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Prospective Elementary School Teachers' Views about Socioscientific Issues: A Concurrent Parallel Design Study

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Abstract

The purpose of this research is to examine the prospective elementary school teachers' perceptions on socioscientific issues. The research was conducted on prospective elementary school teachers studying at a university located in western Turkey. The researcher first taught the subjects of global warming and nuclear power plants from a perspective of socioscientific issues in the science and technology education course and then conducted the research. Concurrent parallel design, one of the mixed-method research approaches, was used to conduct the research. In this context, semi-structured interviews were conducted with eight teachers in the qualitative strand of the study to explore the phenomenon. The data obtained from the interviews were analyzed using thematic analysis. During the quantitative strand of the research, 113 prospective teachers were administered a questionnaire form. The results of the study revealed that none of the participating prospective teachers mentioned about the religious and cultural characteristics of socioscientific issues, and they need training about how to use socioscientific issues in teaching.

Keywords: Science Education, Scientific Literacy, Socioscientific Issues, Mixed Methods, Concurrent Parallel Design

Introduction

The main goal of science education is to enhance scientific literacy (American Association for the Advancement of Science [AAAS], 2009; Ministry of National Education [MoNE], 2013; National Research Council [NRC], 1996) and scholars argued that scientific literacy can be achieved by integrating socioscientific issues (SSI) into science education (Ekborg, Ottander, Silfver, & Simon, 2013; Kolstø, 2001; Sadler & Zeidler, 2005a, 2005b; Zeidler & Nichols, 2009).

SSI are contemporary controversial issues with no established consensus on, which arise from advances in science and technology and have individual, social, political, economic, ethical and moral aspects (Ozden, 2011). These issues can alternatively be defined as the issues which are complex, open-ended, have no definite solutions and

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emerge in the form of controversial dilemmas (Sadler, 2004), that people face in their daily lives (Kolstø, 2001), that focus on scientific content and the social dimension of the scientific content (Topcu, 2010). The definitions suggest that in an educational approach based on SSI, students are faced with issues incompatible with their own belief systems or containing different scientific, social, and moral perspectives (Zeidler, Sadler, Applebaum, & Callahan, 2009).

SSI are generally related with advances in biotechnology and environmental problems (Sadler & Zeidler, 2005a). For example, deforestation, genetically modified foods (Foong & Daniel, 2013), climate change (Morris, 2014), cloning, nuclear energy, depletion of the ozone layer, and epidemics can be specified as SSI (Pedretti, 2003). In addition, some controversial issues such as embryo selection, stem cell, tissue or organ transplantation between two distinct species are acknowledged as SSI (Levinson, 2006). These issues are employed by science educators as current and interesting contexts, as well as being considered as significant social problems (Topcu, Yilmaz-Tuzun, & Sadler, 2011). It can be asserted that with the introduction of 3rd-8th Science Teaching Curriculum (MoNE, 2013) in 2013, Turkey had an opportunity for employing SSI in teaching.

There are certain reasons for employing SSI in science education. First of all, SSI are a means of improving scientific literacy (Sadler, 2009). SSI involve political, personal, and moral issues, as well as scientific claims and arguments. However, for many SSI, basic scientific claims are controversial. Therefore, when making decisions about these issues individuals should consider two main aspects, one being political/ethical and the other scientific (Kolstø et al., 2006). For example, it may be political decision when it comes to permitting to trade genetically modified food. On the other hand, whether genetically modified foods are a threat to human health is a scientific question, which receive different scientific explanations. Allowing the students to evaluate and construct their thought on the scientific descriptions, views, and arguments brought about the issues can be an example to the development and utilization of scientific literacy skills.

Secondly, SSI help students understand the social, moral, political and economic effects of science (Dawson, 2001) by providing a context for a better understanding of both the epistemological beliefs and science (Zeidler, Herman, Ruzek, Linder, & Lin, 2013). Thus, it becomes easier for the students to understand the nature of science (Jones et al., 2011). Students will realize that they use personal beliefs and values as well as scientific knowledge, while they are interpreting and evaluating evidence related to SSI, and offering solutions to these problems. In a curriculum based on SSI, for the students to use scientific knowledge together with their personal beliefs may help them realize the procedures and processes of science. Thus, it becomes easier to teach the nature of science within the context of SSI.

Thirdly, SSI help enhancing the students' abilities to make decisions based on evidence, to make argumentation, and to debate (Ideland, Malmberg, & Winberg, 2011), thus improving their analytical thinking skills. Since SSI are complex, open-ended, controversial problems with no definite answers, the possible solutions to the emerging dilemmas can be discovered if only multiple perspectives are employed. On the other hand, when limited and controversial sources of information are taken into consideration, students and ordinary citizens can develop their own cognitive constructs and produce explanations in response to the controversial scientific problems if they can develop informal reasoning skills (Sadler, 2004).

Finally, SSI make contributions not only to students' cognitive development but also to their emotional and social development (Topcu, 2010; Topcu, Sadler, & Yilmaz-Tuzun, 2010). Science teaching based on SSI supports the character development (Zeidler et al.,

2009) and citizenship skills (Barrue & Albe, 2013; Lee et al., 2013) of individuals by focusing on the discourse and regarding the moral and ethical issues. Thus it is apparent that use of SSI in science education has four main goals: to improve scientific literacy, to provide an understanding about nature of science, to enhance higher order thinking skills by promoting cognitive development, and finally, to ensure emotional and social development. The potential of SSI to perform multiple goals simultaneously, to offer students interesting and authentic learning experiences has led an increasing interest among science educators into this subject and facilitated its inclusion in the curriculum.

The movement of SSI has emerged in the United States (Saunders & Rennie, 2013). However there have been an increasing interest at the international level and many research carried out. Among these researches, the effect of SSI on scientific literacy (Kolstø et al., 2006; Ritchie, Thomas, & Tones, 2011) and learning the nature of science (Albe, 2008, Eastwood et al., 2012; Khishfe 2012, 2014; Sadler, Chambers, & Zeidler, 2004) have become the two important research topics. Another important field of researches included the attempts to understand the relationship between SSI and cognitive skills. In this context, some commonly studied topics included argumentation in SSI (Dawson & Venville, 2013), the transfer of argumentation skills (Foong & Daniel, 2013), decision making (Greschner, Hasselhorn, & Bögeholz 2013; Zeidler et al., 2009), epistemological (Zeidler et al, 2013), moral (Sadler & Zeidler, 2004) and informal reasoning patterns (Topcu et. al, 2010; Topcu et al., 2011). Similarly, the importance of content knowledge in terms of informal reasoning and argumentation skills has been studied (Sadler & Donnelly, 2006; Sadler & Zeidler, 2005b). Fewer studies investigated the relationship between SSI and learning outcomes as another component of the cognitive skills. In this respect, researches have focused on the effect of SSI in facilitating learning (Rudsberg, Öhman, & Östman, 2013) and on the learning outcomes (Ottander & Ekborg, 2012).

Previous research investigated SSI relationship with affective variables, in addition to the cognitive ones. In this respect, researchers have investigated the impact of the SSI students interest in and attitudes towards science lessons (Albe, 2008; Ottander & Ekborg, 2012; Thomas, Ritchie, & Tones, 2011) and prospective teachers' perceived competencies on SSI (Kara, 2012; Kilinc et al. 2013; Lee, Abd-El Khalick, & Choi, 2006). In a research study, an attitude scale towards SSI was developed (Topcu, 2010). Other research studies focused on difficulties teachers faced in classroom discussions (Day & Bryce, 2011), teachers' views on SSI (Ekborg et al., 2013), the role of SSI in citizenship education (Barrue & Albe, 2013; Lee et al., 2013), how SSI are used in classes with students representing different socioeconomic status and ethnicities (Ideland et al., 2011). One study evaluated how SSI are handled in textbooks (Morris, 2014).

Researches in the literature can be grouped under two categories according to the use of SSI: using socioeconomic issues as the goal and using socioeconomic issues as an instrument (Topcu, Mugaloglu, & Guven, 2014). In a more detailed analysis, the focus of the studies on SSI can be categorized as (i) the nature of science and scientific literacy, (ii) argumentation, reasoning and decision-making processes, (iii) content knowledge, (iv) views and sense of efficacy in using SSI in teaching, (vi) interest in and attitudes towards in science lessons. In this contexts, data were obtained from teachers (Day & Bryce, 2011; Lee et al., 2006), prospective teachers (Kara, 2012; Topcu et al., 2010), secondary (Ideland et al., 2011; Khishfe, 2014) and high school (Eastwood et al., 2012; Thomas et al., 2011) students. However, there is no study which focuses mainly on elementary school teachers regarding the SSI. Nevertheless, Alacam-Aksit (2011) conducted a research to detect the prospective elementary school teachers' on teaching of SSI.

Many research studies about SSI have not been directly associated elementary school teachers or prospective elementary school teachers. This implies that while the rapidly growing literature on SSI puts forward new implications for science education, the roles and functions of elementary school teachers have not been discovered yet. Because of the reasons specified above, new researches should be conducted to determine and improve the views prospective elementary teachers who will be responsible for guiding the science lessons in the future. Determining the views of prospective elementary school teachers may help evaluating the problems and views to affect their instructional practices. Moreover, such an evaluation may contribute to take necessary measures in the relevant field and to promote the quality of teaching activities to be planned for the students of prospective elementary teachers in the future. Therefore, determining the prospective elementary school teachers' views on SSI, their perceptions about the characteristics of SSI, and their beliefs about their roles as teachers will form the basis for an effective science teaching. In this respect, the aim of the present research is to examine the perceptions prospective elementary school teachers on SSI. This research study seeks answers to the following questions:

- What are the perceptions of prospective elementary school teachers about SSI?
- What are the views of prospective elementary school teachers about the use of SSI in science teaching at elementary school?
- Do prospective elementary school teachers' views on the use of SSI in science education differ significantly by gender to academic success?

Method

Design

Present study was conducted based on mixed methods design (Tashakkori & Teddlie, 2010). Mixed methods research merges qualitative and quantitative data to answer the research question (Creswell, 2014). There are other terms used to refer to mixed methods such as integration, synthesis, qualitative and quantitative methods, multiple methods, and mixed methodology (Byrman, 2006; Tashakkori & Teddlie, 2010). In the present study, mixed methods was used to overcome the restrictions of using either of the qualitative or quantitative approaches alone, and to find a comprehensive answer to the research question.

More specifically, the convergent parallel design, one of the mixed methods (Creswell & Plano Clark, 2011) was used in the study. In this design, qualitative and quantitative data were collected in a parallel manner, but analyzed independently. Next, qualitative and quantitative results were mixed to make an overall interpretation about the research question (Creswell & Plano Clark, 2011; Creswell, 2014).

There are some reasons for using the convergent parallel design. First reason is the need for different but complementary data regarding the research question, which is believed to lead to obtain a more effective answer to the research question. Second reason is to overcome the limitations to emerge when qualitative and quantitative would be used alone. Third reason is that this method allows comparing the qualitative and quantitative data in order to increase the internal validity of the study. In this respect, thanks to the qualitative data participants were able to comment on and explain the research topic in a detailed manner with their own words, and quantitative data made it possible to understand the perceptions of a larger group on SSI in general.

In the present study, both qualitative and quantitative methods were given the equal priority (Creswell & Plano Clark, 2011). That is, qualitative and quantitative procedures of the study had equal responsibility in answering the research questions. The symbolic representation of the design is QUAL+QUAN (Morse, 1991), which is displayed in Figure 1:

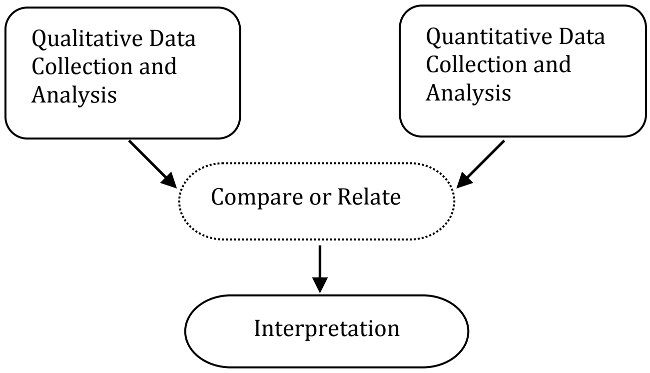

Figure 1. *Symbolic representation of research design* (Creswell, 2015).

Qualitative Strand

Context and Participants

Present research was conducted with the participation of prospective elementary school teachers studying at a State University in western Turkey. The researcher has taught Science and Technology Teaching course in the program mentioned above. SSI and their use in education was one of the topics involved in the course content. A two-week period was allocated for SSI in the Science and Technology Teaching course program. The researcher as the instructor discussed the topic of global warming during the first week and nuclear energy during the second week with the students. These rather current and interesting topics were selected because recently they have been discussed in the society broadly with their political, economic, ecological and scientific aspects. Participants were asked to find scientific articles offering different arguments about both topics, to read this article critically, and to use these articles while forming and defending their own ideas. Students participated into discussions directed by researcher after making these preparation before coming to the class. At the end of the second week of the discussions, researcher informed the participants that the topics discussed are named SSI in the relevant literature. Next, the participants were asked to reflect on the characteristics of SSI, the SSI that can be handled at elementary school level, the roles that teachers and students should have while addressing SSI based on the classroom discussions and to form their own opinions. At every stage of the research, the researcher refrained from disclosing his own ideas or giving information about SSI, but directed the participants to express their opinions based on political, social, economic, and moral aspects.

During the week after the classroom discussions were completed, the researcher announced the participants that he would like to conduct semi-structured interviews with to examine the educational characteristics of SSI, and he asked the volunteering participants to give feedback about their intent to take part in the study by sending an e-mail, visiting the researcher's office, or just calling. Since the research was conducted with the natural members of the researcher's class, convenience sampling method was used in the research (Yildirim & Simsek, 2013). After the announcement, 8 of the prospective teachers informed the researcher about their voluntary participation to the research either by visiting the researcher's office or sending a message via social network (Facebook) although it was not an announced way of feedback. Next, a timetable was arranged with the participants according to their convenient days and times, and semi-structured interviews were conducted according to this meeting schedule. Among the participants, five were women and three were men. In terms of their academic, while the 7 participants had average grade points of 3.00 or more, only one had an average grade below 2.99.

Data collection and analysis

The qualitative data of the study was collected through interviews (Spradley, 1979). Interviews are effective data collection tools enabling to obtain and record the individuals' or groups' views, feelings, ideas, values, attitudes and beliefs about their experiences and social worlds in in their own words (Saldaña, 2011). It is known that there are different approaches about classifying the interviews (Patton, 2001; ten Have, 2004; Spradley, 1979; Yildirim & Simsek, 2013). In the present study semi-structured interviews were used (Yildirim & Simsek, 2013). Open-ended questions are used in semi-structured. The main responsibility of the interviewer is to explore the participants' responses to open-ended questions and to build the research on the basis of their responses (Seidman, 2006).

The semi-structured interview form consisted of four open-ended questions. These questions are: 1) How do you describe in your own words the concept of SSI? 2) Can you give examples of SSI that can be used in science and technology courses? 3) What can be the contribution of involving SSI into science and technology course? 4) What should be the roles of teachers in teaching SSI? Interview questions were derived from notes the researcher took during class discussions and the relevant literature. All semi-structured interviews were conducted face to face with each participant individually.

Data were analyzed using thematic analysis (Gibson & Brown, 2009; Yildirim & Simsek, 2013). Thematic analysis requires the analysis of the data according to common features, relationships, and differences in the dataset (Gibson & Brown, 2009). Thematic analysis is a descriptive strategy which facilitates the search of patterns of experiences present in the qualitative dataset. Therefore, the outcome of the thematic analysis is a structure which enables the identification and integration of existing patterns (Ayres, 2008). In the thematic analysis, themes do not involve a process of simply counting the words (Firmin, 2008), but that of examining the structures both hidden and apparent in the data (Vaismoradi, Turunen, & Bondas, 2013).

The following sequential steps were followed during the thematic analysis: 1) identification of the data by the researcher, 2) the creation of basic codes, 3) establishment of leading themes, 4) revising themes 5) identifying and naming themes, and 6) writing the research report (Braun & Clarke, 2006). In this respect, clusters of related themes were examined within the data set and two major themes were produced as the end of the data analysis: "the nature of socioscientific issues" and "educational use of socioscientific issues".

Quantitative Strand

Samples

Sometimes mixed methods researchers work on completely different samples in qualitative or quantitative strands of their research. However, a good mixed methods research is carried out on different samples selected from within the same population at every stage. At this point, researchers should be careful not to involve the same individuals into both samples (Creswell, 2014). In this respect, no sampling strategy was used and all prospective teachers other than the ones participating in the qualitative strand of the study were invited to participate in the quantitative strand of the study. A total of 113 prospective teachers other than those participated in semi-structured interviews agreed to participate in the study. Demographics of prospective teachers participating in the quantitative strand are presented in Table 1.

Table 1. Demographics of the participants attending the quantitative strand

Variables	*f*	%
Gender		
Woman	68	60.2
Man	44	38.9
Missing data	1	.9
Grade average		
2.99 and below	68	60.2
Between 3.00-4.00	44	38.9
Missing data	1	.9
Total	**113**	**100**

Among the participants 60.2% were female and 38.9% were men. On the other hand, 60.2% of them had 2.99 or lower GPAs and 38.9% had a GPA between 3:00 and 4:00. One participant did not answer questions about gender and GPA.

Collection and analysis of data

Quantitative data were collected using "Socioscientific Issues in Science Course Questionnaire", which was developed by the researcher. To develop the questionnaire items, firs the literature was examined. In this context, an item pool was formed using the questionnaire forms used in Lee et al. (2006) and Kara (2012). Relevant items were evaluated by the researcher in terms of content and those items which are not compatible with the research questions, not clearly understood, not specific to the topic, and contain multiple statements, were discarded. The draft questionnaire form was consulted to an expert panel to check its content validity and necessary corrections were made in accordance with the feedback received. To test the intelligibility of the questionnaire form, a pilot study was conducted with 52 students in the Elementary Science Education Program and after necessary modifications were made questionnaire preparation process was finalized.

The questionnaire was used as a structured written interview form to obtain participants' views about SSI. In this respect, since it is not proper to refer to any internal reliability or construct validity to estimate a total score as in the scales (Erkus, 2011), no reliability coefficient estimation or factor analysis were done on the questionnaire items.

The questionnaire was composed of three parts. In the first part, there were two questions asking for the prospective teachers demographics. In the second section, there was a supplementary knowledge which describes the characteristics of SSI with examples. The third part consists of 13 items asking for prospective teachers' views about SSI. Prospective teachers were asked to select one of the responses including "strongly disagree," "disagree," "undecided", "agree" or "strongly agree". Participants completed the questionnaires during their regular classes.

The data obtained from the quantitative strand of the research was analyzed using frequency, percentage, and mean scores. Chi-squared test was used in order to test weather prospective teachers' views on SSI differ by gender and academic achievement scores (Buyukozturk, 2005; Tabachnick & Fidell, 2000).

Findings

Findings were presented below under two sections as required by the mixed methods design.

The findings of the qualitative strand of the research

The nature of socioscientific issues

The participants described the SSI as the current events which affect individuals, have no consensus on, include understanding the risks and probabilities, are structured in the form of open-ended dilemmas, necessitate moral and ethical choices to be made, have more than one alternative solutions (having no definite solution, however).

Sophia described SSI as issues, which emerge as a result of scientific developments and affect individuals in a society. Sophia puts her thought in more detailed way as follows: "SSI are the ones with scientific basis existing in a society. They are the issues directly or indirectly affect the society."

Jackson regards SSI as the issues with no consensus on. To him, the SSI are related with understanding certain risks and possibilities. He comments on the issue as: "SSI are the issues whose pros and cons have been discussed for some time, and hardly any conclusion was made upon". Emma also referred to the aspects of SSI in terms of understanding the risks and possibilities, stating that "SSI are the ones about which everybody has some knowledge, but no consensus has been established about the benefits and costs." Emma did not mention about the controversial nature of SSI in terms of understanding the risks and possibilities alone. In addition, it is remarkable that she put that individuals in the society are aware of these issues and are informed, through limited, about these issues. Olivia also stated supporting ideas. She stated that SSI are "the ones on which everyone have some idea, about which one can talk in a classroom or community. Generally it is a current issue". Olivia also mentioned that everybody knows about the SSI, as suggested in the previous thought. On the other hand, she also recognized the social impact of these problems. This is because SSI are not only a tool to be used in instructional educational environment, but they are also important in everyday social relations of individuals in a society. Another important emphasis was on the actuality of the SSI. Participants were observed to refer frequently to their in-class experiences while voicing their views. The fact that participants voice similar views may suggest that they gain similar learning outcomes from in-class practices.

Ava noticed that SSI involve certain uncertainties and thus they have no definite solutions. Similarly, Ava argued that SSI often arise in the form of media news, stating that "I believe that they are the issues that media publicizes to some extent and on which we cannot make to a definite conclusion." Similarly, Isabella mentioned that SSI emerge in the form of media news, stressing that individuals are informed about them via Internet and social networks.

Unlike other participants Jackson was no mention that requires ethical choices of SSI. To him, contemporary developments in science and technology are threatening the future of the humankind, because human life is entirely built on mobile phones, computers and other smart systems and they are likely to threaten the future of human existence. He explains that "Google has purchased a robot company... For example, some think that eventually the future will turn out to be a land of robots and robot fights. Above all, if you make robots become completely human-like, thinking and acting like humans, they could become a threat to the human race in the future." Therefore, he believes that integrating SSI into science lessons would enable students contemplate on the ethical consequences of the scientific and technological application.

Two of the participants, Sean and Connor, defined the SSI as scientific events. Sean stated that "... a socioscientific issue is a scientific event concerning normal people. Scientific event which interests people." Connor on the other hand explained a socioscientific issue as "a scientific event which affects our lives, our being, that is our social life, and the world universally". SSI are the dilemmas concerning economy, environment, politics, moral and ethical subjects, and bears in conflicts at least in one of these fields. As a matter of fact, while scientific developments emerge as the activities of scientists, SSI are the problems are outside the scope of the world of science and they have been debated for long and affecting the daily life of an ordinary individual. In this sense, it can be asserted that Sean and Connor fall into a misconception in defining SSI as "scientific events".

Educational use of socioscientific issues

Participants expressed their views about the benefits of using SSI in science teaching and teacher roles under the theme of educational use of SSI. Participants believed that the benefits of SSI are closely related with providing students with higher order thinking skills. In this respects, they stated that SSI can have students gain such higher order thinking skills as argumentation, opinion development, scientific process skills and creativity. Likewise, they thought that, though limited, integrating SSI into science teaching can help students think on their citizenship responsibilities.

Sean expresses his point about the positive contribution of use of SSI on students' argumentation ability as such: "For example, I think differently about nuclear energy. I believe they should be built. However, if one of my friends who opposes nuclear power plants can make a pretty good argumentation, I can be convinced (...) I may change my mind finding his arguments wise." To Sean, discussing the SSI in class necessitates the students to use information resources to create the necessary basis for their opinion. Thus, evidence-based discussions by the students becomes a means of analyzing different views, and evaluating and developing opinions. Similarly, Olivia associated the use of SSI in science lessons with the creation of argumentation and development of opinions. She believes that in order to engage in class discussions and create a foundation for the defended opinion, students would read scientific articles, and be able to disprove each other's thesis during the class discussions and sometimes the processes may end up with the development of the initial opinion, i.e. adoption of the opposing opinion. Olivia puts in her thoughts as follows:

"We read an article before coming to the class. I was indecisive about whether nuclear power plants should be founded or not, but after I read the article I dominantly got idea that they should be built. While listening to the opponents' ideas, you may learn something new or the opposite party can disprove your thesis (...) You can adopt opposite views. There may be such changes in your opinion."

Connor claimed that SSI cannot be taught directly saying "we are not going to tell these directly. We have to provide students with perspectives, scientific perspectives, about SSI. Hence, it can be asserted that Connor accepts SSI not as an educational goal, but as a context to be used to achieve a goal. Emma believes that SSI help students gain scientific thinking skills, explaining that "Scientific process skills can be improved, and children's thinking skills can be improved." Similarly, Sophia believes that SSI should be used to develop reasoning ability among students and to help them notice different viewpoints. Jackson and Sean highlighted that integrating SSI into lessons can work in maximizing the imagination and creativity of the students.

Ava believes that SSI may help the students contemplate on their individual responsibilities as good citizens. Ava pointed that SSI such as genetically modified foods, organ transplantation, global warming, nuclear power plants can be used in science education and these issues can lead the learners inquiry the answers of such questions as "What is my responsibility in this issue? What would be my responsibility? What can I do myself in this matter?"

Participants also stated that teachers should have certain roles in the course of using SSI in science education. According to the participants, teachers should have content knowledge, not impose their views on students, guide students, lead the discussions, select challenging problems for the students, get prepared before the lessons, ask intriguing and thought-provoking questions. So, according to the views of the participants, teachers should have content knowledge about SSI, as well as the pedagogical competence that accompanies this content knowledge. Emma points out that a teacher needs to have content knowledge, if she is to integrate SSI into science lessons. To her, a teacher's role as a guide requires making necessary explanations, offering resources for the students to acquire knowledge and being impartiality. She expresses her views on this issue as follows:

"I think teachers should play the role of guide, just like you. She should not disclose her opinion first, but listen to students. (...) The teacher should give information on some issues as you do. (...) I would give resources about the topics in advance, and ask students to explore the topic in advance. "

Sean also believes teachers should tell their views while discussing the socioscientific discussing issues. He justifies himself stating that "Because every student imitate their teachers." Also Sean emphasized the importance of traditional role of teachers as "the transferor of knowledge". However, he stressed the importance of the information given to the students should not be in the form of a detailed presentation, but the students should discover the details. Following is Sean's other views on the use of SSI:

"While selecting the topics, everything should be considering including students' age, level and context. If we bring in a big socioscientific problem for student discussion, let alone improving students' problem solving abilities, they cannot even speak as they are shocked. This is because they cannot find any views."

Olivia emphasizes the need that teachers should select topics suitable for learners' level, while Isabella mentioned that the language used should be appropriate for student's level. While Ava points out that teachers should arrange their questions very well before the lesson, Sophia associated teacher roles with the characteristics of SSI, explaining that "Since these subjects are open-ended, teachers should set a framework. Teachers should guide students well. Teachers should be guiding their students, but should not express a definite opinion. Students should ask the students to freely defend and express their opinions."

As it is understood, almost all of the participants emphasized the guidance role of the teachers, and stated that especially in classes with young students, teachers have the responsibilities to access to resources, to lead to class discussions, to redirect the discussion when students deviate from the subject and to make theoretical explanations to some extent.

The findings relating to the quantitative strand of the research

Participants views about the use of socioscientific issue in primary science education

Participants commented on the use of SSI in primary science education by responding to the questionnaire items. The participants' responses for each item are presented in Table 3.

Table 3. *Participants' views on the characteristics of SSI*

Item		Strongly Disagree	Disagree	Indecisive	Agree	Strongly Agree	*M*
1) Successful students would be more interested in SSI in science lessons.	*f*	13	39	16	40	3	2.82
	%	11.7	35.1	14.4	36.0	2.7	
2) Elementary students are not mature enough to be interested in SSI.	*f*	6	39	31	28	8	2.93
	%	5.4	34.8	27.7	25.0	7.1	
3) Science lessons are more suitable for SSI than other lessons.	*f*	4	9	19	58	19	3.72
	%	3.7	8.3	17.4	53.2	17.4	
4) Integrating SSI into science lessons is not compatible with the essence of science course.	*f*	28	63	11	6	3	2.03
	%	25.2	56.8	9.9	5.4	2.7	
5) Teachers are not competent in integrating SSI in science lessons.	*f*	2	18	38	46	8	3.35
	%	1.8	16.1	33.9	41.1	7.1	
6) It is hard for primary students to understand SSI.	*f*	4	30	17	37	3	3.05
	%	4.4	33.0	18.7	40.7	3.3	
7) Integrating SSI would increase the primary students' interest in science lessons.	*f*	2	11	19	63	18	3.74
	%	1.8	9.7	16.8	55.8	15.9	
8) Teachers can answer easily the student questions about, SSI.	*f*	2	23	36	45	6	3.26
	%	1.8	20.5	32.1	40.2	5.4	
9) Prospective teachers should be trained about SSI.	*f*	4	3	3	54	43	4.15
	%	3.6	2.7	7.1	48.2	38.4	
10) Integrating SSI into science education would increase scientific literacy.	*f*	6	9	9	56	32	3.88
	%	5.4	8.0	8.0	50	28.6	
11) Integrating SSI into science education means simplifying science education.	*f*	18	37	28	25	5	2.66
	%	15.9	32.7	24.8	22.1	4.4	
12) I think primary school students can learn science better by discussing SSI.	*f*	3	10	14	66	19	3.78
	%	2.7	8.9	12.5	58.9	17.0	
13) SSI should definitely be involved in science lessons.	*f*	3	5	13	55	37	4.04
	%	2.7	4.4	11.5	48.7	32.7	

An analysis of the Table 3 reveals prospective teachers have positive views on the use of SSI in science education and tend to strongly agree to the relevant items. The item that participants agreed the most was "Prospective teachers should be trained about SSI" (*M* = 4.15). Accordingly, it can be understood that prospective teachers have highly in need of being trained about SSI. Despite this educational need, prospective teachers seem to believe in the importance of integrating SSI in science lessons. This judgement is supported by the following findings:

"SSI should definitely be involved in science lessons." (*M* = 4:04), "Integrating SSI into science education would increase scientific literacy." (*M* = 3.88), "I think primary school students can learn science better by discussing SSI." (*M* = 3.78) and "Integrating SSI would increase the primary students' interest in science lessons." (*M*=3.74). According to these findings, it can be stated that prospective teachers think that integrating SSI into science education would increase students' interest in learning science, facilitate learning science, and improve scientific literacy.

On the contrary, it was seen that prospective teachers agreed less with the negative statement about the integration of SSI into science education. Among them the item participants agreed relatively the least was “Integrating SSI into science lessons is not compatible with the essence of science course.” (M = 2.03). In other words, it can be said that participants do not find it incompatible with the nature of science education to integrate SSI into science education. Another item that prospective teachers agreed rather at a low level was "Integrating SSI into science education means simplifying science education." (M = 2.66). However, it is a remarkable finding that while participants generally agreed at a low level to this item, about one third of them agreed that “Integrating SSI into science education simplifies science education” and a good number of them (24.8%) were indecisive about this issue. Other items which the participants had rather low levels of agreement included "Successful students would be more interested in SSI in science lessons.” (M = 2.82), "Elementary students are not mature enough to be interested in SSI." (M = 2.93) and "It is hard for primary students to understand SSI." (3.05), respectively.

Prospective teachers’ views about SSI according to their gender and academic achievement

Chi-square test was used to find whether prospective teachers’ views on the SSI differ significantly according to their gender and academic success. However, since in the first attempt the number of cells which had expected count less than five exceeded 20% of total number of cells, some categories were merged and the chi-square analysis was repeated (Buyukozturk, 2005). For this purpose "strongly agree" and "agree" categories were merged under "agree" category, and "strongly disagree" and "disagree" categories were merged under "disagree" category.

As a result of the chi-square analysis for gender variable, a significant difference was found only for the item “Elementary students are not mature enough to be interested in SSI” [$X^2(2) = 6.51$, $p = .038$]. The analysis revealed that 25.6% of the male participants and 50% of the female participants disagreed with this item. Thus, it can be said that female prospective teachers believe that elementary students are mature enough to be interested in SSI more that male prospective teachers do.

Chi-square test results revealed significant differences only for three items in terms of academic achievement. The first item with significant difference was “Successful students would be more interested in SSI in science lessons.” [$X^2(2) = 8.93$, $p = .01$]. The analysis proved that 41.8% of the prospective teachers who had 2.99 and lower average scores and 32.6% of the prospective teachers who had 3 and above average scores stated that successful students would be more interested in SSI in science lessons. This finding suggests that participants with 2.99 and below average scores believe more strongly that successful students would be more interested in SSI in science lessons. The second item with significant difference was “Integrating SSI would increase the primary students’ interest in science lessons.” [$X^2(2) = 6.42$, $p = .04$]. The analysis proved that 6.8% of the prospective teachers who had 2.99 and lower average scores and 23.5% of the prospective teachers who had 3 and above average scores were indecisive about statement that integrating SSI would increase the primary students’ interest in science lessons. This finding suggests that participants with 2.99 and below average scores are more decisive about the statement that integrating SSI would increase the primary students’ interest in science lessons.

The last item with significant difference was “Teachers can answer easily the student questions about, SSI.” [$X^2(2) = 6.37$, $p = .04$]. The analysis proved that 51.5% of the prospective teachers who had 2.99 and lower average scores and 34.9% of the prospective teachers who had 3 and above average scores agreed that teachers can answer easily the student questions about, SSI. This finding suggests that compared to participants with 2.99

and below average scores, those prospective teachers who had 3 and above average scores agreed more strongly that teachers can answer easily the student questions about, SSI.

Results, Conclusions and Recommendations

It is of great importance for the student to learn to make decisions based on the information in SSI to achieve the goal of scientific literacy (Sadler, 2004). It is the responsibility of the teachers to teach scientific literacy to students in a broader sense, and to teach how to think through SSI in a narrower sense. In this respect, the present study aimed to explore the views of prospective elementary school teachers' about SSI. The results obtained from this study are valuable in producing principles in terms of teaching SSI at elementary school.

It was concluded in this study that prospective teachers described the SSI as current events which affect individuals, have no consensus on, include understanding the risks and probabilities, are structured in the form of open-ended dilemmas, necessitate moral and ethical choices to be made, have more than one alternative solutions, but having no definite solutions. These results have both similarities and differences with the findings of previous research in the literature. For example, the participants in Ekborg et al. (2013)'s study also assessed SSI as a current and interesting context. However, unlike their research findings, present study found that participants mentioned that SSI have scientific basis, they require an understanding of the risks and possibilities, and they incorporate ethical dilemmas, though to a limited extent. SSI arise on the basis of developments in science and technology, but their solutions require not only thinking scientifically but also considering the ethical and moral values. Therefore, when faced with any SSI, it is useful for the students or regular citizens to consider the ethical problem or problems inherent in the structure of the relevant socioscientific issue. This is because the active citizens of the future are expected to interpret the possible outcomes of the relevant SSI based on certain ethical and moral principles.

In the qualitative strand of the study, only one participant mentioned about the ethical characteristics of the SSI. Accordingly, it can be asserted that the participants are not aware of the moral and ethical values to be considered during the decision making process concerning the SSI. However, the opportunity to make choices in terms of ethical and moral issues concerning the SSI have been studied directly or indirectly in many research studies (Barrett & Nieswandt, 2010; Fleming, 1986; Sadler & Zeidler, 2004; Topcu et al. 2011). For example, Sadler & Zeidler (2004) examined how prospective teachers interpret SSI within the context of genetic engineering and found out that moral factors have important impact in decision-making processes regarding genetic engineering. Topcu et al. (2011) found out that moral and ethical considerations were one of the components which affect the informal reasoning processes. Fleming (1986) also concluded that moral issues are important in students' decision-making processes. The literature reveals that students' decision-making process concerning the SSI is a highly complex situation. Students' decision-making process cannot be explained by scientific knowledge alone. It should be noted that personal experiences, values, social and epistemological issues are also important beside scientific knowledge.

It was also found that belief systems or religious properties, which are important agents of reasoning processes regarding SSI has not been mentioned at all. However, previous research findings suggest that individuals' characteristics derived from their belief systems are effective on their way of thinking about their SSI (Sadler & Donnelly, 2006; Topcu et al., 2011; Zeidler et al, 2013). Sadler and Donnelly (2006) argue that rating ethical judgements regarding the SSI are affected from individuals' religious point of view. In the relevant research, half of the participants stated that religious belief is an important factor. Zeidler et al. (2013) posits that throughout the history belief system have always been effective in peoples' discourses and reasoning about the SSI. This is because theological overtones do seem to be driven by the belief that humans are fulfilling a divine plan that implicitly removes one from the tacitly taking responsibility for a given decision. At this point arises the influence of beliefs in reasoning process about SSI. In the judgment process based on beliefs, individuals tend to merge religious beliefs with scientific data or explanations. People certainly are affected by the belief systems which are the product of culture and society. These systems affect individuals' reasoning and decision-making processes while forming their judgements of what is right, wrong, good and evil. In this context, what matters is not to evaluate SSI with the characteristics of moral, ethical, and belief systems alone, but to do so considering scientific, economic and political components.

The present study also found that socioscientific events are referred to as "scientific events". SSI are the dilemmas concerning economy, environment, politics, moral and ethical subjects, and bears in conflicts at least in one of these fields. As a matter of fact, while scientific developments emerge as the activities of scientists, SSI are the problems are outside the scope of the world of science and they have been debated for long and affecting the daily life of an ordinary individual. In this sense, it can be asserted that some of the participants' fall into the misconception in defining SSI as "scientific events". As specified by Eastwood et al. (2012) for a problem to be named socioscientific, it is content must be based on scientific development, but it must also be meaningful socially.

Both qualitative and quantitative strands of the research revealed that participants believe SSI help primary school students gain higher order thinking skills. In this context, it was understood that participants believe science education involving SSI can have students gain such higher order thinking skills as argumentation, opinion development, scientific process skills and creativity. While this finding overlaps with some previous research findings in the literature (Dawson & Venville, 2013; Dolan, Nichols & Zeidler, 2009; Gresch et al., 2013; Khishfe, 2014), it also contrasts with some others (Foong & Daniel, 2013). For example, Dawson and Venville (2013) found that using SSI improved the argumentation and informal reasoning skills of the students in the experimental group. Similarly Gresch et al. (2013) have also found that SSI have a positive impact on students' decision-making skills. However, Foong and Daniel (2013) found that in their research that using SSI in certain instructional methods caused some progress in the argumentation skills of some students, but not on some others.

It was determined in the present study that instruction based on SSI can improve the citizenship competencies of the students. There are similar findings in the literature. For example, Lee et al. (2013) investigated the impact of instruction based on SSI on the development of favorable characters and values among students as global citizens. The research results indicated that students have developed sensitivity concerning the moral and ethical aspects of scientific and technological developments. The same study also revealed that students developed compassion for the students who are deprived of the benefits of advanced technologies or who suffered the adverse effects those technologies. Also, it was understood that students promised to act more responsively in the future regarding the solution of SSI in the field of genetics. In another study, Lee et al. (2006) found that education based on SSI help the students gain insights about the positive and negative aspects of science as citizens and develop a deep and unbiased understanding of science among students.

It was found that while the using the SSI in science education, teachers "should not impose their views on students, guide students, lead the discussions, select challenging problems for the students, get prepared before the lessons, and ask intriguing and thought-provoking questions". In a research conducted by Van Rooy (1993) it was also reported that teachers should have similar roles. Van Rooy (1993) found that while using the SSI in their classes, teachers play the roles of helping, supporting, facilitating, impartiality, being devil's advocate, and counselling. Zeidler and Nichols (2009) argues that it is important to encourage students to think about alternative evidences. Likewise, it is important for teachers to ask meaningful questions during class discussions and manage class discussions, thus they need to use the research and current information about the SSI discussed. Ekborg et al. (2013) found that science teachers encouraged students to ask questions and answer to these questions, as well, arrange class debates, and perform web quests. Foong and Daniel (2013) indicated that teachers played the facilitator role instead of the traditional role of transferor or knowledge. Throughout the study teachers refrained from affecting their students' decisions, thus they neither supported nor rejected their decisions.

The results obtained in the present study, as well as the previous research findings suggest that teachers should play the following roles regarding the use of SSI in general: firstly, after the teacher announces the socioscientific issue to be handled in the lesson, she should ensure that students are engaging in reading or inquiring about the relevant issue. In the second stage, teacher should check whether the students have understood the socioscientific issue and answer possible questions from the students. If students need and demand, teacher can give students some information in an objective manner. In this process, teacher's objective attitudes is very important in order not to affect students' assertions. After fulfilling these roles described, teacher should ask the students to express their viewpoints about the SSI justifying their assertions and supporting arguments. At the final stage, after listening to the explanations of each of the volunteering students, teacher should ask other students or the student who explained his/her view earlier to express opposite ideas which would disprove the initial views of their own or friends again with supportive ideas or arguments. On the condition that instruction is conducted in accordance with these steps, a teacher can improve the thinking skills of students and have the students discover scientific, political, personal, social, economic, religious, moral and ethical characteristics inherent in the SSI.

It was found in the present study that prospective teachers believed that SSI would increase the interests of students in science classes. This result is in agreement with other research findings in the literature (Anagun & Ozden, 2010; Ekborg et al., 2013; Kara, 2012; Lee et al., 2006; Ottander & Ekborg, 2012). The key for the students to understand science courses effectively and bear more responsibility in their lessons is their interest into the science. Therefore current and dynamic topics like SSI can be used as an instrument to increase the students' interest into the content of the course by making it easier for the students easier to establish a link between the real-life and the lessons

Like many studies in the relevant literature (Anagun & Ozden, 2010; Ekborg et al., 2013; Kara, 2012; Lee et al., 2006), the present study showed, too, that prospective teachers have training needs regarding SSI. However, the dimensions of these training need are not known well. In general, competencies of teaching profession include learning and teaching process, monitoring and assessing student learning, school-family and social relationships, curriculum and content knowledge. It is important to determine in which field(s) the prospective elementary school teachers have training needs. On the other hand, there are research findings indicating that prospective teachers have positive perceptions of competency. For example Kilinc et al. (2013) found that prospective science teachers found themselves efficient to teach SSI. Researchers also detected that underlying reasons for the strong content knowledge of the prospective teachers include their undergraduate courses, informal environment, and participants' personal interest in food technology. While content knowledge is undoubtedly important for effective teaching, it is not possible to acknowledge it as the only and most important condition due to some limitations. For an effective teaching one should have curriculum knowledge, competence in teaching methods and techniques, good command on the assumptions of development and learning psychology, as well as know how to measure and evaluate. However, the importance of the content knowledge cannot be denied. As a matter of fact, Sadler & Zeidler (2005b) also revealed that individuals with rich content knowledge face fewer problems during informal reasoning compared to those with poor content knowledge. It can be claimed that the most important component affecting the individuals' perceptions of their competencies is content knowledge. The participants of the present research comprise prospective elementary school teachers. It is possible that since prospective elementary school teachers do not acquire in-depth knowledge about a particular discipline, lack of content knowledge may have a negative effect on their perceptions of competence.

Participants believe that elementary school students are mature enough to understand SSI. There are example researches in the literature proving that SSI can be used with younger age groups (Dolan et al., 2009; Pedretti, 1999; Ritchie et al., 2011; Rose & Barton, 2012). For example, Dolan et al. (2009) presented some sample activities in which SSI can be used with the fifth grade students and concluded that SSI improve learners' scientific literacy. Ritchie et al. (2011) found that in the science lessons where the SSI were used, students aged eleven showed significant improvement in terms of scientific content, with increased levels of interest and self-efficacy regarding the science lesson. In another study Pedretti (1999) revealed the fifth and sixth grade students can improve their critical thinking and decision-making skills if faced with SSI.

Unlike the research findings above, some research (Ekborg et al., 2013; Lee et al., 2006; Ozden, 2011) found that participants, though a few, consider the immaturity of the students as an obstacle for the use of SSI. For example Ekborg et al. (2013) reported that some teachers believe that it is difficult for students aged 13-16 to work on SSI. According to the teachers, students from this age range have difficulty in focusing on specific questions and understanding the respective tasks. Similarly, Ozden (2011) reported that one participant of his research believed elementary school students would have difficulty in understanding the SSI. At this point, what matters is to decide how SSI can be used so as to contribute to the developmental features of the students at each class level, but not whether SSI can be used with certain age groups or not. Teachers are responsible to design activities in which students will enjoy learning, discussing, and involving into the SSI, considering the characteristics of the age group.

It was also found that participants in the present study believed that integrating SSI into science education would improve the scientific literacy of the students. There is evidence in the literature suggesting that using SSI in science education improve the learners' scientific literacy. For example, Ritchie et al. (2011) reported improved levels of scientific literacy on the part of learners who participated into scientific writing activities where SSI were used. It is important to use SSI in science lessons as an instrument to achieve the goal of scientific literacy. Therefore, while the information and resources to be used by the teachers are important, what matters more is to provide prospective teachers with an understanding of how to teach scientific literacy using the SSI and to develop teaching skills through example practices. Moreover, science curriculum should include the reflections of the features of SSI for scientific literacy.

In the study, it was found that prospective teachers with low academic achievement believed successful students would be interested in the SSI more. This result is very important. As discussed earlier, learners should have adequate level of knowledge in order to make reasoning against SSI. Prospective teachers with low academic achievement might have remembered the problems they faced during the sessions where SSI were discussed, and reflected that rather successful students would attend the discussion about SSI. On the other hand, SSI does not address to a particular group of students. Unlike the findings of the present study, Lee et al. (2006) found that teachers believed that not only the successful students, but all students would benefit from the SSI. It was found that male and female participants' views differed significantly only for one item. Accordingly, female prospective teachers believed more strongly than the male ones that elementary students are mature enough to be interested in SSI. The absence of any significant differences for other items is in agreement with the research findings in Kara (2012).

Present research has some limitations. First, the research is limited with the views and experiences of the prospective elementary school teachers studying at a university. Thus, this limitation should be considered while making generalizations. Also in the future, a qualitative research can be done in order to understand how (prospective) elementary school teachers integrate SSI in to their learning-teaching process; and a quantitative research can be done to determine (prospective) elementary school teachers' senses of self-efficacy in teaching SSI. Similarly, future researches can be done to explore prospective elementary school teachers' epistemological patterns about SSI.

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