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PRESERVICE SCIENCE TEACHERS' VIEWS TOWARDS SOCIOSCIENTIFIC ISSUES AND SOCIOSCIENTIFIC ISSUE-BASED INSTRUCTION

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LIST OF ABBREVIATIONS

GM	Gene Modification
GMOs	Genetically Modified Organisms
NOS	Nature of Science
PSTs	Preservice Science Teachers
SL	Scientific Literacy
SSI	Socioscientific Issues
STS	Science-Technology-Society
STSE	Science-Technology-Society-Environment

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ABSTRACT

PRESERVICE SCIENCE TEACHERS' VIEWS TOWARDS SOCIOSCIENTIFIC ISSUES AND SOCIOSCIENTIFIC ISSUE-BASED INSTRUCTION

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MSc. Thesis

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The aim of the present study is to explore pre-service science teachers' (PSTs) views towards socio-scientific issues (SSI) and SSI-based instruction. In the present study, the researcher, first, examined PSTs' views towards SSI and, second, their views towards SSI-based instruction.

Thirty PSTs in total from two state universities in Istanbul, Turkey voluntarily participated in the study. The researcher included both 3rd and 4th grade students as participants. All PSTs answered an interview instrument which consists of two different parts and 11 semi-structured interview questions. The researcher transcribed all the audio recording data into written form. To analyze the data, content analysis technique was used by the researcher of the present study.

The researcher investigated based on the analysis that two third of the participants were aware of SSI and others were not. PSTs who were aware of SSI before the present study also aware of National Science Education curricula and the place of SSI in them. On the other hand, it was found that there are still some PSTs who did not examine the curricula and the place of SSI within those curricula. The researcher found PSTs who confronted with SSI before the present study conceptualized SSI and provided examples for SSI more satisfactorily or partial satisfactory than other PSTs who did not confront with SSI. PSTs generally pointed out that SSI are real life issues which have social and scientific dimensions and those issues are ill-structured and up to date. In addition, PSTs generally pointed out environmental and biotechnological topics as examples of SSI.

In the present study, the researcher also aimed to investigate the views of PSTs towards SSI-based instruction and students' roles, teachers' roles, and other stakeholders' roles for SSI-based instruction. PSTs provided different instructional models by which they

can deal with SSI in science lessons and which are generally guided by constructivism. In addition to that PSTs noticed different facilitating factors such as increase classroom communication, and learning rate; and impeding factors such as requirement of huge amount of time, cost, and preparation for SSI-based instruction. About teachers' roles, PSTs emphasized that teachers should have guidance role and satisfactory classroom management skills; should be impartial during discussions and knowledgeable about issues; and, should present the lesson after good preparation. PSTs mostly emphasized active participation during discussions and coming class after good preparation as students' roles. Being respectful towards each other was also shown as a students' role. Providing flexible curricula, opportunities like time, materials, class, and also informing society about SSI were pointed out as other stakeholders' roles by PSTs.

In the present study, lastly, the researcher aimed to reveal PSTs' self-efficacy beliefs towards SSI and investigated that PSTs do not have high self-efficacy beliefs towards integrating SSI to their future science classes. Necessity of experience, practice, content knowledge, research and etc. were emphasized as the basic reasons for low teacher self-efficacy beliefs by PSTs.

Key words: Socioscientific issues, socioscientific-issue based instruction, pre-service science teachers, views

ÖZET

FEN BİLGİSİ ÖĞRETMEN ADAYLARININ SOSYOBİLİMSEL KONULARA VE SOSYOBİLİMSEL KONU TEMELLİ ÖĞRETİME YÖNELİK GÖRÜŞLERİ

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Bu çalışmanın amacı fen bilgisi öğretmen adaylarının sosyobilimsel konulara (SBK) ve SBK'nın öğretimine yönelik görüşlerini incelemektir. Sunulan çalışmada öncelikli olarak fen bilgisi öğretmen adaylarının sosyobilimsel konulara yönelik görüşleri; sonrasında ise onların sosyobilimsel konu temelli öğretime yönelik görüşleri incelenmiştir.

İstanbul'da bulunan iki devlet üniversitesinden toplam 30 fen bilgisi öğretmen adayı gönüllü olarak çalışmaya katılmıştır. Araştırmacı 3. ve 4. sınıf fen bilgisi öğretmen adaylarını çalışmaya katılımcı olarak dâhil etmiştir. Çalışmaya katılan tüm fen bilgisi öğretmen adayları, iki bölüm ve 11 yarı yapılandırılmış soru içeren bir görüşme formunu cevaplamıştır. Araştırmacı bütün ses kayıt verilerinin yazılı suretini çıkarmıştır. Verilerin analizi için, sunulan çalışmada, araştırmacı tarafından içerik analizi tekniği kullanılmıştır.

Analizler doğrultusunda araştırmacı katılımcıların üçte ikisinin diğer katılımcıların aksine sosyobilimsel konular ile daha önceden karşılaşmış olduklarını keşfetmiştir. Sosyobilimsel konularla daha önce karşılan fen bilgisi öğretmen adaylarının ayrıca ulusal fen bilgisi programları ve sosyobilimsel konuların bu programlarda ki yerleri hakkında farkındalıkları tespit edilmiştir. Bunun yanı sıra, fen bilgisi programlarını incelemeyen ve sosyobilimsel konuların bu programların içerisinde ki yeri hakkında farkındalıkları olmayan öğretmen adayları da mevcuttur. Araştırmacı sunulan çalışma öncesinde sosyobilimsel konular hakkında bilgi sahibi olan adayların, sosyobilimsel konular hakkında bilgi sahibi olmayan adaylara oranla, sosyobilimsel konuların tanımını ve konu hakkında verilen örnekleri daha başarılı bir şekilde sunduklarını

bulmuştur. Adaylar sosyobilimsel konuları genellikle sosyal ve bilimsel boyutu olan, kesin bir cevabı olmayan, güncel, günlük hayatla ilişkili konular olarak tanımlamışlardır. Adaylar genel olarak, sosyobilimsel konulara çevre ve biyo-teknoloji konularından örnekler sunmuşlardır.

Sunulan çalışmada, araştırmacı ayrıca, fen bilgisi öğretmen adaylarının sosyobilimsel konu temelli öğretime ve sosyobilimsel konu temelli öğretim için gerekli öğretmen, öğrenci ve diğer paydaşların rollerine yönelik görüşmelerini keşfetmeyi amaçlamıştır. Fen bilgisi öğretmen adayları, yapılandırmacı yaklaşımı temel alan, sosyobilimsel konuların derslere entegresi için çeşitli öğretim modelleri sunmuşlardır. Buna ek olarak, adaylar sosyobilimsel konu temelli öğretim için olası zorlaştırıcı örneğin daha fazla zaman, maddiyat, hazırlık vb. gerektirmesi ve kolaylaştırıcı örneğin artan sınıf içi diyalog, öğrenme vb. faktörleri belirtmişlerdir. Öğretmen rolleri hakkında adaylar, öğretmenlerin rehber olmaları ve iyi sınıf yönetimi yeteneğine sahip olmaları; argümantasyon süresince tarafsız ve sunulan konular hakkında bilgili olmaları ve dersleri iyi bir hazırlık sürecinden sonra sunmaları gerekliliğini sunmuşlardır. Öğretmen adayları, argümantasyon sürecine aktif katılım göstermeyi ve derslere iyi bir hazırlık sonrası katılımı öğrenci rolleri olarak belirtmişlerdir. Ayrıca, argümantasyon süresince sınıf üyelerinin birbirlerine karşı saygılı olmaları gerekliliği de bir öğrenci rolü olarak belirtilmiştir. Diğer paydaşların rolleri olarak; esnek bir müfredat sunma; zaman, materyal, sınıf ve benzeri imkânlar sunma; toplumu sosyobilimsel konular hakkında bilgilendirme öğretmen adayları tarafından belirtilmiştir.

Sunulan çalışmada, son olarak, araştırmacı fen bilgisi öğretmen adaylarının sosyobilimsel konulara karşı olan öz-yeterlilik inancını ortaya çıkarmayı amaçlamış ve adayların gelecek fen bilimleri derslerine sosyobilimsel konuları entegre etmelerine yönelik öz-yeterlilik inançlarının düşük olduğunu bulmuştur. Deneyim ihtiyacı, pratik, içerik bilgisi, araştırma ve benzeri nedenler düşük öz-yeterlilik inancının temel sebepleri olarak adaylar tarafından vurgulanmıştır.

Anahtar Kelimeler: Sosyobilimsel konular, sosyobilimsel konu temelli öğretim, fen bilgisi öğretmen adayları, görüş

CHAPTER 1

INTRODUCTION

1.1 Literature Review

In today's world for developed and developing countries, science and science related areas (e.g. technology) are highly important in order to maintain and further the development in the areas such as science, health, industry more and more. Under this scope, most of the countries such as Turkey, Australia, and Sweden [1], [2] revised their science education programs for better improving the science education in accordance with the new trends for instance socio-scientific issues (SSI) and science-technology-engineering and mathematics (STEM) in science education because of the fact that science education is the first step for science and science related areas. In Turkey, science education program [2] has been revised by following such new research, scope shifts and developments. The main aim of the changes in science programs and the residual number of scientific studies can be perceived as to reach effective scientific literacy, in other way to increase the scientific literacy level of the society.

At that point, it is important to examine what scientific literacy is. In National Science Education Standards [3], scientific literacy has been defined and explained as follows:

"Scientific literacy means that a person can ask, find, or determine answers to questions derived from curiosity about everyday experiences. It means that a person has the ability to describe, explain and predict natural phenomena. Scientific literacy entails being able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusion… (p.22) [3]"

By examining the previous definition and explanation about scientific literacy provided by National Science Education Standard [3], some inferences can be made. First, new inventions and discoveries which are originated by curiosity can be found out by any member of the society by using his-her scientific knowledge. By wondering, asking

questions and searching for answers to corresponding questions about an issue or towards making the life easier to live, some attempts can be made by scientifically literate persons. Second, due to the fact that as a gain of having scientific literacy, people who are scientifically literate can make sense of the events by asking questions and wondering in their surroundings and by using their scientific knowledge, they could interpret the events. For example, a member of society can show his-her willingness towards usage of antibiotics by conceiving the possible consequences of using them. Additionally, he or she can use his-her previous physics and chemistry knowledge while deciding about construction of a nuclear power plant by examining the possible consequences of such a construction on environment physically and chemically. Deciding on societal, economic and political consequences by examining risks and benefits of constructing a nuclear power plant, a member of society could express his-her opinion towards building such a structure. When considering these perspectives, it can be interpreted that to increase scientific literacy is highly significant. Therefore, in order to reach this aim, different studies towards how to reach scientific literacy are being made in science education. One of the studies which are very riveting and up to date is the studies made on SSI. In the following paragraphs, first, what SSI is; then, how SSI revealed and are developing; and lastly, what SSI can contribute a member of a society and his or her scientific literacy.

SSI are open-ended, complicated, argumentative and ill structured issues which have scientific and social dimensions at the same time [4], [5], [6], [7], [8], [9], [10]. SSI can be handled and interpreted differently by the different parts of the society. For instance, nuclear energy, global warming, genetically modified foods (GMOs), take home foods, and embryonic stem cell can be given as examples of SSI (e.g. [11], [12], [13], [14]). As Eastwood et al. [15] point out that there are some main criteria to introduce a topic as SSI. They are: The issue must be related with science, firstly and next it should have significance on a society and might affect the member of the society.

When one examines SSI closely, she or he can realize its multidimensional structure. Ratcliffe & Grace emphasize the multidimensional structure of SSI and explained that SSI:

- has moral dimension,
- is found in media frequently,
- is related with science and society at the same time,

- is up to date topics,
- has risk-cost analysis by looking the interactive relations between risk and values,
- has such as social, economic and political dimensions, and containing all these make SSI to have a very different and important points as compared with other science topics [6], [14].

To sum up, it is possible to say that SSI are the topics which are up to date; are related with society; contain cause-effect and risk-benefit analysis; has moral and ethical dimensions. Because of the fact that the points which were emphasized above, one can easily interpret that SSI can comprise a huge place in science education and therefore, it is important to examine its historical development closely.

It is possible to say that when examined the recent history (especially in the last few decades), the historical development of SSI was form as hoops of a chain. In 1980, firstly, the researchers studied out on a new approach, science-technology-society (STS), and integrated STS into science education. With this approach, science educators aimed to emphasize the social dimension of the science and technology, in other words they wanted to reveal the relationship between science and society [14]. However, as Zeidler et al. [16] pointed out in their studies that *"while STS education typically stress the impact of decisions in science and technology on society, it does not mandate explicit attention to the ethical issues contained within choices about means and ends, nor does it consider the moral or character development of student (p.359)"*. Consequently, science educators concluded STS approach as inadequate from the perspectives which Zeidler et al. [16] emphasized and started studies in order to revise STS approach.

Later in the 90s, "environment" dimension were added into science-technology-society approach and the new form, science-technology-society-environment (STSE) approach, have been brought to science education [17] however, in this traditional approach although ethical issues or quarrels were pointed out, STSE approach did not make emotive, developmental, cultural or epistemological connections between issues; care about nature of science (NOS); and use argumentation, discourse despite inherent power of it [14], [16].

At the beginning of the 2000s, SSI has been given place within science education as a more popular and modern approach. SSI has all the components of STSE approach and additionally the dimensions moral reasoning; social, political, economic dimensions [18]. As Zeidler et al. [16] point out that:

"Whereas the overarching purpose of the STS approach is to increase student interest in science by placing science content learning in a societal context, SSI education aims to stimulate and promote individual intellectual development in morality and ethics as well as awareness of the interdependence between science and society. SSI therefore does not simply serve as a context for learning science, but rather as a pedagogical strategy with clearly defined goals (p.360). "

As Zeidler et al. [16] also emphasized, teachers can care students' moral and ethical development as a consequence of using SSI. Therefore, it can be concluded that SSI has an important place in science education because of the fact that SSI were evolved from STS and STSE approaches by closing the gaps where STS and STSE does not satisfactorily touch on structurally and pedagogically.

After STSE approach has transformed to a new approach SSI at the beginning of 2000, it is observed that SSI has also continued to develop in itself [19]. This development can be examined under different phases (figure 1.1). In Phase-1 (2000s), mostly conceptual and theoretical studies related with SSI have been carried out by the researchers, and in Phase-2 (2010s), by considering the previous studies about SSI done in Phase-1, the researchers started to develop curriculum studies and teaching models in order to deal with SSI in classroom settings. From this perspective, it is possible to conclude that in 2020s, new study trends related with SSI can be carried out by researchers. In order to produce new study about new trends related with SSI, on the other hand, it is significant to understand the development and phases which were done and passed for SSI.

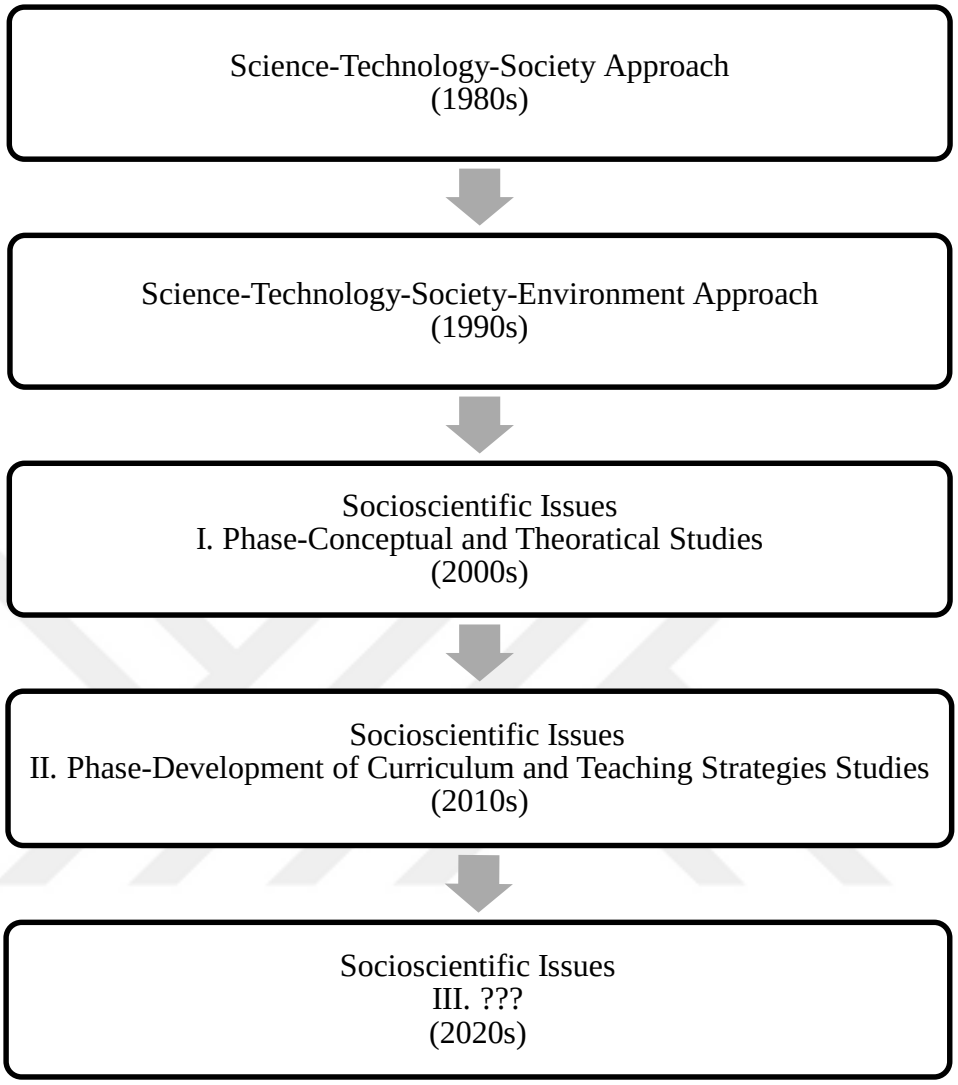


Figure 1.1 Development of socioscientific issues (Taken from: [19])

Up to now, the researcher presented some information about SSI and SSI's historical development. In the following, SSI's contributions to science education and the development of the members of a society will be shared. In the studies, it was found that in order to grow scientifically literate person, SSI is very crucial [8], [20], [21]. Due to the multidimensional structure, SSI has a role of educating scientifically literate person; because a scientifically literate person has an interpretative and argumentative abilities and abilities to use them after being confronted with an issue related with science and society in media, society or his/her personnel relationship. The following example might be provided to clarify this point further. For instance, as noticed previously about *"nuclear energy"*, to bring such an issue to classrooms settings can enhance students' scientific literacy because they can use their interpretative and argumentative abilities

while dealing with such an issue by examining the consequences from different perspectives; as economically and politically, and expressed their own ideas about using nuclear energy as to provide more energy or not. Zeidler and Keefer [17] point out in their studies that using moral and ethical reasoning which is a part of multidimensional structure of SSI is a reason for contribution of SSI towards increasing scientific literacy.

Inclusion of SSI into science education also brings other outcomes in addition to enhancing scientific literacy. One of them is that dealing with SSI can enhance students' scientific content knowledge (e.g. [22], [23], [24], [25]). Enhancing motivation (e.g. [26]) and interest (e.g. [27]) towards science learning; increasing students' communication abilities (e.g. [28]) and argumentation abilities(e.g. [22], [29]); and raising nature of science understandings, decision making skills, and etc. [15], [30] can be shown as other outcomes of inclusion of SSI into science teaching. Additionally, Lee and Erdoğan [31], in their study, found that dealing with SSI can enhance attitudes towards science education.

Zohar and Nemet [29] in their study examined the effect of using controversial topics on students' biology knowledge and argumentation abilities. They conducted an experimental study with 9th grade students. There were both experimental group who have taken genetic course with a special instruction technique and comparison group who have taken genetic course with normal instruction such as traditional textbook approach. Before intervention, they applied pre-test and found that there were no significant differences between comparison and experimental groups in terms of biological knowledge and argumentation skills and both of them were at low levels. After the intervention, it was found that in the experimental group students, who were taught with dilemmas on human genetics such as Huntington's disease with special instruction techniques, developed complex arguments and their biological content knowledge were higher than comparison group.

In their study, Klosterman and Sadler [23] aimed to reveal the effect of SSI-based instruction on 9-12 grade students' science content knowledge. In order to reach that aim, they designed a SSI-based instruction intervention in which global warming was the SSI. To measure scientific content knowledge, they used standard-aligned tests and curriculum aligned tests. Before and after the instruction which held through fifteen lesson hours, they applied those data collection tools. As a result of the study, they found that before and after intervention there were found significant differences among

students' global warming knowledge, greenhouse effect comprehension, and also comprehension towards argumentative and challenging issues related with global warming and greenhouse effect in a positive way.

Shoulder & Myers [25] in their studies aimed to reveal how students' agriscience content knowledge would change after application of SSI-based instruction. Before interventions, students answered pre-tests and then lesson plans prepared by using SSI-based instruction techniques presented to students. After instructions, post-tests were applied. As a result of the study, it was found that there were significant differences among pre and post-test results and the increase in students' agriscience content knowledge.

Dawson and Venville [22] examined that whether using argumentation while conducting the science lessons affects students' argumentation skills, informal reasoning and genetic knowledge. They have selected genetics topics because, they noticed in the study, genetics was directly related with society and the research done on genetics directly effects the society, e.g. studies on GMOs. The researchers, then, conducted a quasi-experimental research design with year nine and year ten students. The experimental group has been taught with five teachers trained about argumentation and the control group has been taught with four teachers. The intervention has been held through eight to ten weeks and the genetic lesson covered wide range of topics related with basic genetic topic such as Mendelian genetics and controversial genetic topics such as human genetic diseases. At the end of the study, it was explored that argumentation and informal reasoning abilities of students, who were taught in experimental group which have taught through argumentation, improved. In addition, they also found that students' genetic knowledge improved.

Sadler et al. [24] searched that how SSI-based instruction affects students' science content learning related to molecular biology and genetics. Sixty nine high school students who were taught with three different teachers were participants of the study. Students were taught genetics and molecular biology which were focused on biotechnology held through 3 weeks. Before and after intervention researchers have applied proximal which have multiple choice questions directly related with science content and distal assessments which have items focused on science concepts in order to measure students' science content learning. At the end of the study, after comparison of

pre and post-tests, they found that inclusion of SSI-based instruction have contributed students' science content learning.

Walker and Zeidler [30] in their study aimed to examine how SSI embedded lessons influence students' NOS conceptualization and argumentation and also discourse usage by students. They used genetically modified foods (GMFs) as SSI. To 36 high school students who were purposefully selected the intervention, which were web based lessons as activities about GMFs including explicit NOS questions and discussions, were applied. At the end, researchers concluded that students' answers contained the elements of nature of science but they did not use them for discussions. In other words, fostering students' NOS abilities of using SSI have been found in this study.

Eastwood et al. [15] have examined how students' NOS understandings shaped and changed after implementing NOS instruction in the context of SSI-learning environment and science content driven curriculum. In both implementation, they used explicit-reflective NOS instruction. 11^{th} and 12^{th} grade anatomy and physiology class students were hired as participants from four classes (two classes were SSI classes and the other classes were content classes). Every classes have been implemented NOS questionnaire as pre and post-test. In pre application of the test, there were not found any statistically significant differences between two groups. According to the post-test results, researchers found significant differences between control and experimental group; in other words, they concluded that SSI can contribute students' NOS understandings.

Lee and Erdoğan [31] with their study aimed to reveal how STS education affects students' attitudes towards science and their creativity. Seven teachers volunteered for participation among twenty teachers and five hundred ninety-one middle school students have participated in the study. Researcher assigned the teachers for experimental and control groups. The experimental groups have taught students with STS approaches by using different topics and the control groups have taught with traditional approaches. Teachers in experimental groups used more student-centered teaching strategies. Before and after intervention, participants have been applied pre and post-tests. Two different tests have been used; one of them aimed to reveal students' attitudes towards science and the other aimed to reveal their creativity with different subscales such as questioning, reasoning and predicting consequences. As a result, researchers have found that there is significant differences among students' attitudes towards science education between experimental and control groups. In addition, they

concluded that inclusion of STS approach contributed students' creativity based on analysis although, in sub scale bases, they did not find any significant differences.

Chung, Yoo, Kim, Lee & Zeidler [28], in their studies, examined the effect of SSI instruction on students' communicative abilities. They applied a SSI program which was created on Gene Modification (GM) to 132 9^{th} grade students. In the study, before intervention, pre-test applied and after intervention post-test applied. Three different data collection tool, which were "communication skill questionnaire, semi structured interview and classroom observations, have been used by the researcher. As a result, researchers found that students' communication skills have developed positively when comparison pre and post-test and examination of interviews and classrooms observation after dealing with GM.

In one of the other study, Wongsri and Nuangchalerm [32] indicated how SSI-based instruction affects students' learning achievement, analytical thinking, and moral reasoning. They carried out a quantitative study by comparing control groups which took conventional instruction and experimental groups which took SSI-based instruction. It was found in the study that when students participated with SSI-based instruction, their scientific literacy, placement of discussions on ethical issues and analytical thinking skills increase. Nuangchalerm [33] also pointed out, in another study, that SSI-based instruction can facilitate engaging in higher order thinking skills such as argumentation. Moreover, integrating SSI-based instruction can also facilitate nature of science comprehension.

Because of the fact that SSI has significance for science education and its contributions pointed out so far, there were some attempts in which researchers tried to develop some instructional models for dealing with SSI and also some studies in which pre-service teachers SSI-based instruction experiences examined. One of the study is the study of Presley et al. [34] through which researchers aimed to develop a framework for SSI-based instruction (In the following chapter, further details about this study will be shared under *"The Framework of the Study"* part). Friedrichsen et al. [35] developed a socioscientific curriculum unit for antibiotic resistance and natural selection in another study. They have built an instructional model for SSI. Morever, Sadler, Foulk and Friedrichsen [36] developed another instructional model by examining the previous one Presley et al.'s [34] and Friedrichsen et al.'s [35] studies. In short, in those studies how

to deal with SSI were noticed by providing different instructional models and presenting some plans about specific SSI.

Taking everything into consideration, most of the developed and developing countries like England, South Korea, and Sweden have perceived the importance of SSI for science education and included them into their science education curricula [1], [37]. The inclusion of SSI to our national science education program was also done by Ministry of National Education with the revision of 2005 science and technology program [38]. In 2013 [2], SSI has been included and directly emphasized in the science education program. Under *"Science-Technology-Society-Environment"* scope, SSI was placed and defined as *"Covered scientific and moral reasoning skills towards solution of socioscientific problems which are related with science and technology (p.vi.)"* [2].

Due to the fact that SSI included in national science education program, it gains high importance to understand what SSI is and how to bring and use them into classroom as in-service science teachers and pre-service science teachers (PSTs). In the literature, there are some studies in which the views of educators (PSTs) towards SSI and SSI-based instruction were got through by using different study and data collection methods like interviews and questionnaires nationally and internationally. For example, Alaçam-Akşit [39] and Lee et al.'s [11] studies can be given as examples to such studies (More information was provided in *Chapter 2*). However, studies which were aimed to reveal PSTs' and STs' views towards SSI and SSI-based instruction are limited. This is especially valid for national base and it can be said that the literature needs more studies.

1.2 Objective of the Thesis

The aim of the present study is to reveal pre-service science teachers' views towards SSI and also SSI-based instruction. In accordance with this aim, in the following, the researcher presented two main and seven sub questions for which this study aimed to reveal.

1. What are the views of pre-service science teachers towards socioscientific issues?
    a. What are pre-service science teachers' awareness of socioscientific issues?

b. How do pre-service science teachers conceptualize socioscientific issues and explain its features?

2. What are the views of pre-service science teachers towards socioscientific issue based instruction?
    a. How do pre-service science teachers perceive socioscientific issue based instruction?
    b. How do pre-service science teachers view teachers' roles for socioscientific issue based instruction?
    c. How do pre-service science teachers view students' roles for socioscientific issue based instruction?
    d. How do pre-service science teachers view other stakeholders' roles (such as program developers and administration) for socioscientific issue based instruction?
    e. How are pre-service science teachers' self-efficacy beliefs towards using socioscientific-issue based instruction?

Above, the questions labelled with numbers are the main questions of this study and the ones labelled with the letters are the sub questions of the corresponding main questions.

1.3 Rationale of the Study

As provided so far by examining the literature, one can possibly conclude that due to the fact that SSI can contribute students' intellectual, emotional, ethical development, the inclusion of SSI was made into science education programs for most of the countries as in our country (e.g. [2], [37]). In our country, as expressed and explained in the previous parts, with newly published science education program for elementary education [37], SSI was directly expressed and emphasized in the curriculum. Since SSI has taken into science education program, it gains high importance to know and comprehend what SSI is and how to deal with such issues during regular class hours for science teachers and educators. This is especially substantial for PSTs because in their professional lives as science teachers they might easily encounter with one of the SSIs during regular class hour and in their free time [20] and one of the students of the teachers might want to learn more about the issue. Due to this situation, it gains importance for a PST to be aware of what SSI is and how to deal with such topics in the classes.

In this scope, as expressed previously, it is possible to find some studies in which the views of educators (e.g. PTs, STs) towards SSI and SSI-based instruction were taken. In Turkey for instance, studies of Alaçam Akşit [39], Balım & Özcan [40], Kara [41], Muğaloğlu et al. [42], Özden [43] can be given as examples of such studies. There are also other examples out of Turkey which reveals PSTs' views towards SSI (e.g. [11], [44], [45]) (In the following chapter, *"Related Studies and The Framework of the Study"*, detailed examination of such studies have been shared by the researcher). However, in spite of the present studies related with PSTs' views towards SSI, in order to understand the views of PSTs towards SSI further, more studies are needed. In addition to that it is not possible to find any study in the literature which reveals teacher candidate knowledge about the place of SSI in the available science education program [2], [38]. To comprehend their knowledge towards science education programs is also highly important because when PSTs start their professional lives, they will use the programs provided by Ministry of National Education. Lastly, it was also realized that in most of the studies, PSTs or STs have been implemented with a SSI intervention and after interventions their views towards SSI have been received.

Therefore, in the present study, the researcher will examine what were PSTs' views towards SSI and its features; what they know about the placement of SSI into previous and current science education programs; what are their views towards SSI-based instruction, its easiness and difficulties and teaching methods best fit to SSI-based instruction; during SSI-based instruction, the role of different stakeholders (such as teachers and students); and their self-efficacy beliefs towards dealing with such issues in their professional lives without any implementation or intervention. The original contributions of this study in science educations, thus, are as follows: With the present study, PSTs' awareness towards SSI and the place of SSI in national science education programs will be understood; without any interpretation this study will be held and thus their original views towards SSI can be obtained; and lastly, their views and comprehensions towards SSI-based instruction can be obtained too in detail.

To sum up, it can be concluded that in the case of the findings will be as expected; with the findings of this study, it can be understood the necessity for a need about revision in university science education programs towards placing into the programs whether a compulsory or an elective course in which the aim is to explain and teach SSI and SSI-based instruction. In addition, based on the findings of the present study, some in-

service courses in which SSI and SSI-based instruction are presented and some activities related with SSI are developed might be planned by the MONE; because, the participants of the present study are future's science teachers and, thus, we might proportionally generalize findings of the present study to science teachers.

CHAPTER 2

RELATED STUDIES AND THE FRAMEWORK OF THE STUDY

In this chapter, the researcher present studies found from literature through which the views of teachers or preservice teachers from different grade levels and courses such as science and biology towards SSI and SSI-based instruction firstly; and then, he presented the framework of the present study.

2.1 Studies on PSTs' Views towards SSI and SSI-based Instruction

In this part, the researcher presented some studies through which the views of science teachers and pre-service teachers towards SSI, SSI-based instruction, and their self-efficacy beliefs towards inclusion of such issues into their educational settings were examined by analyzing the available literature. The researcher represented the chosen articles as a table (Table 2.1) below and he provided further information afterwards.

Table 2.1 Studies on views towards SSI and SSI-based instruction

Researcher (s)	**Article**
Özden [43]	Prospective Elementary School Teachers' Views about Socioscientific Issues: A concurrent Parallel Design Study
Kara [41]	Pre-service Biology Teachers' Perceptions on the Instruction of Socio-scientific Issues in the Curriculum
Alaçam Akşit [39]	The Views of Primary Education Pre-service Teachers on Socioscientific Issues and Their Perspectives on the Teaching of These Issues
Lee et al. [11]	Korean Science Teachers' Perceptions of the Introduction of

Table 2.1 Cont'd

	Socio-scientific Issues into the Science Curriculum
Balım & Özcan [40]	Pre-service Science Teachers Views' towards Socio-scientific Issues
Yapıcıoğlu [46]	Fen Bilimleri Öğretmen Adaylarının Sosyobilimsel Durum Temelli Öğretim Yaklaşımı Uygulamalarına Yönelik Görüşleri ve Çalışmalarına Yansıtmaları
Muğaloğlu et al. [42]	Pre-service Science Teachers' Self-Efficacy Beliefs to Teach Socio-scientific Issues
Espeja & Lagaron [47]	Socio-scientific issues in initial training of primary school teachers: Pre-service teachers' conceptualization of SSI and appreciation of the value of teaching SSI
Sönmez & Kılınç [48]	Preservice Science Teachers' Self-Efficacy Beliefs about Teaching GM Foods: The Potential Effects of Some Psychometric Factors

With their study in which Lee et al. [11] worked with secondary science teachers, they aimed to understand what science teachers' views towards SSI and the place of SSI in their curriculum, and also to understand the effecting factors for integrating SSI into their lessons. Researchers have chosen participants from an in-service training program and applied data collection tools which were questionnaire and open ended questions to eighty-six in service science teachers. Among those science teachers, a group of randomly selected twelve science teachers, have been applied semi-structured interviews.

Lee et al. [11], as a result of their study, have explored that: First of all, science teachers perceived SSI as dangerous and destructive topics which were occur because of the usage of science improperly by humans. In addition to that there were other participants who pointed out that SSI was a natural consequences of NOS. Secondly, about inclusion of SSI into science lessons, most of the science teachers had positive feelings because of

the contributions of SSI to students' decision making, judgment, NOS conceptualization; however they noticed also that they did not have enough material to deal with such issues. The researcher, in this study, also wanted to perceive participants' self-efficacy beliefs and found that they had low self-efficacy beliefs to deal with SSI in their classrooms due to the pedagogical and content knowledge factors. Lastly, it has been found that factors such as being time consuming, requiring materials to deal with, requiring time for planning, and requiring a proper level of classroom management skills were shown as reasons for other situational factors which affect the inclusion of SSI into science lessons according to in-service science teachers.

Kara [41] in his study participated with pre-service biology teachers (PBTs) in order to study on their views towards SSI and SSI instruction. After participating fifteen weeks course in which current trends in biology education were taught, both a questionnaire and open ended questions were used as data collection tools which were filled and held through with 102 PBTs. In the study, it has been found that the participants of the study perceived SSI as having moral and ethical dimensions, occurring from human kind issues. Most of them knew SSI and accepted them as negative things. About integrating SSI into biology lessons, it was emphasized that most of the participants expressed acceptance towards integrating SSI into their lessons by pointing out the contributions of SSI towards providing classroom discussions and connecting intriguing topics with science lessons easily, however they have also pointed out that there were not enough available materials to deal with such issues. About why PBTs did not express positive attitudes towards integrating SSI into their education, it has been found that factors such as being time consuming, requirement of materials to deal with those issues, requirement of time for planning, requirement of a proper level of classroom management skills were shown as reasons for that. Lastly, PBTs' self-efficacy beliefs have been searched in this study and it has been found that most of the PBTs have perceived themselves as having enough content and pedagogical knowledge and expertise and also enough understandings about SSI. When compared Kara [41] and Lee et al.'s [11] studies, we can notice that both studies findings have similar patterns. However, the differences reveals in the self-efficacy part. While teacher candidates perceive themselves with high self-efficacy, teachers from learned profession perceived themselves with low self-efficacy.

In their study, Balım & Özcan [40] examined pre-service science teachers' views towards socioscientific argumentation. They carried out a qualitative study in which they used five open-ended interview questions prepared as semi-structured interview form and applied them to six pre-service science teachers. They have found that while participants were indicating views towards SSI and argumentation, they had difficulties about indicating views towards socio-scientific argumentation. Additionally, researchers asked about students' and teachers' role for socio-scientific argumentation. It has been found that PSTs' expressed that teachers should act as a guide and create comfortable environments for discussions. Students should respect each other and do not beware expressing ideas. In that study, researchers also wanted to learn PSTs' views towards assessment of socioscientific argumentation and it has been explored that PSTs thought assessment through paper-pencil semester end exams are not enough to assess socio-scientific argumentation method; and thus, process assessments are more valid than those methods.

In her thesis study, Alaçam-Akşit [39] studied with pre-service elementary school teachers in order to comprehend their views towards SSI. She performed a mixed method study in which both qualitative and quantitative studies are used together. In that study, 357 participants were applied a questionnaire and 24 participants were interviewed by the researcher. As a result of the study, some of following points have been found: Most of the teacher candidates' SSI sources were social and science lessons; besides, some extrascholastic factors such as media and family were emphasized as SSI sources. Some pre-service elementary school teachers are willing towards inclusion of SSI into their university education in order to learn how to deal with them effectively because of the fact that they have thought they did not have enough knowledge both content and pedagogical knowledge in order to deal with them in their further professional lives. It is found also in this study that most of the teacher candidates perceived environmental issues as socioscientific issues.

Özden [43] was another researcher who studied on pre-service elementary school teachers' views towards SSI. In that study, he aimed to examine prospective elementary school teachers' views towards SSI, usage of SSI in science education and whether the use of SSI in science education affected by gender to academic success. In this study, thus, a mixed method research type has been used. In the qualitative part, four open-ended questions were asked eight participants. In the quantitative part, 113 participants

were asked to fill a questionnaire consisting 13 items which were prepared by the researcher. The quantitative part of the study was used to assess whether views of prospective teachers towards SSI differ by gender and academic achievement or not and the qualitative part to examines views of them towards SSI and usage of SSI.

According to the results [43], it has been found that the participants of the study emphasized about SSI that they are topics which are open ended, current; affect individuals; include risk and probabilities analysis and also moral and ethical dimensions and; having multiple solutions. Additionally, being reported in the media was also pointed out by the participants. As contributions of SSI, the participants thought that using SSI in science education might have positive effects on higher order thinking skills. In this research, it has been found that participants hold views towards teachers' role as being a guide who direct discussions and chose the topics and problems which the class is faced with. In the quantitative part, the researcher has found that gender differences have found only about the maturity of elementary students for interesting in SSI. In other words, if student are mature enough, they might be interested in with SSI more. For academic achievement, it has been found that participants whose academic achievement were low believe that successful learners are interested in SSI more and more.

Espeja & Lagaron [47] aimed to measure pre-service elementary school teachers' SSI understandings in general and their appreciations about usage and purpose of them as pre and post-tests. Researchers participated with fifteen participants. After three-week long application of SSI training, the participants which were volunteers prepared lesson plans by using SSI. When the researchers examined pre and post-test results about pre-service elementary teachers' SSI conceptualizations and appreciation of usage of them, they found that there was a positive recovery. While participants had simple conceptualization and understandings towards SSI after intervention recovery in such points have been observed.

Evren-Yapıcıoğlu [46] in her study aimed to examine pre-service science teachers' views towards SSI and how they reflect SSI into their studies. In her study, she participated with both experimental and control groups in order to gather data. 3rd grade PSTs were the participants of that study. In that study, in order to comprehend PSTs' views towards SSI and how they reflect SSI into their lesson plans and studies different data collection tools such as unit plans, focus group interview, observation and teacher

candidates' diaries have been used by the researcher after interventions. In experimental group, PSTs carried out unit developments and application about the topics with a special method which was socioscientific-issue based approach. On the other hand, the control group carried out those application with already available methods in science education, however, socioscientific issue-based approach have been presented here too without putting emphasis on it.

As a result of this study, it has been searched that what kind of topics do PSTs point out as SSI; which teaching strategies do they think SSI can be taught more effectively; to what extent science education objectives from national science education curriculum are related with SSI; and also which strategies teacher candidates prefer while reflecting SSI into their studies. Most of the PSTs from both experimental and control group pointed out "organ donation and transplantation", "environmental topics" and "GMOs" as examples for SSI. Some more examples which were given to SSI such as cloning, and base station were there. For effective teaching methods and strategies in order to deal with SSI, it has been found that "dilemma cards (ikilem kartları)", "argumentation", and "problem scenarios" were mostly emphasized teaching strategies by the teacher candidates. About curriculum objectives, the researcher has found that most of the PSTs had difficulties by connecting and separating the objectives as related with SSI. Lastly, it has been found that while PSTs in experimental group used dilemma cards in the cases of dealing with SSI, instead of the fact that they pointed out to use dilemma cards in their studies, control group's teacher candidates mostly used news in their SSI studies.

Muğaloğlu et al. [42] aimed to examine how PSTs' self-efficacy beliefs changed after giving a special training of SSI. In this study, a well-known self-efficacy tests derived by adapting SSI and given participants, twenty-three PSTs, of their study as pre-test. After that in three weeks, the participants of the study took SSI modules as education and the following three weeks they, participants of the study, made some microteachings about the provided SSIs. After this process, the derived self-efficacy test was applied to PSTs as post-tests. Based on statistical analysis, researchers have found that there are meaningful differences between pre and post-tests. In order words, they have pointed out that after teacher candidates learn and deal with SSI, their self-efficacy beliefs increased.

In their study, Sönmez & Kılınç [48] used GMOs as SSI in order to examine what PSTs know about them, their risk perceptions and attitudes towards GMOs and self-efficacy beliefs of PSTs towards teaching such a topic. In order to assess them, researchers used different data collection tools (quantitative study) and applied them third and fourth grade science education students. As a result, they have found that PSTs had knowledge about production and purposes of GMOs. Additionally, high risk perception and negative attitudes of PSTs towards GMOs have been found. About their self-efficacy, it has been concluded that PSTs have perceived themselves as enough to deal with such issues instead of pointing out difficulties of ethical and moral and also conceptual argumentations.

To conclude, as can be seen there are different available studies through which the perception and understandings towards SSI and SSI-based teaching of teachers and pre-service teachers from different educational area have been explored. Moreover, it is possible to find some studies in which pre-service teachers self-efficacy beliefs have been examined in the literature. The present study as stated before aims to contribute those areas, views towards SSI and SSI-based instruction, by working with pre-service science teachers and dealing with missing points pointed out in Chapter 1. In the next part, the researcher presented the framework which guided the present study.

2.2 The Framework of the Study

In this part, the researcher presented the framework of the study. As Savin-Baden and Major [49] expressed in their book that: *"A framework is a structure that is intended as a guide for thinking about the research subject and as an interpretive lens through which to view data (p. 134)"*. In the present study, therefore, the researcher used a framework in order to guide the study. Under Ratcliffe & Grace's SSI definition and explanations [6], Presley et al.'s study [34] which is about SSI-based instruction were used to frame this study. In the following parts, the researcher provided further detail.

The present study's one of the aims (the aim has been shared in the previous chapter) is to comprehend PSTs' views towards SSI. Therefore, at that point Ratcliffe & Grace's definition and explanation about SSI [6] guided the present study. In the previous chapter, that has been noticed, however, below the researcher shared the important points.

Ratcliffe & Grace [34] have emphasized the multidimensional structure of SSI and show that SSI:

- has moral dimension,
- are found in media frequently,
- are related with science and society at the same time,
- are up to date topics,
- has risk-cost analysis by looking the interactive relations between risk and values,
- has such as social, economic, and political dimensions, and containing all these make SSI to have a very different and important points as compared with other science topics [6], [14].

As a conclusion, inferences related with SSI such as; they are the topics which are up to date; are related with society; contain cause-effect and risk-benefit analysis; has moral and ethical dimensions could be made easily.

In the present study, the other aim of the study (the aim has been shared in the previous chapter) is to comprehend PSTs' views towards SSI-based instruction. At that point, thus, the framework developed by Presley et al. [34] about SSI-based instruction guided the present study.

Presley et al. [34], in their study, developed a SSI-based instruction framework to guide teachers and researchers who study in science education area. Their framework has three core aspects in order to successfully deal with SSI-based instruction. Those are: "*design elements*", "*learner experiences*", and "*teacher attributes*". It is also emphasized that "*classroom environment*" and several "*peripheral influences*" such as curricula, politicians, and society have impacts on SSI-based instruction [34]. As a core aspect, *design elements*, researchers point out that for SSI-based instruction, there are some requirements. For instance, the instruction must be built around a tough topic. In other words, the topic must be, for instance, easy about which students do not need to make brainstorming and argumentation in depth and easy to understand. After building instruction around a compelling issue, the issue must be presented at the beginning of the lesson and through the lesson(s), the structure of the lesson(s) must permit students to participate easily in higher order practices. Lastly, as another required design element, integrating a culminating experience is shown in the study. With culminating

activity, the connections of previous knowledge and already learned knowledge are pointed by the researchers. In the study [34], using media and technology are presented as recommend elements to integrate the lessons.

Presley et al. [34] emphasize that "*learner experiences*" is another core aspect of SSI-based instruction. In this aspect, they provide some features of framework. Learners must participate during higher order practices and they must be provided environments which let them to participate in higher order practices to determine their stand point during lecture. For instance, such higher order practices which learners engage are: argumentation and decision making. Learners also must confront and examine all the claims produced by other students and in order to make their own claims/arguments, they should search, examine and analyze different data from different stakeholders that is to say learners must be eager to researching about giving issue. When participating on the provided issue, learners also must consider all the different dimensions such as political, economic, and health as far as the topic permit. For "learner experiences", researchers also provide two recommendations, confronting with ethical dimensions and nature of science (NOS) themes related with the issue provided. However, they importantly indicate that using ethical dimensions might not be appropriate for all topics and might result with high tensions among learners.

In this paragraph, the researcher presented third and the last core aspect according to the framework of Presley et al. [34] shortly. This core aspect is "*teacher attributes*". Teachers, who will deal with SSI-based instruction, must know the science content of the issue and the social issues related with the topic. Teachers must know the dimensions of the issue like ethical, political, and economic as far as they can [50]. Teachers must also be open to learn more and more because during SSI-based instruction they might, most probably, encounter with new knowledge. Additionally, teachers must not act as the only authority in the class instead, they must provide authoritative classroom environments. Lastly, knowing how to act when confronting with uncertainty are another characteristics of teachers which is emphasized by researchers.

Together with those three core aspects, *design elements, learner experiences and teacher attributes*, Presley et al. [34] also point out that *classroom environment* and several *peripheral influences* have impacts on SSI-based instruction (see *Figure 1.2*). Curriculum, community, the number of SSI-based materials can be counted as

peripheral influences. For instance, if teachers have flexible curriculum which let SSI to include into science lessons easily and materials which can be used in SSI lessons, they might increase inclusion of SSI into science lessons. As for classroom environment, creating the classes as providing the usage of higher order practices and participations, in other words, if the classes become interactive in which teachers and students have mutual respect and trust, then SSI-based instruction can be made and reach its aims accomplishedly.

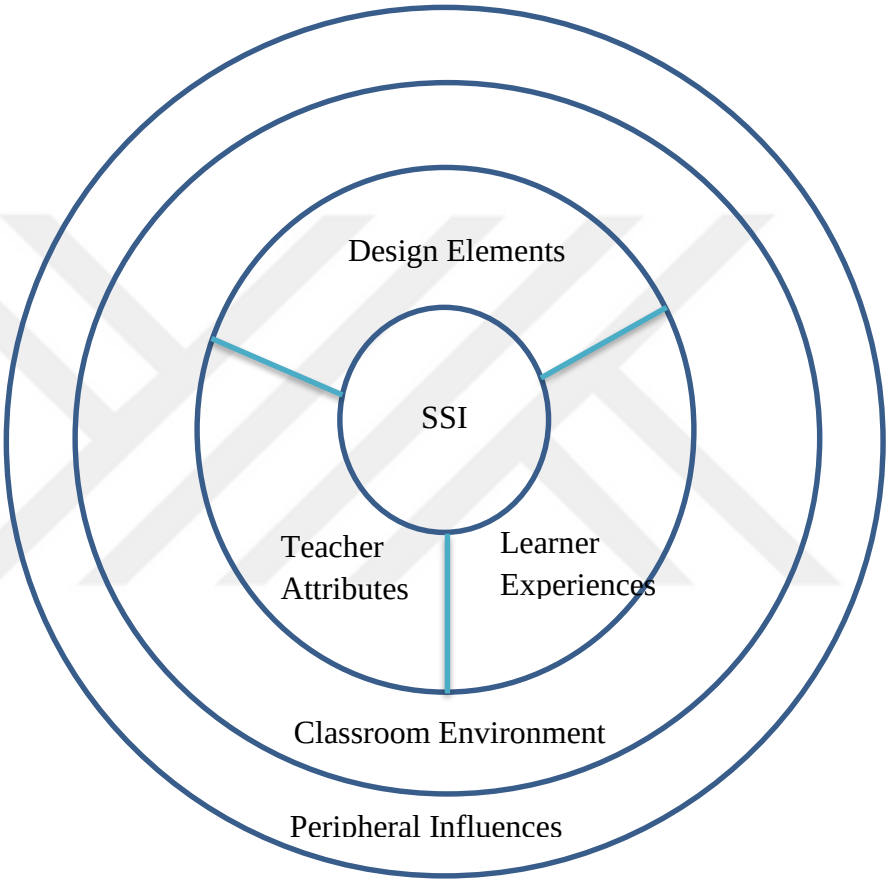


Figure 2.1 Graphical representation of SSI (Taken from; p.28 [34])

CHAPTER 3

METHODOLOGY

In the present study, the researcher used qualitative research method. As Merriam pointed out [51], in qualitative research, a researcher can search and examine research question(s) of his/her study deeply. Thus, it is an appropriate study method for present study, however, the researcher has to admit that in this method; the generalizability of the research results might be low because of the number of participants included in the study. The participant number are generally low in qualitative research method due to the fact that the researcher must examine all the data gathered from participants in detail which requires huge amount of time.

The researcher used qualitative research method due to the aims and the research questions of the present study and also his philosophical stance. By this way, he thought that he can examine PSTs' views towards SSI and SSI-based instruction very deeply.

3.1 Participants

The participants of the present study consisted of pre-service science teachers (PSTs) from department of science education. In order to be able to find available and appropriate participants for the present study, the researcher selected two state universities in Istanbul (as universities names, University A and University B will be used in order to provide confidentiality). Both universities accept students based on their points which are taken as a result of the central exam done for university placement. After examining the universities educational programs, the researcher explored that both universities have also the similar educational programs for science teacher education. The researcher also found out that there are some differences in terms of elective courses between University A and University B. University A have elective courses through which PSTs can have more chance to confront with SSI and learn how

to deal with SSI during science lessons. On the other hand, both universities have compulsory courses such as Special Issues in Biology and Special Issues in Chemistry in which PSTs can confront with examples of SSI and also SSI itself.

In the present study, from two different state universities, 30 PSTs participated voluntarily. All the participants were enrolled either 3rd or 4th grade. From each university, 15 PSTs participated in the present study. 8 out of 30 participants were male and 22 of them were female participants. By virtue of huge number of female students in science education department, this reverberated to the present study's participant pool. Most of the participants' age were in 21-23 age interval. In addition, there was one male participant whose age was 27. In the following, the researcher presented relevant table related with demographic features of participants in terms of gender and university.

Table 3.1 Demographical features

	Gender		Total	
	Number of Male Participants	Number of Female Participants		
University A	3	12	15	30
University B	5	10	15	
	Grade		Total	
	Number of 3rd Grade Participants	Number of 4th Grade Participants		
University A	8	7	15	30
University B	8	7	15	

3.2 Data Collection Process

In the present study, the researcher used interview method to gather PSTs' views towards SSI and SSI-based instruction. All participants participated in semi-structured interviews each lasted approximately 25-45 minutes. The researcher of the present study, then, transcribed all the audio recording interviews into written form in order to analyze data in depth.

3.3 Instrument

The researcher used a semi-structured interview tool to be able to find out answers to each one of the present study's research questions. In the following, he shared the process of generation of that semi-structured interview instrument and also connections of interview questions with the present study's research questions explicitly.

In the present study, in order to answer research questions, the researcher prepared an interview instrument consisting of semi-structured questions. The first version of the instrument which aimed to reveal participants' understanding about SSI and SSI-based instruction consisted of seventeen questions. In *Appendix-A*, the researcher presented the very first version of the instrument. After long standing research, the researcher agreed upon those seventeen questions as sufficient to provide answers for research questions. While constructing the instrument, the advisor of the present study who is an expert on SSI and argumentation with different studies in top journals related with those topic areas provided expert opinions to the researcher of the present study. After examining relevant literature (see *"Chapter 1 & Chapter 2"*) and framework of the present study in depth, the researcher created the questions. As a next step after creating the instrument, the researcher actualized pre-interviews with some participants who were not included the present study's participant pool and get expert opinions from different researchers. Three science education experts except the author and the advisor of the present study examined the instrument. Two of them were experts on qualitative research with different studies in some of which interview instruments were used. The other was an expert on quantitative studies and also science education with lots of studies and experiences.

After receiving expert opinions, the researcher made some major modifications on the instrument. One of the major modifications was partition the instrument into two different parts, *Part-A* and *Part-B*. The researcher made this modification considering

the purpose of interview questions by being associated with research questions. In *Part-A*, it was aimed to reveal PSTs' views towards SSI; what they know about SSI, its features, and also the place of SSI in national science education programs. This part has six questions. In *Part-B*, it was aimed to reveal PSTs' views towards SSI-based instruction: How to plan and carry out SSI-based instruction; difficulties and easiness of SSI-based instruction; and different stakeholders' (e.g. teachers and students) roles for SSI-based instruction. Additionally, PSTs' teachers' self-efficacy beliefs towards carrying out SSI-based instruction was aimed to reveal by the researcher. This part has five questions and some questions have different sub questions. In *Appendix-B*, the researcher presented the final version of the instrument. In addition, he also presented English version of the instrument in *Appendix-C*.

In the following tables (Table 3.2, Table 3.3), the researcher presented research questions and related interview questions as tables in an explicit way.

Table 3.2 Research questions and interview questions (Part-A)

Research Questions		
Main Question	**Sub Question**	**Related Interview Questions**
What are the views of pre-service science teachers towards socioscientific issues?	What are pre-service science teachers' awareness of socioscientific issues?	Have you ever met with "socioscientific issues (SSI)" concept? If yes, how? Through lessons, own efforts, etc. (Q1 & Q1.a) What do you think about the place of SSI in 2005 national Science and Technology Curriculum which was published by Ministry of National Education? (Q5) What do you think about the place of SSI in 2013 national Science Education Curriculum which was

Table 3.2 Cont'd

		published by Ministry of National Education? (Q6)
	How do pre-service science teachers conceptualize socioscientific issues and explain its features?	What do you think what is SSI? (Q2) Could you give any examples to SSI? (Q3) What kind of features do you think SSI might have? (Q4)

Table 3.3 Research questions and interview questions (Part-B)

Research Questions		
Main Question	**Sub Question**	**Related Interview Questions**
What are the views of pre-service science teachers towards socioscientific issue based instruction?	How do pre-service science teachers perceive socioscientific issue based instruction?	What do you think how SSI-based instruction which are based SSI should be? (Q1) What do you think about; Difficulties of SSI-based instruction? Easiness of SSI-based instruction? (Q2.a. & Q2.b) What kind of teaching strategies would you prefer if you are dealing with SSI-based instruction? Why? (Q3.a)
	How do pre-service science teachers view teachers' roles	What do you think about; The role of teachers for SSI-based

Table 3.3 Cont'd

	for socioscientific issue based instruction?	instruction? (Q4.a)
	How do pre-service science teachers view students' roles for socioscientific issue based instruction?	What do you think about; The role of students for SSI-based instruction? (Q4.b)
What are the views of pre-service science teachers towards socioscientific issue based instruction?	How do pre-service science teachers view other stakeholders' roles (such as program developers and administration) for socioscientific issue based instruction?	What do you think about; The role of other stakeholders for SSI-based instruction? (Q4.c)
	How are pre-service science teachers' self-efficacy beliefs towards using socioscientific-issue based instruction?	Do you see yourself enough for dealing with SSI-based instruction in your future professional teaching life? If yes, why? (Q5.a) If no, why? (Q6.a)

3.4 Data Analysis

In this part, the researcher presented the way and appropriate method by using which he analyzed the collected data. To comprehend participants' views towards SSI and SSI-based instruction, the researcher made data analysis by using one of the qualitative data analysis methods.

After conducting all the interviews with participants, the researcher transcribed all the audio tape recordings verbatim. On the purpose of detecting, removing and correcting any possible involuntarily mistakes done during transcription process, he made this process with high level of attention. By this way, he converted all the audio tape data to their correct and most sufficient written forms to understand and analysis them which is pointed by Baş & Akturan [52] as a critical stage for a research. After this process, as shown in the literature, among different data analysis methods and coding techniques [49], [51], the researcher must choose a strategy or strategies in order to present readers most effective way for understanding the data obtained through the study.

In the present study, therefore, the researcher decided to conduct content analysis technique to analyze the data because of the fact that it was an appropriate technique for most of the philosophical stances and widely used in qualitative studies [49]. Savin-Baden and Major [49] mentioned about content analysis as a method in which a text or texts is/are examined in a fundamental level and used widely in the qualitative research. Baş and Akturan [51] also mentioned about content analysis as classification of data by including them to appropriate categories and analyzing them objectively. Among different content analysis techniques, the researcher implemented Harris's content analysis technique [53] in the present study. Content analysis contains different steps to provide clear analysis [53]. Those are: Determining studies research questions, choosing the text which is examined and deciding "unit of analysis", determining categories and making coding, and evaluating reliability and validity. In accordance with this purpose, the researcher of the present study read all the transcribed data carefully and decided about the unit of analysis as "sentences" for each of the data. Afterwards, he constructed categories (e.g. "biotechnology" and "student-centered") and made coding (e.g. "argumentation" and "GMOs"), then he presented findings in terms of frequencies. In the next chapter, *"Results"*, the researcher presented all the results in a correct order.

In the present study, during application of the instrument to participants, the researcher realized that some of the participants confronted with SSI and SSI-based instruction before the present study while some were not. Thus, he did not ask some of the questions in Part-A which are related with the awareness of SSI in national science education curriculums to those students because of the fact that they were not aware of SSI in any way. On the other hand, before asking Part B's questions to those participants who did not confront with SSI before the present study, the researcher also

provided them some information about SSI by using Ratcliffe & Grace's SSI definition [6] in order to continue the study with those participants which the researcher thought providing such information does not have any effect on the actual findings for the present study. In the following chapter, the researcher presented findings for each group differently (for Part B's findings which are related with views towards SSI-based instruction) as participants who confronted with SSI before the present study (Group 1) and participants who did not confront with SSI before the present study (Group 2). It is important to point out that the researcher followed the same data analysis method for each group (PSTs who confronted with SSI before the present study and PSTs who did not confront) and the reason for such representation is to present the differences between those groups explicitly.

3.5 Trustworthiness

There are some criteria for a researcher that (s)he must consider to provide the quality of the inferences made for his or her research [49]. One of the criteria is called as "trustworthiness". Lincoln and Guba [54] point out trustworthiness with the questions: "How can an inquirer persuade his/her audiences (including self) that the findings of inquiry are worth paying attention to, worth taking account of? What arguments can be mounted, what criteria invoked, what question asked, that would be persuasive on this issue? (p.290)". By dealing with trustworthiness, valid and reliable inferences can be made and the readers can be persuaded about the findings, inferences and interpretation done by using the collected data are reliable and valid.

In qualitative studies, to provide quality of the study, a researcher must consider about credibility (internal validity; truth value), transferability (external validity; generalizability; applicability), dependability (reliability; consistency), and conformability (objectivity; neutrality) [54], [55]. By considering four factors, a researcher can provide the trustworthiness of the study. In the following, the researcher presented how to deal and provide quality and quality of inferences and interpretations for the present study.

3.5.1 Credibility (Internal Validity; Truth Value)

As equaled to internal validity in quantitative studies [51], credibility is related with truth value [54]: "How can one establish confidence in the "truth" of the findings of a

particular inquiry for the subjects (respondents) with which and the context in which the inquiry was carried out? (p.79)" [55]. In the present study, in order to affirm credibility, the researcher used two different strategies. In the following, he presented the two strategies – triangulation and member checking – that he used to affirm credibility.

3.5.1.1 Triangulation

Denzin [56] notice that triangulation might be data, investigators, or theory which can help researcher(s) to broaden his or her understanding. In the present study, to satisfy triangulation, the researcher studied cooperatively with another researcher who was an expert on SSI and the advisor on collected data. Two researchers independently examined transcribed interview questions. Between the researchers' interpretations on the data consistency was found at least 80% by the researcher. They, then, came together in different times to deal for 20% of inconsistency.

3.5.1.2 Member Checking

Guba [55] refers member checking in his study as: *"data and interpretations are continuously tested as they derived with members of the various audiences and groups from which data are solicited. (p.85)"*. To affirm this strategy, the researcher met with the participants of the present study about his interpretations over data. By this way, he raised participation and the quality of data more; and also he checked and corrected the misinterpretation on analysis.

3.5.2 Transferability (External Validity; Generalizability; Applicability)

In the article [55], transferability is referred as: *"For the naturalist, then, the concept analogous to generalizability (or external validity) is transferability, which is itself dependent upon the degree of similarity (fittingness) between two context. (p.81)"*. In order to provide transferability, the researcher presented clearly the thick descriptions; participants' characteristics and demographic features, data collection procedures, data analysis procedures, and the quality procedures.

3.5.3 Dependability (Reliability; Consistency)

"How can one determine whether the findings of an inquiry would be consistently repeated if the inquiry were replicated with the same (or similar) subjects (respondents)

in the same (or similar) context? (p.80)" [55] is the question that Lincoln and Guba [54] asked to indicate dependability. In the present study, to provide consistency the researcher used different method. One of the methods was before conducting the study, he made interviews with some science education students. As another method, he used inter-rater consistency as a method to affirm dependability. In this method, different researchers and participants worked over the data; and interpretations were checked and controlled by the researcher of the present study.

3.5.4 Conformability (Objectivity; Neutrality)

Lincoln and Guba [54] refer conformability with the following question: "*How can one establish the degree to which the findings of an inquiry are a function solely of subjects (respondents) and conditions of the inquiry and not of the biases, motivations, interests, perspectives, and so on of the inquirer? (p.80)"* [55]. Therefore, in the present study, the researcher used triangulation and member checking methods to affirm conformability.

CHAPTER 4

RESULTS

This chapter consists of two parts with their sub parts in which the researcher presented findings about two main research questions of the present study. The researcher presented findings about each research question with their details and, in the next chapter, he discussed (*Chapter 5 Discussion*) the findings of the present study by comparing, relating, and interpreting them with the relevant literature presented earlier through the present study.

4.1 PSTs' Views towards SSI

The first research question of this study is: What are the views of pre-service science teachers towards socioscientific issues? In this part, the researcher presented findings towards this research question and its related sub questions. In order to explore PSTs' views towards SSI, participants answered the first part of the data collection instrument which aims to explore PSTs' awareness towards SSI, their SSI conceptualizations, and views towards the features of SSI.

4.1.1 Awareness of SSI

In this section, the researcher presented findings about the first sub question. The first sub question of the present study is: *"How are pre-service science teachers' awareness of socioscientific issues?"*. In order to examine this research question, he asked three different interview questions (Q1, Q5, Q6) to participants. Below, he presented findings by representing tables and interview quotations acquired from interviews.

When the given answers for the first interview question which aims to comprehend whether PSTs confronted with SSI before or not examined, the researcher explored that nearly two third of the PSTs confronted with SSI (Table 4.1) and one third of the PSTs

(mostly fourth grade PSTs) did not confront with SSI before the present study (Note: In order to provide easiness for reading the following tables, the researcher labeled the tables by adding "Group 1" if the tables belong to PSTs who confronted with SSI before the present study. On the other hand, if the tables belong to PSTs who did not confront with SSI before the present study, the tables are labeled by adding "Group 2" to the tables' names). It is important to note that the researcher called PSTs as confronted or not confronted with SSI according to some criteria. First, if PSTs experienced SSI through lessons, the researcher called those participants as PSTs who confronted with SSI before the present study. For instance, a PST might have taken a course in which they deal with SSI and SSI-based instruction or in which SSI took place by its name and as examples. Second, if PSTs learned what SSI is with their own efforts by researching or if they hear of and wonder, then the researcher called those participants as PSTs who confronted with SSI.

Table 4.1 Number of participants (Confronted or not confronted with SSI)

PSTs……(before)	**Frequency (f)**
who confronted with SSI	19
who did not confront with SSI	11

Table 4.2 Ways of meeting with SSI

		Frequency (f)
Through Lessons	Lessons in which SSI taught	15
Own Efforts	Research or hearsay	4

In Table 4.2, the researcher presented how PSTs confronted with SSI. By examining the table, it can be noticed that most of the PSTs confronted with SSI through lessons.

Interviewer: Have you ever confronted with SSI before?

STD8: Yes, I have. I have confronted through lesson.

Interviewer: What kind of lesson was it, could you explain please?

STD8: It was done as adaption of SSI to science program in its (the lesson) content, I mean we had a lesson in which how to adapt SSI that we encounter in our daily lives to science education…

The researcher acquired the above quotation directly from a PST's answer for corresponding interview question who received special course about SSI and SSI-based instruction. Most of the participants of the present study who confronted with SSI pointed out that they received such a course and the other PSTs pointed out that they confronted with SSI through lessons such as "Special Issues in Biology".

Interviewer: Have you ever confronted with SSI before?

STD13: Socioscientific issues… we had a lesson, "Special Issues in Biology", I have confronted there, not in the previous week but two weeks ago […]

Additionally, there were also other PSTs who confronted with SSI by way of their own efforts such as researching or hearsay.

Interviewer: Have you ever confronted with SSI before?

STD15: Socioscientific… not exactly. I have confronted but I do not have enough and appropriate ideas about it.

Although two third of the PSTs confronted with SSI, there were still other PSTs who did not confront with SSI before.

Interviewer: Have you ever confronted with SSI before?

STD27: No, I have not.

As explained in the previous chapters, SSI was directly included into 2013 National Science Education curriculum [2]. Therefore, in the present study, the researcher also aimed to reveal PSTs' awareness of the SSI in national science education curricula, current, 2013, and previous one, 2005. In this scope, he asked Q5 and Q6 to PSTs who confronted with SSI before the present study which was explored through Q1. Below, the researcher presented findings about awareness of PSTs towards the place of SSI in both 2005 and 2013 science curricula. Due to the fact that one third of the PSTs did not confront with SSI before, the researcher did not ask those questions to them.

Before asking the place of SSI in the curricula, firstly, the researcher asked a question to comprehend whether PSTs aware of and examine the national science education curricula or not. In the following, the researcher, firstly, presented PSTs' awareness of the 2005 National Science Education Curriculum and the place of SSI in that curriculum; then, he presented findings about 2013 National Science Education Curriculum.

Table 4.3 Awareness of 2005 curriculum and the place of SSI

Awareness of 2005 Curriculum	**Frequency (f)**	**Presentation of SSI**	**Frequency (f)**
I did not examine	1		
I examined	18	Presented	5
		Not presented	13

As can be understood from Table 4.3 that most of the PSTs were familiar with 2005 Science and Technology curriculum except one of them. While five of the PSTs emphasized the presence of SSI in 2005 curriculum, thirteen of them emphasized that SSI was not included in that curriculum.

Interviewer: Do you examine Science and Technology curriculum published in 2005 by Ministry of National Education?

STD17: A little. Socioscientific issues have not been given under a separate heading. There are perception and motivation kinds of things but it did not separate socioscientific issues. It was not shared as word, as socioscientific issues. Maybe, it could be integrated.

After the researcher revealed PSTs' awareness of the 2005 National Science and Technology Education curriculum and the place of SSI in that curriculum, he aimed to reveal PSTs' awareness of the 2013 Science Education curriculum. Similarly, with the previous one, first of all, he asked whether PSTs examined 2013 Science Education curriculum or not; and, then, he asked about the inclusion of SSI in that curriculum.

Table 4.4 Awareness of 2013 curriculum and the place of SSI

Awareness of 2013 Curriculum	**Frequency (f)**	**Presentation of SSI**	**Frequency (f)**
I did not examine	1		
I examined	18	Presented	16
		Not presented	2

As a result of Q6, the researcher investigated that while eighteen participants were aware of the 2013 Science Education curriculum, only one participant emphasized the opposite. Among eighteen participants, sixteen of them pointed out that SSI was included in the 2013 Science Education curriculum (Table 4.4*).*

Interviewer: Do you examine Science Education curriculum published in 2013 by Ministry of National Education?

STD1: Yes. We have examined it in the lesson.

Interviewer: Have socioscientific issues included into this curriculum?

STD1: Yes, socioscientific issues have been examined under a separate heading there, in this curriculum. Objectives have been regulated based on that. Additionally, the ability of constructed arguments has been given with socioscientific issues. I remember in this way.

As can be understood up to now, the participants emphasized that SSI was included directly in the curriculum, however there were two participants who pointed out being absence of SSI in that curriculum.

The researcher investigated that 8 out of 18 PSTs who emphasized the presence of SSI in 2013 Science Education Curricula also emphasized that SSI was shared under STSE.

STD12: It (SSI) has been included (2013 National Science Education curriculum). It is a subheading of science-technology-society.

4.1.2 SSI, Its Features, and Some Examples

Second sub question of the study: *How do pre-service science teachers conceptualize socioscientific issues and explain its features?*

In the present study, with the second sub question, the researcher aimed to examine how PSTs conceptualize SSI, and how are their views towards SSI's features. In accordance with this aim, he asked to PSTs three interview questions (Q2, Q3, and Q4). He revealed PSTs' SSI conceptualization with Q2, their understandings and views towards features of SSI with Q4, and what kind of topics PSTs perceive as SSI with Q3. Below, he presented the findings.

4.1.2.1 SSI Conceptualization and Features of SSI

As presented previously in Table 4.1, the researcher investigated that while some of the participants of the present study confronted and were aware of the SSI, other participants did not confront with SSI. Therefore, in this section, the researcher presented the findings as explained in the "Data Analysis".

In the following table, Table 4.5, and following explanations, the researcher presented SSI conceptualizations of participants who confronted with SSI before this study.

Table 4.5 Features of SSI (Group 1)

Category	**SSI is/has...**	**Frequency (f)**
Features	social and scientific topics	16
	scientific topics	13
	interesting, riveting topics	11
	social topics	8
	argumentative topics	7
	ill-structured topics (with not exact solution)	7
	up to date topics	5

Table 4.5 Cont'd

Features	from real life	5
	multidimensional topics	4
	reliable topics	4
	ethical and moral topics	3
	risk and benefit analysis	2
	applicable	2
Other	Science branches related with structure of society	1

When the answers examined, the researcher found that most of the PSTs conceptualized SSI as issues which have social and scientific dimensions at the same time (f=16). Interestingly, while some of them were emphasizing SSI as social topics with scientific dimensions (f=8), others emphasized SSI as scientific topics with social dimensions (f=13). In other words, some of the PSTs perceived SSI as social sciences topics, others did not. As shown by Ratcliffe & Grace [6], SSI is a multidimensional construct containing such as economic and politic dimensions and also have ethical and moral dimensions too. In the present study, only four participants emphasized the multidimensional structure of SSI and 3 of them expressed that SSI have ethical and moral dimensions.

Most of the participants, also, emphasized being interesting, riveting and society-related nature of SSI (f=11); and additionally being ill-structured without exact solution and argumentative were other most emphasized features (f=7 for each one). Five of the participants emphasized that SSI is the issue from everyday life. In addition, only a small number of participants (f=2) pointed out risk and benefit analysis which are important elements of SSI (*See quotation taken from STD17*).

STD17: Socioscientific issues... they should be open for argumentation, construct dilemmas, have both risks and benefits. There should be risk and benefits analysis.

Then… they have both social and scientific dimensions, it is too important I think. They should be open-ended, that's it.

Although most of the participants who confronted with SSI before the present study conceptualized SSI in a consisted way with the literature, there were still other participants who did not conceptualize SSI properly or incompletely. For instance, a participant conceptualized SSI as scientific branches and the areas such as sociology and archeology. (*See quotation taken from STD15).*

STD15: So, in general, it could be science branches related with structure of the society. Like, I don't know, I think maybe sociology and archaeology kinds of sciences could be.

Another participant's SSI understanding was only the relationship of daily life and science (*See quotation taken from STD4 quotation*).

STD4: What could be socioscientific issues? Socioscientific issues, I think, explain the relationship of science with everyday life somewhat and the relationship of science with everyday life and might deal with their common areas. Taking everyday life into science more.

Below, the researcher presented some other quotations.

STD10: Socioscientific issues, on the name, are social, scientific, quotidian, interesting, argumentative, and argumentative in ethical and moral dimensions topics.

STD2: Socioscientific issues are issues which have both scientific content and social content. They were argumentative, could not be solve exactly, then, tour teacher emphasized the need of presence of ethical and moral elements. So, that's it.

Up to now, the researcher presented findings by examining the data gathered from participants who confronted with SSI before the present study. In the following table, Table 4.6, and the following explanations, he presented SSI conceptualizations and understandings towards SSI's features of participants who did not confront with SSI before the present study. In order to examine that, he asked participants to make any inferences about SSI and its features (Q2-Q4). He presented the findings below.

Table 4.6 Features of SSI (Group 2)

Categories	**SSI is/has……**	**Frequency (f)**

Table 4.6 Cont'd

Features	topics related with real life	6
	scientific study related with society and structure of society	3
	social plus science	2
	socialize the science	2
	testable	1
	entertaining	1
	repeatable	1
	communication	1

As can be seen in the table, those participants mostly emphasized that SSI are the issues related with real life (f=6). Among eleven participants only 2 of them emphasized its social and scientific dimensions. One of the participants pointed out that SSI are testable, repeatable and entertaining topics.

Below, the researcher presented some quotations which belong to participants who did not confront with SSI:

STD28: Socioscientific… I think it has been aimed to teach science in more social environments. So, disseminating it among that environments, social environments. I mean it could be dissemination to environment.

STD30: Could it be something such as a scientific branch which interest in with social life? Let's say a scientific branch.

"STD22: Presumably, it is something related with society.

Interviewer: Could you expand?

STD22: Socio, society, social structure of society, it came into my mind from there. I mean it is a scientific study related with social structure of society."

STD27: Socioscientific issue… I thought, from societal perspectives, something like reducing science in a societal level but it came into my mind with science… In order students to connect science and social life together […]

When the researcher examined the above quotations, he realized that PSTs who did not confront with SSI before the present study mostly noticed that SSI is more likely to be related with society. In addition to that they noticed that those kind of issues can make the science for everybody.

4.1.2.2 Examples of SSI

The researcher investigated PSTs' SSI examples after examining their conceptualization about SSI and views towards SSI's features. Because of the fact that they will be teachers in the future, it is important to find out what kind of issues do they classified as SSI. Below, the researcher presented a table related with examples which were emphasized as SSI by PSTs (Table 4.7).

Table 4.7 Examples of SSI

Category	**Code**	**Frequency (f)**	**Total Frequency (f)**
Environment	Global Warming	7	22
	Environmental Pollution	7	
	Acid Rains	3	
	Zoo	3	
	Greenhouse	1	
	Migration	1	
Biotechnology	Genetically Modified Organisms	11	18
	Cloning	2	
	Experimental Animals	2	

Table 4.7 Cont'd

	Organ Donation	1	
	Stem Cell	1	
	Genetics	1	
Health	Health	3	15
	Nutrition	3	
	Antibiotic Usage/Insensible Drag Usage	3	
	Vaccination	2	
	Puberty	1	
	Cancer	1	
	Consanguineous Marriage	1	
	Smoking	1	
Energy	Nuclear Power Plant	5	11
	Nuclear Energy	2	
	Energy	2	
	Nuclear Weapons	1	
	Energy Plants	1	
Technology	Base Stations	3	9
	Electricity	3	
	Technology	1	

Table 4.7 Cont'd

	Technological Weapons	1	
	Cyber Attacks	1	
Others	Anatomy	1	5
	Light	1	
	Viruses	1	
	Sociology	1	
	Teeter Totter	1	

When the given examples examined, it was observed that PSTs provided examples mostly from environment category (f=22) which was followed with biotechnology (f=18). Additionally, health (f=15) and energy (f=11) also revealed as other popular categories in which PSTs mostly provided examples for SSI. Among all groups, GMOs (f=11) were the most popular examples for SSI pointed out by PSTs and this was followed with examples related with nuclear (f=8), global warming (f=7) and environmental pollution (f=7).

Below, the researcher presented quotations from PSTs who confronted with SSI before the present study:

"STD8: […] we can talk about zoo from this point such as taking animals from their natural environments and placing them into artificial environments. Else, it might be the benefits of GMOs or normal foods that we use in our daily lives.

Interviewer: *Well, could you tell me why those examples are SSI?*

STD8: *Those examples are not actually the topics which are needed to explain in the lessons but the topics that we encounter in our daily lives and we might encounter with some of them in our lessons. So, since we encounter with them in the lessons and show examples from everyday lives."*

For instance, STD8 emphasized that zoo is an example for SSI and also noticed the high probability of presence of such an argumentative topic in science lessons.

STD12: Examples […] Acid rains. I don't remind too many examples right now.

STD18: For example, GMO is a socioscientific issue […] or for example, nuclear power plants, energy types, I mean those kind of topics included. […]

When the researcher examined the provided examples of SSI, he can note that those are very popular SSIs. On the other and, in spite of the fact that most of the participants provided valid examples about SSI, there were still other examples which were open to question about being an SSI or not. For instance, light (f=1), electricity (f=3), and viruses (f=1) can be shown as examples which are related with this condition. At the same time, participants also expressed some examples which were not related with SSI such as teeter totter (f=1).

Below, the researcher presented quotations from STD23 who did not confront with SSI ever:

STD23: *For instance, firstly, teeter totter came into my mind. In the park for example, using a physics low with such a tool, but maybe we don't even recognize […]*

4.2 PSTs' Views towards SSI-based Instruction

The second research question of the present study was: *"What are the views of pre-service science teachers towards socioscientific issue based instruction?"*. In this part, the researcher presented findings towards this research question. In order to examine PSTs' views towards SSI-based instruction, participants were asked the second part of the interview. Because of the fact that the second research question has five different sub questions, in the following, the researcher presented results for each sub question in different parts. In these parts, the researcher presented findings about the views of PSTs towards SSI-based instruction, the roles of teachers, students, and other stakeholders for SSI-based instruction, and self-efficacy beliefs of PSTs towards inclusion of SSI in their future science classes.

At that point, it is important to remind that the researcher explored there are PSTs who confronted with SSI before the present study and who did not (the researcher labelled those groups as Group 1 for the former and Group 2 for the latter). Therefore, in order to pursue the study with PSTs who did not confront with SSI before the present study,

the researcher provided them some information about SSI by using Ratcliffe and Grace's definitions and explanations on SSI [6] as explained in "Data Analysis". The aim for this is to gather all of the participants' considerations about SSI-based instruction.

4.2.1 Instructional Approaches for SSI-based Instruction

In this section, the researcher presented findings towards the first sub question of the study. The first sub question is: *"How do pre-service science teachers perceive socioscientific issue based instruction?"*. With this research question, the researcher aimed to investigate PSTs' views towards how to construct a lesson(s) in which SSI will be integrated.

In order to investigate the research question presented above, the researcher asked Q1 of the Part B to the participants. According to the obtained replies of PSTs, the researcher found that PSTs pointed out some characteristics of SSI-based instruction; in other words, PSTs emphasized instructional approaches through which they can deal with SSI during lesson(s). In Table 4.8, the researcher presented instructional approaches for SSI-based instruction of PSTs who confronted with SSI before the present study (Group 1). PSTs who confronted with SSI before the present study through a special course in which SSI and SSI-based instruction were taught mostly emphasized the instructional approach that they learned through that course (f=9). In this approach, first of all, a teacher gets students' attention about the issue and then arouse the curiosity of them towards that issue by presenting video, news or something else related with the topic. Then, the whole class discusses on the issue, makes different activities related with the issue and discusses again on their decisions related with the issue.

About another instructional approach, PSTs who confronted with SSI before the present study pointed that, first of all, they present the issue and provide information to students about presented SSI. Then, the whole class including teacher discusses on the issue (f=6). Throughout those discussions, different materials can be presented by members of the class.

PSTs who confronted with SSI before the present study also provided two different instruction approaches for SSI based instruction. In the first one, the teacher groups the class and then distributes essays, which are related with the corresponding SSI. Student groups, then, read the essays and make in-group discussions. As a next step, in-class

discussions are made and the members of the class choose their sides. In the other approach, a PST pointed out that she can organize field trip to places where/which are related with corresponding SSI. Then, she stated that she present information in these places and discuss the corresponding SSI.

Table 4.8 Instructional approaches for SSI-based Instruction (Group 1)

Instructional approaches for SSI-based instruction	**Frequency (f)**
Getting attention about SSI provided – arousing curiosity by presenting video, news etc. – discussing on the SSI – making related activities	9
Informing students about SSI provided – discussing on the SSI – showing and sharing different sources	6
Grouping students – distributing essays related with given SSI to groups – discussions on essays in between groups – discussion among class about SSI	1
Real setting observation – discussions	1

Below, the researcher presented some interview quotations.

STD12: I think, it is started with socioscientific issues, I mean because of the fact that they are already issues from everyday life, by starting with them students' attention should be taken and this should be explained like that […]

Interviewer: How do you continue the lesson?

STD12: Some video could be watched related with the lessons. Anew, news examples could be shown, they are already confronted mostly.

STD2: First of all, whether which topic would be talked, the concepts related with them should be provided to students […] then, because of the fact that I teach students I have to have more and more sources […]

The researcher present two different quotations. When those quotations examined, it can be noticed that PSTs provided different approaches. For instance, while STD12 aim to

start the lessons by getting students attention, other participant aim to provide some information and data source about SSI which will be handled and continue the lesson.

Table 4.9 Instructional approaches for SSI-based instruction (Group 2)

Instructional approaches for SSI-based Instruction	**Frequency (f)**
Presenting SSI which is next lessons topic – students' research on provided SSI – discussion in class about topics by asking questions – making activities – evaluating idea (how they changed)	3
Informing students about SSI provided – getting students' idea – discussions on them	3
Creating small discussion groups – discussions among those groups – presenting groups' idea – discussions on them	2
Researching about issues without teachers' interpretations	2

The researcher explored the idea of PSTs who did not confront with SSI before the present study about instructional approaches for SSI-based instruction (Group 2). Among 11 PSTs, 10 of them were provided possible instructional approaches and only one PST did not provide any for SSI-based instruction. The researcher investigated that there is no general consensus on a single instructional approach for SSI-based instruction (Table 4.9). For instance, 3 of them pointed out that before presenting SSI, they want student to come the class after making research about the presented issue. Then, by discussing on the issues, making activities with related issues if possible and finally presenting students' idea, the lesson(s) can be provided by the teachers.

PSTs from this group also noticed another instructional approach for SSI-based instruction. In this model, teachers provide information about presented SSI, get students' idea, and make whole class discussions (f=3).

In this group, two different instructional approaches were provided by PSTs additionally. Two of the PSTs emphasized that teacher make small groups and present SSI to them. Then, in-group discussions are made. As a next step, each group presents

their group's idea and whole-class discussions are made (f=2). Other two PSTs emphasized that they expect students to search about presented SSI and share their idea. Throughout this process, teacher should not interfere the discussions.

Below, the researcher presented one of the quotations from interviews.

STD27: Actually, I want students to make research about those issues. Of course, specific sources maybe I provide specific sources because there are infollution especially on the Internet. […] then I created discussion environment by directing some questions. Then, I could talk about ethical dimension of the topics. […] maybe I could prepare activities […]

4.2.1.1 Teaching Methods for SSI-based Instruction

In the present study, the researcher aimed to explore which teaching methods PSTs prefer to provide SSI-based instruction in their science classes. In the following, the researcher presented related findings.

Table 4.10 Teaching methods for SSI-based instruction (Group 1)

Category	**Code**	**Frequency (f)**	**Total Frequency (tf)**
Student Centered	4E-5E-7E Methods	7	27
	Argumentation	6	
	Investigation	5	
	Brainstorming	3	
	Gagne's teaching method	2	
	Researching-questioning	1	
	Gaming	1	
	Concept maps-Concept web	1	

Table 4.10 Cont'd

Teacher Centered	Presentation	5	11
	Question-Answer	2	
	Precedent	2	
	Demonstration	1	
	Experts' Presentations	1	

According to the results, the researcher found that most of the PSTs who confronted with SSI before the present study were willing to use student-centered approaches to deal with such issues (Table 4. 10). 5E teaching method and its derivatives (f=7), argumentation (f=6) and investigation (f=5) were mostly emphasized student-centered teaching methods which PSTs noticed as appropriate methods for SSI-based instruction. Methods such as researching-questioning (f=1), concept map & web (f=1), gaming (f=1), and brainstorming (f=3) were pointed out by the participants also.

Below, the researcher presented some quotations from interviews. In both quotations, the researcher observed that participants are willing to use student-centered teaching methods.

STD13: Which teaching strategies and methods mostly… there are discussion environment, brainstorming, concept map and concept webs kind of things, I mean I put a bait middle and try to make students active. […]

STD7: […] I would prefer 5E but apart from that the methods that we saw 4E method or any method, method of Gagne… […]

Apart from student-centered methods, participants also emphasized teacher-centered methods. Presentation (f=5) and question and answer (f=2) methods were mostly stated methods among teacher-centered methods.

STD1: I wanted to say investigation method but I do not know how to use investigation method, I mean what I am discovered to students so about socioscientific issues I would use presentation method more and more I mean by showing something to them.

Up to now, the researcher noticed teaching methods according to PSTs who confronted with SSI before the present study. In addition to that, after examining answers of PSTs who did not confront with SSI before the study for corresponding question, the researcher explored that most of the PSTs were willing to use student-centered teaching methods as other group's PSTs (Table 4.11). For example, STD20 and STD27 pointed out that point explicitly.

STD20: So, researching-questioning because students make research themselves. Then I would use project definitely. […]

STD27: It could be constructivist approach. Actually, I do not think presentation, never. By discussing or communicating with students I think it could be done […]

Table 4.11 Teaching methods for SSI-based instruction (Group 2)

Category	**Code**	**Frequency (f)**	**Total Frequency**
Student Centered	Argumentation	8	25
	Researching-questioning	5	
	Brainstorming	3	
	Investigation	3	
	Problem based	2	
	Project-Material	3	
	Cooperative learning	1	
Teacher Centered	Presentation	2	4
	Question-Answer	1	
	Precedent	1	

Among the student-centered teaching methods which were pointed out by PSTs, most of the participants emphasized argumentation (f=8) which was followed by researching and questioning (f=5) and brainstorming (f=3). On the other hand, there were some PSTs who were willing to use teacher-centered approaches such as presentation (f=2), question and answer (f=1) and precedent (f=1). At that point, it is important to emphasize that PSTs who did not confront with SSI before less willing to use teacher-centered methods than other group.

4.2.1.2 Facilitating and Impeding Factors for SSI-based Instruction

In this part, the researcher presented PSTs' consideration of possible facilitating and impeding factors for SSI-based instruction. In the following two tables, Table 4.12 and Table 4.13, the researcher shared PSTs' general considerations of the related issue. It is possible to note that there are similar patterns of PSTs from both groups who confronted with SSI (see Table 4.12) and who did not confront with SSI before the present study (Table 4.13).

Table 4.12 Facilitating and impeding factors for SSI-based instruction (Group 1)

	Frequency
Impeding Factors	
Planning/Preparing	13
Finding appropriate materials	12
Classroom Management	10
Classroom participation	5
Time-consuming	5
Cost	4
Facilitating Factors	
Expressing idea	8

Table 4.12 Cont'd

Learning and comprehension of topics	7
Connecting issues with everyday life	7
Focusing	2
Developing argumentation skills	2
Being economic	1
Planning	1
Developing curiosity	1
Developing research skill	1

Table 4.13 Facilitating and impeding factors for SSI-based instruction (Group 2)

	Frequency
Impeding Factors	
Classroom management	8
Planning/Preparing	6
Preparation of students	4
Evaluation	4
Teaching issues	2
Dealing with misconceptions	1
Facilitating Factors	
Expressing idea	7

Table 4.13 Cont'd

Connecting issues with everyday life	5
Developing argumentation skills	5
Easy to deal with issues	2
Finding resources	1

The researcher found that PSTs who confronted with SSI before the present study mostly emphasized *planning/preparing* (f=13), *finding appropriate materials* (f=12) and *classroom management* (f=10) as the top difficulties for SSI-based instruction. PSTs from other group also emphasized the same points as top possible impeding factors for SSI-based instruction (classroom management (f=8), planning/preparing (f=6)) except finding appropriate materials. Moreover, while requirement huge amount of time (f=5) and high costs (f=4) were shown as difficulties by participants who confronted with SSI before the present study, other participants did not emphasize such points; however, they emphasized preparation of students (f=4), evaluation (f=4), teaching the issues (f=2) as other possible impeding factors for SSI-based instruction.

Below, the researcher presented some quotations. (STD4, 10, and 12 are participants who confronted with SSI before the present study)

STD28: So, for instance, the impeding factors might be that it could be occur chaos environment in the class. […] that discussion could be change to quarrels. […]

STD12: First of all, more discussion environments are born so this topic could be drag on. It could be gone differently. It could be scattered. […]

STD10: Once, application process might take too many time.

STD4: Once, we said that there is no exact answer, discussion environment will be created so in classroom management there are faced with difficulties definitely. […] and I think about material preparation there could be faced with distress. […] Additionally for example, making students active could be difficult)

After examination of the above quotation, the researcher can notice that STD4, 12 and 28 considered classroom management as an impeding factor. Additionally, STD10

considered being time consuming as a difficulty (impeding factor) for SSI-based instruction.

By now, the researcher noticed possible impeding factors for SSI-based instruction. In the present study, additionally, PSTs' considerations of possible facilitating factors for SSI-based instruction were obtained by the researcher. About facilitating factors for SSI-based instruction, PSTs who confronted with SSI before the present study emphasized that students easily express their idea (f=8) during classes, learn the issues and related topics presented more easily and successfully (f=7) and easily associate the presented issue with everyday life (f=7). Additionally, some of the participants pointed out that SSI-based instruction is economic (f=1), easy to plan (f=1), and easily develop curiosity (f=1), research (f=1) and argumentation skills (f=2).

Below, the researcher presented some quotations which belongs to those participants.

STD6: What kind of facilitating factors could it have… At the end, you could make whatever comment you want, you are free. […] (expressing idea)

STD19: Facilitating factors… once, because of the fact that the topic that we explain is intriguing I think it would be easier to explain that and understanding that. (learning and comprehension of topics, expressing idea)

PSTs who did not confront with SSI before the present study also emphasized some points about facilitating factors for SSI-based instruction (Table 4.13). They pointed out that students express their idea more easily through SSI-based instruction (f=7) and associate the presented issues and their related topics with everyday life more easily. In addition, they emphasized that argumentation skill development can be more easy through SSI-based instruction (f=5). One of the participants emphasized that for SSI-based instruction, it is easy to find resources and this can be a facilitating factor (f=1).

Below, the researcher presented quotations which belongs to those group's participants.

STD24: It (presented SSI) can be related with real life, and students generally have idea about real life; I mean, they develop culturally […] their discussion skills develop. […]

STD21: Easy, I mean it (the lesson) is made in a conversation environment, everybody expresses their idea eventually. It (SSI) produce frank environment.

Instead of the fact that cost was emphasized as an impeding factor for SSI-based instruction, STD19 who confronted with SSI before the present study also emphasized

that the cost issue can be vice versa. In other words, sometimes dealing with SSI-based instruction might not require high costs.

STD19: […] Apart from that financial situation might be vice versa. The school that I go might be very luxury. It could be college, a very rich school. […] we could find a researcher how to say a conference maybe. A conference may be given. That could be an easiness.

4.2.2 Teachers' Roles for SSI-based Instruction

In this part, the researcher presented findings towards the second sub question of the study. The second sub question is: "How do pre-service science teachers view teachers' roles for socioscientific issue based instruction?"

As teachers' role, PSTs who confronted with SSI before the present study mostly emphasized guidance (f=11), good planning/preparation (f=9), and being knowledgeable about issues (f=8) (Table 4.14). In addition to these, to have good classroom management skill (f=6) was also emphasized as an important teachers' role by those participants. Lastly, those participants emphasized being impartial (f=4) and informative (f=3) while dealing with SSI during lessons and also being aware of the place of issues in daily life (f=3) as other teachers' roles.

STD3: First of all, teachers should know that (SSI), first instance we go out there are already so many teachers who do not know that (SSI). They don't know socioscientific issues, 5E teaching method, and constructivism; so there are so many teachers who know none of them because of the fact that they do not follow. […]

STD4: Once, the teachers' role should, it is actually like that for every lessons but, be actually becoming advisor, but in socioscientific issues it becomes guidance role more and more. […]

STD11: I think teachers should not directly explain the topics. They should direct students to discover. I want teacher to have guidance role more and more. I think so. So, as guidance, that's it.

Table 4.14 Teachers' role for SSI-based instruction (Group 1)

Teachers' Roles	**Frequency (f)**
Guidance	11

Table 4.14 Cont'd

Good planning/preparation	9
Being knowledgeable about issues	8
Having good classroom management skills	6
Being knowledgeable	6
Being impartial	4

PSTs who did not confront with SSI before the present study also emphasized similar points as teachers' roles as can be seen in Table 4.15. They pointed out the importance of having a guidance role during SSI-based instruction (f=9). Differently from other participants' answers, they emphasized more being impartial (f=7) and less being knowledgeable (f=3). In addition, coming the class with adequate planning and preparation (f=2) were also less emphasized by those PSTs. While nail-biting and being active were emphasized once, none of them emphasized the importance of having good classroom management skills.

Table 4.15 Teachers' role for SSI-based instruction (Group 2)

Teachers' Roles	**Frequency (f)**
Guidance	9
Being impartial	7
Being knowledgeable	3
Good planning/preparation	2
Being active during class	1
Nail-biting	1

Below, the researcher presented some quotations of PSTs who did not confront with SSI before the present study.

STD21: Once, she/he has knowledge about topics, I mean if she/he does not have enough knowledge, then it is not. She/he should direct students and direct discussions not towards their views but on a different line. Teachers must be active during the process.

STD20: […] becomes guidance, when s/he enter the classroom, s/he becomes guide. As I said that s/he does not impose themselves on students. […]

It is important to emphasize at this point that one of the participants pointed out that the roles of teachers do not differ while dealing with SSI; in other words, he noticed that teachers' roles are stable for all topics.

STD25: […] now, when you said teachers' role, I thought that for instance you are asking for socioscientific issues but I am not seeing a different role of teachers from others' role.

4.2.3 Students' Roles for SSI-based Instruction

In this section, the researcher presented findings towards the third sub question of the study. The third sub question is: *"How do pre-service science teachers view students' roles for socioscientific issue based instruction?"*

In Table 4.16, the researcher presented findings for PSTs who confronted with SSI before the present study for related research questions. It is possible to say that PSTs mostly emphasized the role of participation of students (f=12). Participants also emphasized the importance of expression of students' ideas (f=8). Coming the lesson after researching and preparation for lessons (f=8) similarly were mostly noticed as other important students' roles. Below, the researcher presented some quotations from interviews.

Table 4.16 Students' roles for SSI-based instruction (Group 1)

Students' Roles	**Frequency (f)**
Active participation	12

Table 4.16 Cont'd

Expressing his/her ideas	8
Researching/preparing	8
Being willing towards lessons	5
Respectful towards each other	4

STD10: Students should be willing, active, think; think about that topic. […]

STD3: The roles of students are following teacher's directives correctly, making the activities carefully and then thinking, through the lessons, thinking […]

STD4: […] I am waiting students to be volunteer for researching too. Active participation and making research. Of course, I am creating a discussion environment and I want them to have idea. My main aim is that. During having idea, they should continue by listening and understanding each other's idea with due regard. […]

Table 4.17 Students' roles for SSI-based instruction (Group 2)

Students' Roles	**Frequency (f)**
Being searcher	6
Being knowledgeable	4
Being interested in with presented issues/lessons	3
Active participation	3
Respectful towards each other	2
Liking thinking	1

The researcher examined answers of PSTs who did not confront with SSI before the present study about related question and found that those participants pointed out active participation (f=3) as an important students' role. On the other hand, being searcher role (f=6) was emphasized mostly by those participants as importantly as the other one (Table 4.17). Being respectful (f=2) towards each other during class time, knowledgeable (f=4) and interested in with issues (f=3) were also emphasized as other important students' roles by those participants (Table 4.17).

STD30: Students should express his/her opinions. They participate in the lessons actively. They become searcher a little. It is required to show interests. It is like that.

STD28: Students' roles, once students become very active, they continuously make researches before one day from lessons and get information. Then, they participate in the discussions, continuously become active. […]

4.2.4 Other Stakeholders' Roles for SSI-based Instruction

In this section, the researcher presented findings towards the fourth sub question of the study. The fourth sub question is: "How do pre-service science teachers view other stakeholders' roles (such as program developers and administration) for socioscientific issue based instruction?"

As presented in Table 4.18, PSTs who confronted with SSI before the present study mostly thought that program developers have an important role for SSI-based instruction. They importantly emphasized that program developers should regulate the current programs in order to apply SSI and include SSI into teaching practice easily and appropriately (f=8). For instance, STD15 emphasized that point:

STD15: […] I think while in the process of regulating programs, they might leave open doors for those (SSI). […]

Besides, PSTs emphasized that other stakeholders such as researchers (f=10), parents & society (f=5), and school administration (f=3) have different roles for SSI-based instruction. Presenting information about SSI and examples of SSI such as GMOs were mostly pointed out by the PSTs (f=8). Participants also emphasized the importance of producing and providing such as resources and opportunities (f=4, f=3) for SSI-based instruction. It is important to emphasize that dealing with exam anxiety problems was also shown by one of the PSTs as role of other stakeholders. Below, the researcher presented some quotations from interviews.

STD1: […] students mostly think the exams; their main aim becomes grade continually. There could be done something to prevent that maybe they could been become easier […].

STD3: […] In their (teachers) holiday, they go in-service trainings. In in-service trainings, they could be given information about that (SSI).

Table 4.18 Other stakeholders' roles for SSI-based instruction (Group 1)

Stakeholders	**Roles**	**Frequency (f)**
Program Developers	Making revisions on the available curricula for integration of SSI	8
	Producing materials	4
Researchers	Giving information about SSI and SSI topics	8
	Making continuous research about SSI	2
Parents & Society	Researching with open mindedness	4
	Providing easiness	1
School administration	Providing resources and opportunities	3
Other stakeholders	Dealing with exam anxiety problems	1

In the present study, the researcher also investigated the views of PSTs who did not confront with SSI before the present study towards other stakeholders' roles. The researcher explored that those PSTs also emphasized the roles of program developers toward integrating SSI into program appropriately (f=5). The roles of parents & society were also another point which were emphasized mostly (f=6) (Table 4.19). School administrations' roles towards providing such as enough required materials, rooms, and other opportunities for SSI-based instruction were pointed out (f=3) by PSTs. Below,

the researcher presented some quotations from interviews of PSTs who did not confront with SSI before the present study.

Table 4.19 Other stakeholders' roles for SSI-based instruction (Group 2)

Stakeholders	**Roles**	**Frequency (f)**
Parents & Society	Being searcher	4
	Being knowledgeable	1
	Not being heavy hand	1
Program Developers	Revision the available program for SSI	5
School Administration	Providing resources and opportunities	3
Other branch teachers	Participation	1

STD27: […] maybe it might be required to make researches about those topics (SSI) by parents, families. […] I have thought that they (program developers) have roles. So what kind of roles do they have actually, it is related with program, how those topics might be deal with. They could be prepared auxiliary programs which help teachers to transfer that (SSI) to students.

STD20: […] Ok, school administration should provide whatever materials that students want and open to every students from first grade to eight grade without saying you could not do it. […]

4.2.5 PSTs' Self-Efficacy Beliefs Regarding SSI

In this section, the researcher presented findings towards the fourth sub question of the study. The fourth sub question is: "How are pre-service science teachers' self-efficacy beliefs towards using socioscientific-issue based instruction?"

After asking related interview question, the researcher explored that most of the PSTs from both group, who confronted with SSI and who did not confront with SSI before the present study, have less self-efficacy beliefs towards SSI-based instruction. In total, while eighteen participants of the present study emphasized that they did not perceive themselves as enough for SSI-based instruction, seven of them see themselves partially enough and five of them perceive as enough to deal with SSI in their science classes (Table 4.20).

Table 4.20 Self –efficacy beliefs towards SSI-based instruction

Do you see yourself enough for SSI-based instruction?	**Frequency (f)**
Yes	5
Partially	7
No	18

As further examination, the researcher explored that more PSTs from the first group who confronted with SSI before the present study perceived themselves as having more self-efficacy beliefs towards SSI-based instruction when compared with the second group PSTs who did not confront with SSI before the present study. As shown in Table 4.21 and Table 4.22, while four PSTs perceived themselves as enough from the first group; from the second group, only one PST perceived himself as enough for SSI-based instruction. The researcher presented the interview quotation for this student below:

Interviewer: Do you see yourself enough for dealing with SSI-based instruction in your future professional teaching life?

STD21: I am. I like to take different views, I like searching like scientific magazines. […] and I could use that method.

Table 4.21 Self –efficacy beliefs towards SSI-based instruction (Group 1)

Do you see yourself enough for SSI-based instruction?	**Frequency (f)**

Table 4.21 Cont'd

Yes	4
Partially	6
No	9
Total	19

Table 4.22 Self –efficacy beliefs towards SSI-based instruction (Group 2)

Do you see yourself enough for SSI-based instruction?	**Frequency (f)**
Yes	1
Partially	1
No	9
Total	11

Because of the fact that most of the students perceived themselves as not enough for SSI-based instruction, it become more of an issue to understand the reasons of such a condition. Under the light of that purpose, the researcher explored the reasons of low self-efficacy beliefs; and, in the following table, he presented a general representation and by using quotations from interviews, made further explanations about this condition.

Table 4.23 Reasons of lack of self-efficacy towards SSI-based instruction

	Reasons for Lack Self-Efficacy towards SSI-based Instruction	**Frequency (f)**
Categories	**Reasons for PSTs who confronted with SSI before the present**	

Table 4.23 Cont'd

	study	
Personal Characteristics	Lack of experience	5
	Lack of content knowledge	4
Characteristics of SSI-based Instruction	Requirement of research	6
	Requirement of being up to date	2
Categories	**Reasons for PSTs who did not confront with SSI before the present study**	
Personal Characteristics	Lack of content knowledge	3
	Lack of interest towards SSI	1
	Lack of self confidence	1
	Lack of interest towards science	1
Characteristics of SSI-based Instruction	Requirement of practice	2
	Requirement of research	2
	Requirement of being up to date	1
Characteristics of Scientific Knowledge	Being tentative	1
	Being up to date	1

As can be seen in Table 4.23, most of the PSTs from both groups point out lack of experience (f=5, f=2) and lack of content knowledge (f=4, f=3) as sources of lack of self-efficacy towards SSI-based instruction. Additionally, requirement of more research for dealing with SSI (f=4, f=2) was shown as another reason for their teacher self-efficacy beliefs. While PSTs who did not confront with SSI before the present study

emphasized some points from characteristics of scientific knowledge for lack of self-efficacy such as being tentative and being up to date, none of the PSTs from other group mentioned about such points. In addition to that, while there are PSTs who have lack of interest towards SSI and science, the researcher did not find any PST, who mentioned about those points, from other group who confronted with SSI before this study. Below, he presented some quotations related with self-efficacy beliefs.

Interviewer: Do you see yourself enough for dealing with SSI-based instruction in your future professional teaching life?

STD20: No, of course I am not, at that moment I could not even make normal presentation and so at that moment it is more difficult. […] You could see lack of self-confidence maybe, but when I enter the class I just know A+B=C, I just learned that. I have not educate myself about those, my training is not enough […]

STD8: I could not say directly that I apply, I could apply SSI-based instruction in my lessons because I think that I am not still ready for that […]

STD3: So, I think it is not possible to see completely enough; of course we took lessons of that but this is something open-ended so I could not say I am enough.

CHAPTER 5

DISCUSSIONS

5.1 PSTs' Views towards SSI

Due to the fact that SSI was directly included in the 2013 National Science Education curriculum [2], it is important to examine science teachers, educators and PSTs' awareness and knowledge towards SSI. Thus, in the present study, with first research question, the researcher aimed to investigate PSTs' awareness and views towards SSI. In order to reach that aim, the researcher investigated and presented PSTs' experiences with SSI, whether they confronted with SSI or not and how; how are PSTs' awareness towards the place of SSI in national science education curricula [2], [38]; what PSTs know about SSI and SSI's features in the previous chapter. In the following paragraphs, the researcher discussed the results.

First of all, in the present study, the researcher investigated the awareness of participants towards SSI. Due to the fact that SSI was directly included in national science education curriculum [2] and; as indicated in the previous studies, the substantial contributions of SSI to students' intellectual and emotional development, higher order thinking skills, and so on, PSTs' awareness towards those issues gains significance. In the present study, the researcher found that nearly two third of the PSTs were aware of SSI. The researcher found that receiving a specialized course in which PSTs learn what SSI is and what are the appropriate teaching models for SSI-based instruction are explained can be shown as one of the most significant factors for such an awareness. In addition, the researcher explored also that in the courses such as Special Issues in Biology, SSI were presented by the instructor and these courses contributes PSTs' awareness towards SSI. About national science education curricula, it can be noticed that those participants who are aware of SSI mostly indicated enough awareness

towards the place of SSI in the corresponding 2005 and 2013 National Science Education Curricula. As far as the researcher investigated, such a results occurred due to receiving a specialized course about SSI and participants own attitude levels towards SSI.

On the other hand, the researcher explored that one third of the participants were aware of neither the SSI nor the place of SSI in the national science education curricula. This condition also very important to rake up because todays' PSTs are tomorrows' science educators and it is very probable to blunder on with SSI in the classroom settings.

Secondly, to comprehend PSTs' views towards SSI and its features were another aim of the present study. In the present study, as mentioned earlier, PSTs conceptualized SSI as issues having both social and scientific dimensions at the same time. Participants also emphasized ethical dimension and multidimensional structure of SSI. Lee et al. [11] and Kara [41] found in their studies that the participants emphasized the ethical dimension of SSI. Özden [43] found that the pre-service elementary school teachers described SSI as having ill-structured & open-ended nature; having ethical and moral dimension and also giving place to risk and benefit analysis and the present study's results were consisted with Özden's [43] study results. PSTs who confronted with SSI before the present study described SSI as ill-structured, interesting and riveting, argumentative up-to-date topics which are reliable, applicable and contains topics from real life.

On the other hand, in order to explore what PSTs, who did not confront with SSI before the present study, can conceptualize about SSI, the researcher asked them to explain what they can notice about SSI and its features. PSTs provide their idea about SSI only by considering SSI's name due to the fact that the researcher did not present them any information about SSI at that point. The researcher of the present study explored that participants, who did not confront with SSI before the present study, were not be able to describe SSI very effectively in line with Ratcliffe and Grace's explanations [6] about SSI. Between 11 participants, it was not occurred any consensus on SSI's definition; however, most of them emphasized that SSI are related with everyday life. The researcher of the present study predicts that the reason of such a finding is the presentation of the idea about SSI by only considering SSI's name.

In the present study, the researcher investigated what kind of issues/topics PSTs perceive as SSI and in accordance with this purpose, he found that PSTs mostly pointed

out environmental issues which were followed with biotechnological, technological, health, and energy issues as SSI (Note: Biotechnology, technology, health, and energy are the categories that the researcher constituted after receiving participants' responses). These findings are also consisted with the study findings of Yapıcıoğlu [46]. In her study with pre-service science teachers, she found that mostly environmental and biotechnological issues were indicated as SSI. GMOs, environmental topics (in general), global warming, blood donation, and organ donation were some of the mostly emphasized SSIs by pre-service science teachers. Consistently with Yapıcıoğlu's study [46], in the present study, GMOs, global warming, and environmental issues were the most emphasized SSIs. However, the difference between the study of Yapıcıoğlu [46] and the present study is that while one participant of the present study emphasized organ donation as an SSI, no participant emphasized blood donation as a SSI. In the present study, besides, issues related with nuclear energy such as nuclear power plants and nuclear weapons were mostly emphasized by the PSTs.

The researcher explored that some of the issues/topics were emphasized a considerable amount of more when compared with other issues. For instance, GMOs, nuclear energy issues, global warming, and environmental pollution were the mostly emphasized issues in the present study. The reason of the popularity of such issues can be shown as participants' experiences with them. In the study of Kolsto [20], it was pointed out that a member of a society can confront with any of the SSI through different ways such as media, courses, and so on. In the present study, PSTs who confronted with SSI before through a specialized course, for example, noticed that in their course, they deal with GMOs and global warming. In addition, in Turkey, the constructions of nuclear power plants are being discussed in the media. These points can be shown as the reasons for popularity of such issues.

5.2 PSTs' Views towards SSI-Based Instruction

In the present study with the second research question, the researcher aimed to investigate PSTs' views towards SSI-based instruction. In order to reach this aim, he investigated PSTs' perceptions towards SSI-based instruction; their views towards the roles of teachers, students, and other stakeholders such as program developers and school administrations; and PSTs' self-efficacy beliefs towards SSI-based instruction. In the following, the researcher discussed the findings for each of the count by

associating the similarities and differences of the present study's results with the related literature.

First of all, the researcher examined that how PSTs perceive SSI-based instruction; in other words, the researcher aimed to investigate PSTs' instructional approaches (characteristics of SSI-based instruction) which they consider as useful and appropriate to deal with SSI in science classes, what kind of teaching methods can be used to carry out SSI-based instruction and what can be possible impeding and facilitating factors for SSI-based instructions. In the present study, participants provided their idea about different instructional approaches for SSI-based instruction; however, in general, it can be noticed that among 30 PSTs, there are no general consensus on instructional approaches for SSI-based instruction. In addition to that there were some PSTs who were not be able to provide any idea about instructional approach through which they can deal with SSI in the science classes.

The researcher found that PSTs who confronted with SSI before the present study are more willing to build instructional approaches by using student-centered teaching methods for SSI-based instruction and integrating students more and more into the lessons. Alaçam-Akşit [39], in her study with prospective elementary school teachers, found the similar results with the present study. Her study's participants also more willing to use student-centered teaching methods while dealing with SSI in the classes. In the present study, the researcher found that 9 PSTs, who confronted with SSI before the present study through a specialized course which explained before, provided an instructional approach similar to the approach of Friedrichsen et al. [35] which they used while explaining antibiotic resistance in their study. At that point, it is important to note that those participants learned Friedrichsen et al.'s instructional approach for SSI-based instruction [35] during their training about SSI; and as far as it is comprehended that this shaped those PSTs' suggested instructional approach and their point of view about SSI.

By now, the instructional approaches for SSI-based instruction according to PSTs who confronted with SSI before the present study were discussed by the researcher. On the other hand, the researcher explored also the idea of PSTs who did not confront with SSI before the present study about instructional approaches for SSI-based instruction. It can be said that there is no consensus among those participants on any of the instructional approach (Table 4.9). In addition to that, when both groups' instructional approaches

compared, it can be noticed that those PSTs' suggested instructional approaches were not as effective as the other group PSTs' instructional approaches.

In the present study, apart from instructional approaches for SSI-based instruction which PSTs suggested, the researcher aimed to gather PSTs' views towards what kind of teaching methods can they use while dealing with SSI. It was found that participants preferred mostly student-centered teaching methods for SSI-based instruction. Yapıcıoğlu [46] also explored that most of her study's participants, who are pre-service science teachers, preferred student-centered teaching methods to deal with SSI during science classes. While in her study, PSTs mostly chose dilemma cards, argumentation and problem scenarios as teaching methods, in the present study, PSTs mostly emphasized using argumentation, 5E teaching method and its derivatives such as 4E and 7E, investigation and also researching-questioning methods and none of the participants emphasized using dilemma cards. Friedrichsen et al. [35] created a methodology for SSI-based instruction by combining and using different teaching methods such as 5E and argumentation. In the present study, same teaching methods were noticed by participants and the researcher investigated that most of the participants who confronted with SSI before the present study through a specialized course emphasized those teaching methods. As an important point, it was also discovered that none of the PSTs who did not confront with SSI before the present study noticed using 5E teaching method for SSI-based instruction.

On the other hand, apart from student-centered teaching methods, some of the participants (mostly PSTs who did not confront with SSI before the present study) pointed out teacher-centered methods as appropriate teaching methods to use for SSI-based instruction. Presentation was one of the most emphasized teaching methods. They pointed out by using direct instruction, teachers can deal with SSI in science classes.

After examining PSTs' views towards how to deal with SSI during lessons and which teaching methods they preferred, the researcher aimed to investigate their views towards possible impeding and facilitating factors for SSI-based instruction; in other words, easiness and difficulties of SSI-based instruction. As stated in the studies of Kara [41] and Lee et al. [11], material deficiencies, time problems, planning and preparation, need for advanced classroom management skills and also some other factors were shown as obstacles towards inclusion of SSI into science lessons. In the present study, the researcher investigated similar results. Participants noticed planning and preparation,

finding appropriate teaching materials related with SSI and classroom management as the top difficulties for SSI-based instruction. While planning and preparation and finding appropriate teaching materials related with SSI were shown as the top difficulties by PSTs who confronted with SSI before the present study, other PSTs who did not confront with SSI emphasized classroom management as top difficulty for SSI-based instruction. While requirement of high cost and time to design a lesson for SSI were shown as difficulties by PSTs who confronted with SSI before this study, other PSTs, who did not confront with SSI, did not notice those points as difficulties; however, they noticed the difficulties of evaluation of SSI-based instruction. In Lee et al.'s study with science teachers [11], some participants also pointed out the difficulty of evaluation too.

Heretofore, the researcher discussed the present study's findings about how to deal with SSI-based instruction and possible impeding and facilitating factors for SSI-based instruction according to PSTs. At that point, he discussed about PSTs' views towards other issues such as different stakeholders' roles for SSI-based instruction. Teachers' roles for SSI-based instruction according to PSTs was one of the aims of the present study which the researcher examined. One of the findings as presented before was that most of the PSTs emphasized that teachers should have guidance role during SSI-based instruction. They should direct discussions; interfere when discussions congest or in-class conflicts occurs; and be a guide during activities. Özden [43], in his study with prospective elementary teachers, also explored similar results about teachers' roles. The participants of his study emphasized the guidance role of teachers. Balım & Özcan [40] and Presley et al. [34] emphasized the importance of teachers' guidance role for SSI and SSI-based instruction.

In the present study, PSTs also emphasized the requirement of being knowledgeable. In other words, PSTs think that teachers should have enough and adequate knowledge about SSI which they will present. Alaçam Akşit [39] and Özden [43] attained similar findings in their studies and Presley et al. [34] emphasized these points, having adequate knowledge about SSI and understanding presented SSI's social effect(s), as important teachers' roles. Moreover, in the present study, PSTs emphasized the importance of being impartial during discussions as Özden [43] found in his study too. Lastly, it is also found that PSTs who confronted with SSI before the present study emphasized good preparation for lessons and developing appropriate classroom management skills as

other teachers' roles while other PSTs who did not confront with SSI before the present study did not emphasized such points.

How PSTs considered of students' roles for SSI-based instruction was another aim of the present study. Participants of the present study noticed being active throughout lesson(s) and participating in discussions, activities etc. as most important students' roles. Being searcher and being willing to learn to the presented SSI and coming the class preliminary were shown as other important roles of students. Kara [41], in his study with pre-service biology teachers, also found that students were waited to be concerned and willing to learn the given SSI. In the present study, the researcher found that PSTs who confronted with SSI before the present study, specifically, emphasized the requirement of expression of idea and participation in activities and lessons which are roles of students in order to deal with SSI during lessons successfully.

One of the differences of the present study from other related studies in the literature that in the present study, the researcher investigated the views of PSTs towards other stakeholders' roles for SSI-based instruction in addition to teachers' and students' roles. Program developers, researchers, parents & society, and school administration were the stakeholders that PSTs specified idea about the roles mostly. PSTs emphasized that program developers have an important role for SSI-based instruction. They pointed out the need for revision of science education programs in order to successfully integrate SSI and deal with them in science lessons. In addition to that, PSTs emphasized school administrations' roles such as providing opportunities about resources and materials in order to deal with SSI and parents' roles such as being open and willing to learn given SSI. Presley et al. [34] in their framework for SSI-based instruction, point out the need of creating flexible curriculum in order to give place to SSI, providing support, materials and more as important peripheral influences for SSI-based instruction. Therefore, the researcher can notice that the present study's related findings were consisted with Presley et al.'s [34] points.

In the present study, the researcher investigated also PSTs' self-efficacy beliefs for SSI-based instruction. It is possible to say that PSTs whether they confronted with SSI before the present study or not indicated low self-efficacy beliefs towards teaching SSI. Muğaoğlu et al. [42], Sönmez and Kılınç [48], Kara [41], Alaçam-Akşit [39], and Lee et al. [11] also found the same results in their studies. Participants noticed lack of experience, lack of teaching practice in real classroom settings, and lack of content

knowledge as the top reasons for low self-efficacy beliefs and additionally, the need of researching was also noticed as another reason for that. Alaçam-Akşit [39], in her study, also explored consistently with the present study that because of the lack of knowledge and finding appropriate method, pre-service elementary teachers perceive themselves as not enough for SSI teaching. Lee et al. [11] also pointed out lack of content knowledge and pedagogical expertise as the reasons for low self-efficacy beliefs. About low self-efficacy, the researcher can notice that as stated in Muğaoğlu et al.'s [42] study if PSTs are taught with SSI and special courses through which PSTs can deal with SSI activities, they might develop their self-efficacy beliefs positively towards SSI teaching by determining and dealing with their deficiencies.

Consequently, in the present study, the researcher investigated that the present study's findings are generally consisted with the studies already exist in the literature. It was found in the present study that PSTs generally did not have enough and adequate understanding towards SSI and SSI-based instruction. It was explored that although some of the PSTs have been trained about SSI, some of them in this trained group did not pursue his-her knowledge and understanding about SSI anymore. On the other hand, the researcher noticed that PSTs, whether confronted with SSI or not, still can deal somewhat with SSI in their future science classes since they indigenize constructivism as teaching philosophy which the researcher is thinking as an appropriate philosophy to deal with SSI as presented in different studies e.g. Presley et al. [34] and Friedrichsen et al. [35]. Additionally, the researcher explored that the participants of the present study considered important roles of students, teachers, program developers, school administrations, and more for SSI-based instruction and express their idea towards such roles easily. As can be deduced from the study of Presley et al. [34], for SSI-based instruction not only teachers and students have roles but also other stakeholders have important roles and, with the present study, this point is strongly emphasized by participants.

As another conclusion, the researcher investigated explicit differences among PSTs who confronted with SSI and did not confront with SSI before the present study. The views of PSTs who confronted with SSI before the present study towards SSI and SSI-based instruction, teachers, students, and other stakeholders' roles were considerably more satisfying than other PSTs. At that point, the importance of being familiar and participating in different activities and courses in which SSI presented before

confronting with SSI in real classroom settings brings to light clearly. However, it was surprising that although PSTs' (who did not confront with SSI before the present study) responses were not very satisfying, still, there were some answers which indicate us that they can deal with SSI in their future professional lives; and, if they are provided with opportunities in their teacher educations, their teaching skills of SSI can be raised more and more. Lastly, it is important to note that all of the participants whether confronted with SSI or not before are willing to learn more about SSI and integrate such issues into their future science lessons.

5.3 Limitations of the Study

One of the limitation of the present study is that the researcher carried out this study with 30 participants from both third and fourth grades because of the fact that there were less volunteer participants from fourth grade (14 participants). Participants were chosen from two different state universities' science education programs. It was thought that the chosen universities might reflect general science teacher education students' profile however; in this generalization, there might be deficiencies. Another limitation of the study is that some of the participants behaved as hasty during interviews and the gathered data in such cases might not be possibly adequate. There are less male participants in the present study. Thus, it is not possible to report that the gender has an effect on the present study's findings.

5.4 Suggestions

According to the results of the present study, some suggestions were presented in this section. In the present study, the researcher explored that how are PSTs' views towards SSI and SSI-based instruction. As one of the other aims, he investigated their self-efficacy beliefs towards SSI-based instruction. As long as the researcher found out as a result of the present study, while some of the participants were aware of SSI, some were not. In general, he explored that, PSTs did not have enough adequate knowledge, comprehension and experiences towards SSI and SSI-based instruction and some of the participants did not have any knowledge about SSI. Additionally, nearly all participants had low self-efficacy beliefs towards SSI-based instruction. Therefore, the researcher suggests the integration of an educational course or courses for PSTs' education about SSI and SSI-based instruction in universities. He made this suggestion because he found

that if PSTs attend courses, in which they participate in SSI activities, and have a chance to train about SSI and SSI-based instruction, they develop understandings, comprehension and positive self-efficacy beliefs towards SSI and SSI-based instruction more and more. Similarly, for in-service science teachers, special in-service training programs can be planned by authorities to increase SSI awareness, comprehension and to present possible instructional methods for SSI-based instruction.

For future research, the researcher also provided some suggestions. First of all, the researcher carried out this study with PSTs (third and fourth grades). In the future research, this study can be performed with in-service science teachers. After revision on PSTs' university education programs, if appropriate, this study can be repeated after PSTs received special courses about SSI and SSI-based instruction; and, by this way, how their views towards SSI developed and changed, can be investigated.

Moreover, in the present study, the researcher did not discover PSTs' self-efficacy beliefs in detail, thus, a study in which their self-efficacy beliefs are investigated in depth might be done. Lastly, from the participants of such a study, a researcher(s) might want to prepare lesson plan(s) about any of the SSI and (s)he might analyze those lesson plans in terms of teaching methods which were used to deal with presented SSI and what kind of roles and responsibilities are assigned to teachers and students in a future research.

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APPENDIX-A

INTERVIEW QUESTIONS (FIRST VERSION)

SOSYOBİLİMSEL KONULAR VE ÖĞRETİMİNE YÖNELİK GÖRÜŞ ANKETİ

Sosyobilimsel Konu Tanımı ve Sosyobilimsel Konulara Örnekler

1. Sosyobilimsel konu nedir? Kendi cümleleriniz ile tanımlayınız.

2. Daha önce bu kavramla herhangi bir şekilde karşılaştınız mı? Cevabınız evet ise nasıl ve hangi kaynak aracılığı ile bu kavramla karşılaştınız?

3. Sosyobilimsel konulara örnekler veriniz?

4. Sosyobilimsel konu temelli öğretim hakkında profesyonel veya profesyonel olmayan herhangi bir eğitim (üniversite dersi vb.) aldınız mı?

Sosyobilimsel Konuların Fen Programındaki yeri

5. Sosyobilimsel konular mevcut veya önceki Fen bilimleri programında var mıdır?

Sosyobilimsel Konu Temelli Özellikleri, Öğretmen ve Öğrencilere Düşen Görevler

6. Sosyobilimsel konu temelli öğretimi, diğer öğretimlerden ayıran özellikler nelerdir?

7. Sizce sosyobilimsel konu temelli öğretimin zorlukları ve kolaylıkları nelerdir veya neler olabilir?

8. Sosyobilimsel konu temelli öğretimde en çok hangi öğretim yöntemlerini tercih edersiniz? Bu tercihinizin nedenleri nelerdir?

9. Sosyobilimsel konu temelli öğretim için öğretmenlere düşen görevler nelerdir?

10. Sosyobilimsel konu temelli öğretimde değerlendirme nasıl olmalıdır?

10. Sosyobilimsel konu temelli öğretim için öğrencilere düşen görevler nelerdir?

11. Sosyobilimsel konu temelli öğretimin, fen eğitimine katkısının öğretmen ve öğrenci açısından neler olduğunu düşünüyorsunuz?

Sosyobilimsel Konu Temelli Öğretim Hakkında Yeterlilik ve Öz yeterlilik

12. Sosyobilimsel konu temelli öğretimi hakkında kendinizi yeterli görüyor musunuz?

13. Sosyobilimsel konu temelli öğretimine dair gerekli yazılı ve görsel materyallere sahip misiniz? Bu konuda herhangi bir destek aldınız mı?

Kapanış

14. Sosyobilimsel konu temelli öğretimin Fen bilimleri programında ve uygulamalarında daha çok yer almasını ister misiniz?

APPENDIX-B

INTERVIEW QUESTIONS (FINAL VERSION)

SOSYOBİLİMSEL KONULAR VE ÖĞRETİMİNE YÖNELİK GÖRÜŞ SORULARI

I. BÖLÜM (Sosyobilimsel Konulara Karşı Görüş)

1. "Sosyobilimsel konular" kavramıyla daha önce karşılaştınız mı?

    a. Cevabınız "evet" ise ne şekilde karşılaştınız; ders aracılığıyla mı, kendi çabanızla mı?

2. Sizce sosyobilimsel konu ne demektir?

3. Sosyobilimsel konulara örnekler verebilir misiniz?

4. Sizce sosyobilimsel konular hangi özelliklere sahip olabilir?

5. Sizce sosyobilimsel konulara Milli Eğitim Bakanlığı tarafından 2005 eğitim-öğretim yıllarında yayınlanan Fen ve Teknoloji Öğretim Programında (FTÖP) yer verilmiş midir?

6. Sizce sosyobilimsel konulara Milli Eğitim Bakanlığı tarafından 2013 eğitim-öğretim yıllarında yayınlanan Fen Bilimleri Öğretim Programında (FBÖP) yer verilmiş midir?

II. BÖLÜM (Sosyobilimsel Konu Temelli Öğretime Karşı Görüş)

1. Sizce sosyobilimsel konuları temel alan, sosyobilimsel konu temelli öğretim nasıl olmalıdır?

2. Sosyobilimsel konu temelli öğretimin sizce;

    a. Zorlukları neler olabilir

    b. Kolaylıkları neler olabilir?

3. Sosyobilimsel konu temelli öğretim yapıyor olsanız en çok hangi öğretim teknik ve metotlarını tercih ederdiniz?

a. Belirtmiş olduğunuz bu tercihlerinizin nedenleri nelerdir?

4. Sizce sosyobilimsel konu temelli öğretim için;

a. Öğretmenlerin rolü nelerdir?

b. Öğrencilerin rolü nelerdir?

c. Diğer paydaşların (toplum, araştırmacılar, yetkililer vb.) rolleri nelerdir?

5. Gelecek öğretmenlik hayatınızda kendi sınıfınızda sosyobilimsel konu temelli öğretim uygulayabilmek için kendinizi yeterli görüyor musunuz?

a. Cevabınız "evet" ise bu düşüncenizin sebebi nedir?

b. Cevabınız "hayır" ise bu düşüncenizin sebebi nedir?

APPENDIX-C

INTERVIEW QUESTIONS (ENGLISH VERSION)

QUESTIONS FOR TAKING STUDENTS' VIEWS TOWARDS SSI AND SSI-BASED INSTRUCTION

I. PART (Views towards SSI)

1. Have you ever met with "socioscientific issues (SSI)" concept?

    a. If yes, how? Through lessons, own efforts, etc.

2. What do you think what is SSI?

3. Could you give any examples to SSI?

4. What kind of features do you think SSI might have?

5. What do you think about the place of SSI in 2005 national Science and Technology Curriculum which was published by Ministry of National Education?

6. What do you think about the place of SSI in 2013 national Science Education Curriculum which was published by Ministry of National Education?

II. PART (Views towards SSI-based Instruction)

1. What do you think how SSI-based instruction which are based on SSI should be?

2. What do you think about;

    a. Difficulties of SSI-based instruction?

    b. Easiness of SSI-based instruction?

3. What kind of teaching strategies would you prefer if you are dealing with SSI-based instruction?

a. Why?

4. What do you think about;

a. The role of teachers for SSI-based instruction?

b. The role of students for SSI-based instruction?

c. The role of other stakeholders (program developers and administrations) for SSI-based instruction?

5. Do you see yourself enough for dealing with SSI-based instruction in your future professional teaching life?

a. If yes, why?

b. If no, why?

CURRICULUM VITAE

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EDUCATION

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WORK EXPERIENCE

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PUBLISHMENTS

Conference Papers

1. Sıbıç, O. & Topçu, M.S., (2017). "Preservice Science Teachers' Awareness towards the Place of Socio-scientific Issues in National Science Education Curriculums", International Conference on Education in Mathematics, Science & Technology, May 18-21, 2017, Ephesus-Kuşadası/TURKEY

2. Topçu, M.S. & Sıbıç, O., (2017). "Preservice Science Teachers' Views towards the Contributions of Socio-scientific Issues to Teachers, Students, and Society", International Conference on Education in Mathematics, Science & Technology, May 18-21, 2017, Ephesus-Kuşadası/TURKEY