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Socioscientific Issues in Science Education: The Case of Turkey

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Abstract

The purpose of this study is to identify the foci and results of studies on socioscientific issues (SSI) conducted in Turkey. Additionally, the study aimed to compare the results of this study with ones conducted internationally. For this aim, a literary review of empirical studies related to SSI conducted in Turkey was carried out. Four criteria were used to identify the research studies included in this review: studies which are contemporary (2002-2012), were conducted in Turkey (sampling Turkish populations), which focus on SSI in science education, and which used first-hand data gathered through empirical investigations. Related databases were searched using "SSI and Turkey" and "SSI and Turkish" keywords in both English and Turkish. The search resulted in 13 empirical research articles and 17 Master's and Doctoral theses. After the initial review of the studies based on the established criteria, 11 articles and 13 theses were identified for inclusion in this review. The results showed that SSI related studies conducted in Turkey, similar to international studies, have two roles. While the aim was to teach SSI in some studies, in other studies, SSI were used as a context to reach other broader, science education related aims. Studies mostly focused on the knowledge of pre-service science teachers regarding various SSI, the self-efficacy beliefs of teaching and the informal reasoning skills in the context of SSI. The majority of the studies were master's theses. Another important point that needs to be paid attention to is that SSI related studies in Turkey tended to employ quantitative methods while very few studies utilized in-depth qualitative methods.

Keywords

Socioscientific Issues, Literature Review, Turkey, Teacher Education, Science Education.

Science and society reciprocally influence each other. While societal needs drive science, society is influenced by science in many respects as well (Sadler & Zeidler, 2005b). With the rapid advancement of science, many science-related, societal dilemmas appear, such as whether to use nuclear power. Such complex, open-ended, controversial and uncertain issues involving both science and society are called SSI (Eastwood, Sadler, Zeidler, Lewis, Amiri, & Applebaum, 2012;

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Fleming, 1986a, 1986b; Kolstø, 2001; Patronis, Potari, & Spiliotopoulou, 1999; Sadler, 2004; Sadler & Zeidler, 2005a; Topçu, Yılmaz-Tuzun, & Sadler, 2011; Zeidler, Walker, Ackett, & Simmons, 2002).

Prominent science education organizations (American Association for the Advancement of Science, 1990; Ministry of National Education in Turkey [MONE], 2013; National Research Council, 1996; and Queensland School Curriculum Council, 2001) emphasized that the argumentation, analysis and knowledge-based decision making skills of students regarding SSI need to be improved because these skills are important components of scientific literacy. Many studies utilizing SSI report that such contexts improve a student's conceptual understanding (Klosterman & Sadler, 2010), attract their interest (Albe, 2008; Zeidler, Sadler, Applebaum, & Callahan, 2009), provide additional motivation for learning (Parchmann, Gräsel, Baer, Nentwig, Demuth, & Ralle, 2006), and improve their epistemological development (Zeidler et al., 2009) and attitudes towards science (Lee & Erdogan, 2007).

Starting from 2013, SSI have been specifically included in the Science and Technology curriculum by the Turkish Ministry of National Education (MONE, 2013). This new emphasis on SSI in the curriculum necessitates understanding what has been done by science education researchers in Turkey with respect to SSI and how this research compares with ones conducted internationally. Considering that the context of these studies has its own sociocultural structure and belief system and deals with SSI regarding these characteristics, a national-level analysis will help to better understand the teaching and learning of SSI in the context of Turkey. Following are the two broad research questions that guided this study:

1. What are the focus, utilized topics, sample and research methods of the studies related to SSI in the context of science education in Turkey?
1. What are the similarities and differences between the SSI related studies conducted in a Turkish context and International context?

Method

In this study, a critical review of the research has been carried out (Hart, 2001). This approach included identification of the conceptual or empirical literature based on certain criteria, detailed analysis and description, identification of strengths and weaknesses and proposition of alternative conceptual perspectives and/or suggestion of potential research areas (see Abd-El-Khalick & Lederman, 2000; Sadler, 2004). Reviews carried out with this approach tend to use themes already existing in the literature, rather than qualitative content analysis (Sadler, 2004). In this review, the empirical research studies focusing on SSI have been selected for analysis based on the criteria presented below in Table 1.

Table 1
Criteria Used to Identify Studies to be Reviewed

1. Contemporary empirical investigation (2002-2012)
1. Conducted in a Turkish context, sampling Turkish populations
2. Focusing on SSI in science education
3. Uses first-hand data gathered from the related population

SSI have been conceptualized and studied within the last ten years predominantly for the International literature. Starting with this observation, the researchers decided to search and analyze studies conducted between 2002-2012. Related databases Social Science Citation Index (SSCI), Education Resources Information Center (ERIC), Elsevier, Turkish Academic Network And Information Center (TÜBİTAK-ULAKBİM), and Council of Higher Education Thesis Center databases have been searched with the keywords of "SSI and Turkey" and "SSI and Turkish" both in English and in Turkish.

The search returned 13 empirical research articles and 17 Master's and Doctoral theses. Four theses (Altınok, 2012; Deveci, 2011; Özden, 2011; Tatar, 2012) and two research articles (Kılınç, 2010; Šorgo, Usak, Aydogdu, Keles, & Ambrozic-Dolinsek, 2011) which did not meet the criteria were eliminated and a final review was done on the remaining 11 research articles and 13 theses.

Two themes emerge from the international literature on SSI; Utilizing SSI as an end (see Klosterman & Sadler, 2010; Topçu, 2010) and Utilizing SSI as a means (see Evagorou & Osborne, 2013; Sadler & Fowler, 2006; Topçu, Sadler, & Yılmaz-Tuzun, 2010). These two themes guided the analysis of the identified studies. As seen in Figure 1, the first theme focuses on knowledge level, risk/benefit perceptions and views, and the participants' self-efficacy beliefs about teaching SSI. In the second theme, SSI were used in the context of studying the argumentation and informal reasoning of the participants.

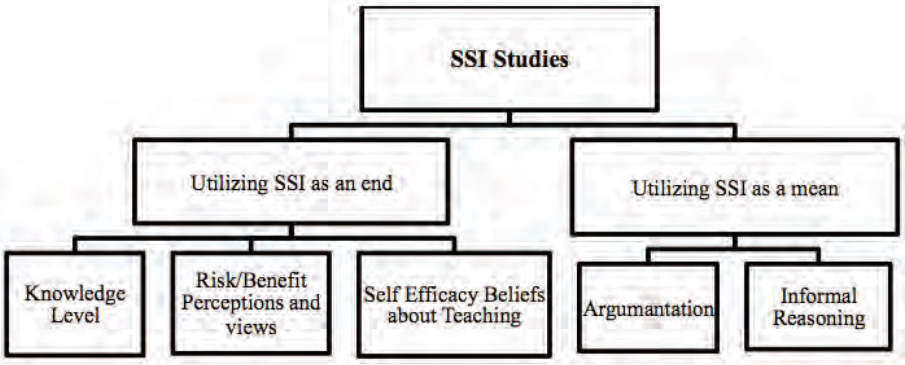


Figure 1: Themes in SSI studies.

Findings

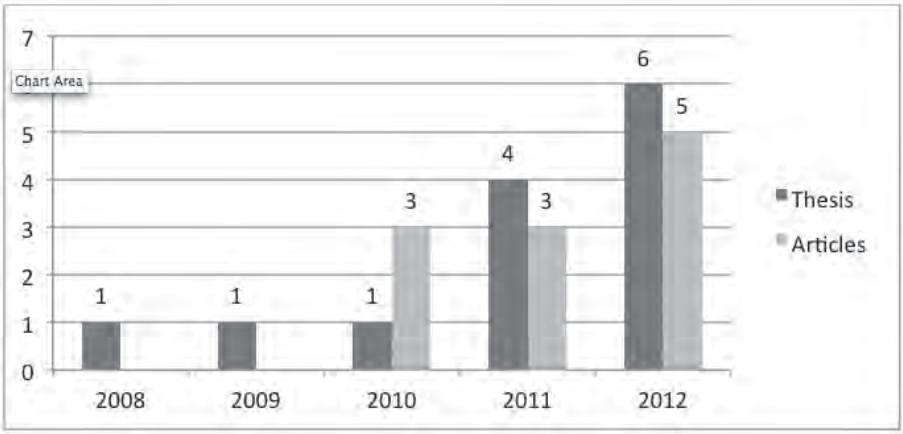
As a result of the analysis, it was found that between 2002-2012, there were 24 studies which met the criteria presented in the previous section. It was interesting that all of these studies were published after 2007. 11 of them were journal articles and 13 of them were theses (Graphic 1).

The authors and the publication years of the 11 journal articles and 13 theses are presented in Table 2 and Table 3, respectively, including the focus of the study, the selected SSI, a sample of the study, and its methodology. Moreover, it was found that 10 of these studies (3 theses and 7 articles) were able to be examined under the first theme while 13 of the studies (8 theses and 4 articles) were analyzed under the second theme and one thesis (Soysal, 2012) was able to be examined under both themes.

Content Knowledge in SSI

As seen from Table 2 and Table 3, in some SSI studies, the researcher(s) selected an SSI and investigated the content knowledge of students about it (Sorgo, Ambrožič-Dolinšek, Uşak, & Özel, 2011; Sönmez, 2011; Soysal, 2012; Sönmez & Kılınç, 2012; Sürmeli & Şahin, 2010, 2012). These studies focused on SSI such as GMOs, cloning, and biotechnology, all of which closely concern society.

The sample of the SSI studies which focused on content knowledge was mostly pre-service teachers (Sorgo, Ambroziv-Dolinsek, Uşak, & Özel, 2011; Soysal, 2012; Sönmez & Kılınç, 2012; Sürmeli & Şahin, 2010, 2012). For instance, Surmeli and Sahin (2012) investigated the content knowledge of 112 pre-service science teachers (PST) on cloning. Sorgo, Ambroziv-Dolinsek, Uşak, and Özel (2011) and Soysal (2012) focused on 281 pre-service teachers' and 71 PSTs content knowledge of GMOs respectively. These studies found that the content knowledge of pre-service teachers was not sufficient. On the other hand,



Graphic 1: Distribution of SSI studies in science education in Turkey with respect to years.

Table 2
Research studies on SSI in Turkey

	Author, Year	Focus of the Study	Selected SSI	Sample		Method
				Target Population	N	
1	Çalık & Coll (2012)	Relationship between SSI and scientific thinking habits	Alternative Medicine, Climate Change	Pre-service Elementary school Teachers and Pre-service Secondary School Science Teachers	290	Quantitative
2	Kara (2012)	Perception of self-efficacy and views on Teaching SSI	Various SSI	Pre-service Biology Teachers	102	Quantitative
3	Kılınç, Boyes, & Stanisstreet (2011)	Beliefs and Behaviors about SSI	Global Warming	6th-10th Grade Students	687	Quantitative
4	Kılınç, Boyes, & Stanisstreet (2012)	Perception of Risk related to SSI	Nuclear Energy	6th-10th Grade Students	2253	Quantitative
5	Šorgo, Ambrožič-Dolinšek, Uşak, & Özel (2011)	Knowledge on SSI	GMO	Pre-service Teachers	281	Quantitative
6	Sönmez & Kılınç (2012)	Knowledge, Perception of Risk and Self-efficacy in SSI Teaching	GMO	Pre-service Science Teachers	161	Quantitative
7	Sürmeli & Şahin (2010)	Knowledge, Perception of Risk, and Decision Making	Cloning/ Genetics Engineering	Undergraduate Medicine and Biology Students, and Pre-service Science Teachers	219	Quantitative & Qualitative
8	Sürmeli & Şahin (2012)	Knowledge	Cloning/ Genetics Engineering	Pre-service Science Teachers	112	Quantitative & Qualitative
9	Topçu (2010)	Attitudes towards SSI	Various SSI	Pre-service Classroom, Science and Social Science Teachers	376	Quantitative
10	Topçu, Sadler, & Yılmaz-Tuzun (2010)	Argumentation and Informal Reasoning in SSI	Gene Therapy, Human Cloning, Global Warming	Pre-service Science Teachers	39	Qualitative
11	Topçu, Yılmaz-Tuzun, & Sadler (2011)	Informal Reasoning regarding SSI and Factors Influencing Informal Reasoning	Gene Therapy, Human Cloning, Global Warming	Pre-service Science Teachers	39	Qualitative

Table 3
Master's Theses and Dissertations on SSI in Turkey

	Author, Year	Type of Thesis	Focus of the Study	Selected SSI	Sample		Method
					Target Population	N	
1	Alaçam-Akşit (2011)	Master	Views and Resources on Teaching SSI	Various SSI	Pre-service Classroom Teachers	357	Quantitative & Qualitative
2	Domaç (2011)	Master	Argumentation and Informal Reasoning in SSI	Biodiversity	Pre-service Biology Teachers	32	Quantitative & Qualitative
3	Goloğlu (2009)	Master	Decision Making in SSI	Nutrition	5th Grade Students	84	Quantitative & Qualitative
4	Gülhan (2012)	Master	Decision Making and Sensitivity in SSI	Various SSI	8th Grade Students	48	Quantitative & Qualitative
5	İşbilir (2010)	Master	Argumentation and Informal Reasoning in SSI	Global Warming, Nuclear Energy, GMO, Human Genome Project	Pre-service Science Teachers	30	Quantitative & Qualitative
6	İşeri (2012)	Master	Perception of Risk and effect of information resource in SSI	Nuclear Energy	Pre-service Science Teachers	222	Quantitative
7	Kutluca (2012)	Master	Relationship between Content Knowledge and Quality of Argumentation in SSI	Cloning / Genetics Engineering	Pre-service Science Teachers	54	Quantitative & Qualitative
8	Öztürk (2011)	Master	Argumentation and Informal Reasoning in SSI	Nuclear Energy	Pre-service Science Teachers	674	Quantitative
9	Soysal (2012)	Master	Knowledge and Argumentation in SSI	GMO	Pre-service Science Teachers	71	Quantitative & Qualitative
10	Sönmez (2011)	Master	Knowledge, Perception of Risk, and Self-efficacy in SSI Teaching	GMO	Pre-service Science Teachers	161	Quantitative
11	Tonus (2012)	Master	Argumentation and Decision Making Skills in SSI	Cloning, Nuclear Energy	Primary School Students	106	Quantitative
12	Topçu (2008)	Dissertation	Informal Reasoning regarding SSI and Factors Influencing Informal Reasoning	Gene Therapy, Human Cloning, Global Warming	Preservice Science Teachers	39	Qualitative
13	Turan (2012)	Master	Relationship between Scientific Thinking Skills and SSI	Various SSI	Preservice Science, Mathematics, Classroom, and Social Science Teachers	1600	Quantitative

Sonmez and Kılınc (2012) conducted a study on 161 PSTs and found that their content knowledge about GMOs was sufficient. Moreover, in addition to PSTs, Sürmeli ve Şahin (2010) investigated medical and biology students' knowledge of genetic engineering. They found that biology students gave the highest number of correct definitions for genetic engineering among the sample. The research also indicated that only 7.1% of PSTs gave the correct definition of genetic engineering.

Perception of Risks and Benefits and Views about SSI

Some studies about the perceptions of risks and benefits related to SSI were also conducted with PSTs (İşeri, 2012; Sönmez & Kılınç, 2012; Sönmez, 2011; Sürmeli & Şahin, 2010). Sönmez and Kılınç (2012) investigated the perceptions of risks of 161 PSTs about GMOs. It was found that PSTs viewed GMO foods as risky and had negative attitudes towards GMOs.

Another study examined PSTs' perception of risks and benefits about nuclear power (İşeri, 2012). According to this study, nuclear power plants were considered highly risky in terms of the possible damage to humans and other living beings. On the other hand, regarding the perception of benefits of nuclear power, it was found that nuclear power and technology were considered beneficial in terms of having a say in international relations. In another study, 6th and 10th graders' perceptions of risks about nuclear power plants were examined (Kılınç, Boyes, & Stanisstreet, 2012). It was found that the students perceived nuclear power plants as risky in terms of its damage to health and environment. Moreover, İşeri (2012) argued that information resources shaping the common view of individuals and therefore the reliability of the resources were important while developing views about SSI. In a study about information resources and the formation of knowledge on SSI, it was also found that one of the most effective information resources was mass media (Alaçam-Akşit, 2011).

On the other hand, in some studies it was found that some SSI were perceived as beneficial. For example, in Sürmeli and Şahin's study (2010), which was conducted with medical school and biology students, 42.9% of the students stated that the benefits of genetic engineering were greater than its risks. Only 17.3% of the students stated that the risks of genetic engineering outweigh its benefits.

In addition to these studies, Kılınç, Boyes, and Stanisstreet (2011) investigated the beliefs of 897 9th and 10th grade students about the benefits of certain behaviors in reducing global warming. 93% of the participants stated that global warming was a problem. 85% and 70% of the participants respectively stated that planting trees and recycling could be helpful for solving the problem of global warming. On the other hand, only 30% of the participants stated that reducing the consumption of trendy products could positively affect the problem of global warming. Moreover, 89% of the participants stated that they would be willing to pay for planting trees whereas 53% of the participants would be willing to consume less trendy products.

Perceptions of Self-efficacy and Views on Teaching SSI

It is argued that improving teachers' perception of self-efficacy increases the possibility of starting to teach new subjects (Ramey-Gassert & Shroyer, 1992). Based on this view, Kara (2012) investigated pre-service biology teachers' self-efficacy and ability to teach SSI such as cloning, medicine, stem cell research, cosmetics, bio-sensors, global warming, and GMOs. In order to assess the pre-service teachers' views of SSI, an instrument developed by Lee and his colleagues (2006) was used in the study. According to the findings of the study, the majority of participants stated that SSI would be helpful for creating fruitful discussions and better understanding of biology. On the other hand, the participants' perceptions of self-efficacy for teaching SSI were low. They also stated that during the course they gained experience in teaching SSI and they learned content knowledge. Although they were not very motivated to develop materials for teaching SSI, they stated that they were able to develop materials.

Another study about self-efficacy was carried out by Sönmez and Kılınç (2012). As opposed to the findings of Kara's (2012) study, Sönmez and Kılınç found that pre-service teachers' perceptions of self-efficacy for teaching SSI were high even though the participants stated that they had some lack of content knowledge. For example, more than half of the participants stated that they were able to teach about GMOs. The study was also aimed to examine the factors affecting perceptions of self-efficacy. It was found that perceptions of risk, attitude and knowledge level were statistically significant factors affecting self-efficacy. Moreover, in a master thesis, Alaçam and Akşit (2011) examined pre-service

teachers' views about teaching SSI. They applied the "Views about SSI" test to 357 pre-service teachers and interviewed 24 of the participants. It was found that pre-service teachers did not consider themselves sufficient in terms of content knowledge, teaching approach, and technique.

Research on Socioscientific Argumentation and Informal Reasoning in Turkey

While an important part of the studies on SSI across the world focused on argumentation and informal reasoning (Albe, 2008; Kortland, 1996; Ratcliffe & Grace, 2003; Zohar & Nemet, 2002), few studies were conducted on these topics in Turkey (e.g., Topçu, 2010, 2011). In recent years, only some master (Domaç, 2011; Goloğlu, 2009; Gülhan, 2012; İşbilir, 2010; Öztürk, 2011; Soysal, 2012; Tonus, 2012) and doctoral (Topçu, 2008) theses focused on argumentation and informal reasoning regarding SSI.

Studies with Pre-service Teachers

Topçu and colleagues (2010) investigated PSTs' argumentation quality and the effects of SSI contexts on their argumentation quality. 39 participants were interviewed and a total of seven SSI were used in this study. The results showed that when SSI contexts changed, participants' argumentation quality significantly changed. Although Sadler and Zeidler (2004) predicted this result hypothetically, Topçu et al. (2010) empirically supported this claim. Topçu and colleagues (2011) also explored PST's informal reasoning patterns and the factors influencing their informal reasoning. Based on the findings, three informal reasoning patterns were observed: rationalistic, emotional, and intuitive informal reasoning. The following factors influencing PSTs' informal reasoning were explored: personal experiences, social considerations, moral/ethical considerations, and technological concerns. Although these factors were determined in Western countries previously (Sadler and Zeidler, 2005a, Yang and Anderson, 2003), this study was the first to explore these factors in a Turkish context.

Another Turkish study focusing on informal reasoning on SSI was conducted by İşbilir (2010). As a part of this study, pre-service teachers' written argumentation quality about SSI was explored. It was determined that with the on-line discussions, students' qualified arguments improved in the following weeks. Öztürk (2011) also investigated PSTs' informal reasoning regarding SSI, epistemological beliefs, and meta-cognition. The results suggested that there were negative and significant relationships among PSTs' informal reasoning about SSI, epistemological beliefs, and meta-cognition. Domaç (2011) studied pre-service biology teachers and explored the idea that argumentation-based instruction improved pre-service teachers' learning about SSI. Kutluca (2012) also studied PSTs' content knowledge, scientific and socioscientific argumentation. Interestingly, the findings suggested that there was no relationship among PSTs' content knowledge, scientific, and socioscientific argumentation. Although Kortland (1996) and Zohar and Nemet (2002) revealed significant relationships between content knowledge and socioscientific argumentation, Kutluca's (2012) study did not suggest significant relationships. Similar to Kutluca's (2012) study, Soysal (2012) investigated the effects of content knowledge on PSTs' argumentation quality on genetically modified foods. Soysal (2012) also found that PSTs' content knowledge did not significantly affect their argumentation quality. Turan (2012) focused on PSTs' decision-making skills about SSI and concluded that PSTs did not use their scientific thinking skills in their decision making about SSI and their scientific thinking skills were not at the expected level.

Studies with Elementary Students

Goloğlu (2009) examined elementary school students' decision making skills about SSI. The findings suggested that nutrition education including SSI activities affected students' conceptual understanding and decision making positively. The other study conducted by Gülhan (2012) investigated the effects of the socioscientific argumentation method on 8th grade students' science literacy and other related variables. It was concluded that the socioscientific argumentation method improved these students' science literacy and decision-making skills.

Similar to previous studies, Tonus (2012) studied the effects of socioscientifc argumentation instruction on elementary school students' critical-thinking and decision-making skills. Tonus (2012) studied with two groups, one consisting of students having low socioeconomic status and another consisting of students having high socioeconomic status. After the instruction, the results showed that while there was no difference between these groups in terms of decision-making skills, there was a significant difference between the groups in terms of critical-thinking skills favoring students having high socioeconomic status.

Research on Socioscientific Issues in Turkey: Where are we?

In the literature, we observed that researchers studied not only global SSI but also local SSI (e.g., Evagorou, Jimenez-Aleixandre, & Osborne, 2012; Jorde & Mork, 2007; Kolstø, 2006; Patronis et al. 1999). For example, Kolstø (2006) studied the construction of electric plants and childhood leukemia in a local context. We suggest that researchers in Turkey can also study local SSI since these local SSI are mostly consistent with their own socio-cultural context, and these issues can improve students' interest and motivation. As an example, in the context of Turkey, earthquakes and urban transformation can be good examples of SSI since they include both social and scientific aspects in addition to the moral and economic dimensions.

When we examined SSI studies conducted in Turkey thus far, we determined that only 2 of the 24 studies used a qualitative approach as the main methodology to address the research questions. The rest of the studies mostly used a quantitative methodology to address their research questions. The international literature showed that the researchers used a balance of both quantitative and qualitative methodologies (see Sadler, 2004, 2009). If we want to understand not only the end-products but also the processes about SSI thinking and understanding in Turkey, we need many more studies which use the qualitative methodology.

Turkish SSI literature also showed that most of the studies (e.g., Çalık & Coll, 2012; Domaç, 2011; Gologlu, 2009; Gülhan, 2012; İşbilir, 2010; Kara, 2012; Kutluca, 2012; Topçu, 2010) focused on pre-service teachers' understanding or views about SSI. In addition to the studies conducted with pre-service teachers, we need a lot more research focusing on student or in-service teacher understanding and views about SSI. As a last suggestion, SSI studies should also focus on a variety of populations in addition to students and teachers because SSI are not only related to students and teachers but also to all people in society. There were few studies which included different groups such as college professors or adults in the international literature (see: Bell & Lederman, 2003; Tytler, Duggan, & Gott, 2001). Therefore, we need a lot more SSI research which includes a different variety of groups, especially in Turkey.

Discussion and Conclusion

The results of this critical review show that the number of studies focusing on SSI in the context of Turkey is increasing. It also shows that research is specifically focusing on university students' knowledge, risk/benefit perceptions, pre-service teacher' views, self-efficacy beliefs about teaching SSI, and their informal reasoning and argumentation. However, about half of these studies at the masters' level employed descriptive quantitative methods.

With the specific introduction of SSI in the science and technology curriculum by MONE (2013), several questions about curriculum, textbooks and SSI implementation in classrooms are awaiting answers. Teachers have an important role as to how SSI are handled in the classroom context (Sadler, 2009). However, the body of research suggests that the teaching of SSI beyond traditional boundaries is problematic (Hogan, 2002; Roth & Lee, 2004, Zeidler et al., 2009). Research conducted in the context of Turkey also indicate that pre-service teachers have concerns about teaching SSI (Kara, 2012); a low level of knowledge leads to reduced self-efficacy belief (Kılınç, 2012). Furthermore, research both in the national and international context shows that teachers do not have adequate knowledge level regarding SSI (Kılınç, Boyes, & Stanisstreet, 2012; Šorgo, Ambrožič-Dolinšek, Uşak, & Özel, 2011; Soysal, 2012; Sürmeli & Şahin, 2010, 2012). These results suggest that the teaching and learning of SSI need to be provided both in pre-service and in-service teacher education in Turkey. It seems like some initial attempts are beginning to appear in educational conferences as well as nationally and internationally funded projects focusing on SSI teaching and learning (e.g. PreSEES, 2013).

Both in the national and international context, teachers seem to have difficulty in finding appropriate curriculum material for teaching SSI, and prefer not to develop these materials themselves. According to Jenkins (1992) teachers who focused on teaching scientific principals and process skills see teaching the broader perspective of science as a burden. For example, Levinson & Turner (2001) reported that teachers would not argue for the inclusion of biomedical issues into the curriculum, while this is considered one of the potential SSI areas. Alaçam-Akşit (2011) reported that pre-service teachers see media as one of the important knowledge resources about SSI more than their degree programs. These findings urge science educators to consider many issues about teaching SSI both in pre-service and teacher education.

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(Footnotes)

1 Bu yüksek lisans tezinin bir bölümü Sönmez ve Kılınç'ın (2012) makalesi olarak basılmıştır.

2 Bu doktora tezinin bir bölümü Topçu, Yılmaz-Tuzun ve Sadler'in (2011) makalesinin bir kısmı olarak basılmıştır.

3 Part of the thesis was published in the article by Sönmez and Kılınç (2012).

4 Part of the PhD dissertation was published in the article by the Topçu, Yılmaz-Tuzun, and Sadler (2011).