilerinin olduğu görüşündedir (örn., Albe, 2008; Holbrook & Rannikmae, 2009; Kolstø, Bungum, Arnesen, Isnes, Kristensen, & Mathiassen, 2006; Sadler, Barab, & Scott, 2007; Sadler et al., 2004; Topçu, Sadler, & Yılmaz-Tüzün, 2010; Zeidler vd., 2002). Fen müfredatına SBK'nın dahil edilmesi; öğretmen eğitimi programlarında FBÖA'nın sınıflarında SBK kullanımını geliştirmelerine ve bu konulardaki tartışmaları yönetebilmelerine imkan sağlayacak şekilde uygulanması gereken ders içeriklerindeki bazı değişim ve düzenlemeleri gerektirmektedir. Üniversitelerin FBÖA eğitim programları metot dersleri aracılığıyla farkındalık düzeyi yüksek, teorik altyapıya sahip ve SBK'yı derslerine entegre edebilen öğretmenler yetiştirmelidir (Öztürk, 2011). Bu metot dersleri ve öğretmenlik uygulaması derslerinde FBÖA ayrıca epistemolojik inançlarını tartışabilir ve SBK hakkındaki görüşlerinin farkına varabilir.

Gelişmiş epistemolojik inançlara sahip olmak da SBK eğitiminde önemlidir. Bu nedenle SBKların fen derslerine ve FBÖA eğitimi müfredatına eklenmesiyle,

daha gelişmiş epistemolojik inançlar oluşturulabilir ve bu inançlar sayesinde de daha etkili SBK eğitimi mümkün kılınabilir.

Öğretmen ve öğretmen adayları elbette ki anlatmakta oldukları/ileride anlatacakları dersin içeriği hakkında detaylı bilgiye sahip olmalıdır. Bu bilgileri genellikle ders kitapları, bilimsel dergiler, gazeteler, internet ve medya aracılığı ile elde ederler. Doğal olarak her bilgi kaynağına güvenmek mümkün değildir. Bu sebeple, öğrenciler ile okudukları kaynağın güvenilirliğinin nasıl değerlendirilebileceği hakkında konuşulmalı, bu konuya derslerde mutlaka yer verilmelidir. Geleceğin öğretmenleri olarak FBÖA, sadece burada adı geçen üç SBK hakkında değil, diğer pek çok konuda da eleştirel okuma ve değerlendirme becerilerine sahip olmalıdırlar.

Kısaca, gelişmiş epistemolojik inançlara ve alanında yeterli bilgiye sahip olmanın, bilgi kaynaklarının güvenilirliklerinin dikkatli ve eleştirel şekilde değerlendirilmesinin ve SBK eğitiminin FBÖA eğitiminde oldukça önemli yeri vardır. FBÖA eğitiminde bu konulara vurgu yapılması ile oluşturulacak öğrenme ortamları sayesinde Türkiye'deki SBK eğitimi gelişecektir.

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