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| Research Article / Araştırma Makalesi |

Analysis of the Implementation Process for Socioscientific Issues In the Context of the Learning Experience

Sosyobilimsel Konulara İlişkin Uygulama Sürecinin Öğrenen Deneyimleri Açısından İncelenmesi[1]

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Keywords

1. socioscientific issues
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Abstract

Purpose: This research was carried out to determine the experiences and views of candidate science teachers (CSTs) participating in the applications dealing with socioscientific issues.

Design/Methodology/Approach: Phenomenological research design, a qualitative research method, was used in line with the purpose of the study. The study group consisted of third-year teacher candidates studying at the science department of a state university. Data were collected through student journals. Students who participated in the application were asked to write journals on a weekly basis. The goal was to evaluate the feelings and thoughts about socioscientific issues of the candidate teachers about the process through the journals. Data obtained from student journals were analyzed using the content analysis method.

Findings: Some of the research results can be listed as follows: Candidate teachers stated that they did not participate in practices based on socioscientific issues before, and therefore, they stated that they had difficulties in subjects such as participating in discussions, conducting discussions, and making claims, especially in the first few weeks. With subsequent applications, they indicated that they were able to actively participate in the process. Further, it was determined that research on socioscientific issues and having discussions during the lesson was considered entertaining and interesting

Highlights: Considering the results of this research, practices related to socioscientific issues can be used in situations where individuals want to participate actively in discussions and increase their motivation for discussions.

Öz

Çalışmanın amacı: Bu araştırma sosyobilimsel konuların temele alındığı uygulamalara katılan fen bilgisi öğretmen adayları (FBÖA)'nın yaşadıkları deneyimlerinin ve bu konulara ilişkin görüşlerinin belirlenmesi amacıyla gerçekleştirilmiştir

Materyal ve Yöntem: Araştırmada oluşturulan amaç doğrultusunda nitel araştırma yöntemlerinden olgubilim araştırma deseni kullanılmıştır. Çalışma grubunu bir devlet üniversitesinin fen bilgisi öğretmenliği bölümünde öğrenim gören 3.sınıf öğretmen adayları oluşturmaktadır. Veriler öğrenci günlükleri aracılığıyla toplamıştır. Uygulamaya katılan öğrencilerden haftalık olarak günlük yazmaları istenmiştir. Günlükler aracılığıyla öğretmen adaylarının sosyobilimsel konulara ilişkin duygu ve düşüncelerini neler olduğunun belirlenmesi amaçlanmıştır. Öğrenci günlüklerinden elde edilen veriler içerik analizi yöntemi kullanılarak analiz edilmiştir.

Bulgular: Araştırma sonuçlardan bazılarını şu şekilde sıralamak mümkündür: öğretmen adayları daha önceden sosyobilimsel konulara dayalı uygulamalara katılmadıklarını bu nedenle özellikle ilk haftalarda tartışmalara katılma, tartışmaları yürütme ve iddia oluşturma gibi konularda zorluklar yaşadıklarını ifade etmişlerdir. İlerleyen uygulamalarla birlikte ise, sürece aktif olarak katılabildiklerini belirtmişlerdir. Ayrıca, sosyobilimsel konulara ilişkin araştırma yapmanın ve ders esnasında tartışmalar gerçekleştirmenin kendilerine eğlenceli, ilgi çekici geldiği belirlenmiştir.

Önemli Vurgular: Bu araştırma sonuçları dikkate alındığında sosyobilimsel konulara ilişkin uygulamalar bireylerin tartışmalara aktif katılımı ve tartışmalara yönelik motivasyon arttırması istenilen durumlarda kullanılabilecek bir bağlamdır.

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INTRODUCTION

The 21st century has been a period wherein developments in many areas, such as business, education, and daily life, have rapidly been introduced, making a difference (Türksever, Karışan Korucu & Yenmez Türkoğlu, 2020). Keeping up with the developing age has become important for all societies. One of the ways in which societies can adapt to innovations in the scientific field is by raising scientifically literate individuals who can comprehend scientific developments and carry out research in this context (Sicimoğlu, 2020). Socioscientific Issues (SSI), which are considered one of the new approaches in science education, provide a meaningful and strong framework for the development of students' and teachers' scientific literacy (Presley et al., 2013; Macalalag, Johnson & Lai, 2020).

Especially in recent years, the participation of individuals in discussions based on the SSI and making decisions on these issues has been a situation that has occupied the agenda of many countries around the world (Erkol & Gül, 2020). Sadler and Zeidler (2004b) have defined SSI, which has become an important context for science education and has seen an increase in the number of studies on it, as open-ended, open to discussions, and solution-pending issues that can be assessed from multiple perspectives. From a more detailed perspective, Ratcliffe and Grace (2003, p. 39) expressed SSI as a subject with local, national, and global dimensions from a social and political point of view, based on science, often in the form of scientific knowledge, involving making choices at a personal or social level, covering scientific evidence-based subjects, and have value and moral reasoning that conflict with each other.

Based on the definitions and characteristics made when examining the relevant literature, we can associate SSI with 10 titles: Scientific developments, social dilemmas, informal and socioscientific reasoning, argumentation, scientific modeling, nature of science, risk analysis, character education and identity, moral-cultural values and media (Topçu, 2017). Considering the content of the SSI, it is possible to say that these issues directly or indirectly affect the life of society in many respects (Türksever et al., 2020). Therefore, decisions on the SSI are of great importance for individuals, societies, and even the future of the world (Sakmen, Genç & Arsalan; 2020). Many institutions, organizations, and projects that carry out Science Education Studies in different countries that take into account all these situations suggest the need to discuss and analyze SSI by giving it a place in school programs (Presley et al., 2013; Durmaz & Seçkin Karaca, 2020). It is important to equip individuals in schools with the knowledge, skills, and tendency to understand these socioscientifically expressed issues and make evidence-based decisions (Dawson & Carson, 2020).

Another reason for the inclusion of the SSI in science education is the rich learning outputs that it will create when properly configured. When the relevant literature was examined, it was seen that SSI contributes to the development of different fields such as field knowledge of students (Yıldırım & Bakırcı, 2020; Özcan & Kaptan, 2020), argumentation skills (Sicimoğlu, 2020,) understanding of the nature of science (Khishfe, 2020). In addition, the SSI also supports the development of critical thinking skills of individuals (Gürbüzkol & Bakırcı, 2020). Apart from this, the increase in the level of knowledge related to the SSI has also positively affected the multiple reasoning forms of individuals (Durmaz & Seçkin Karaca, 2020). Also, SSI provides students with opportunities to learn what it means to be a democratic citizen by allowing the rights of various communities and individuals to be taken into account while accepting how scientific decisions affect various groups (Kinskey & Zeidler, 2020).

Based on all this information, it can be said that positive developments have emerged in classes where SSI is addressed and discussed, that is, used as a context in the learning environment. For this reason, the existence of individuals who can make assessments on these issues from different angles and knowing SSI is considered necessary for today's societies. To improve and enrich students' experiences and activities, their experiences and behaviors in the learning environments related to the SSI play an important role. Also, it is very important for candidate teachers who experience a learning environment based on SSI to experience these issues and their views on those experiences. Therefore, the main objective of this study was to reveal the experience of science teacher candidates towards the SSI and to reveal the relationship between those experiences.

METHOD

The research aimed to determine the opinions of the teacher candidates participating in the practices on which SSI is based. For this purpose, the research was designed as a case study. The study group consisted of 25 Science Department fourth-year students who took the course on the Nature of Science and the History of Science at a State University in Turkey. While determining the study group of the research, an easily accessible sampling method, which is one of the purposeful sampling methods, was used. An easily accessible sampling method gives speed and practicality to research. Because in this method, the researcher selects the situation that is close and easy to access (Yıldırım ve Şimşek, 2016; p. 123).

Data Collection Tool

Student journals were used to determine the opinions of prospective teachers regarding the practices on which the SSI is based. During the 7-week process in which the applications were carried out, students were asked to write a journal. In preparing the questions in the student journals, questions were included to allow one to identify a multifaceted and holistic situation related to the application process. In this context, questions about what they think about the discussions and what kind of changes these discussions have brought about them were included.

Preparation Process of Scenarios

After examining the researches in the literature (Demiral, 2014; Evren Yapıcıoğlu, 2016; Jho, Yoon & Kim, 2014; Kutluca, 2016; Sadler & Zeidler, 2004a; Tekbiyik, 2015), it was decided to conduct discussions based on SSI over scenarios. In the next stage, it was decided on which subjects the scenarios would be developed. At the decision-making point, the researcher paid attention to the fact that the chosen subject is interesting, causes a dilemma, can be discussed, has an up-to-date and ethical or moral aspect. The fact that the subjects included in the scope of the research have been accepted as SSI in the relevant literature has been another important factor. Then, scenarios were prepared by examining the studies containing scenario examples (Demiral, 2014; Evren Yapıcıoğlu, 2016; Jho et al., 2014; Kutluca, 2016; Sadler & Zeidler, 2004a; Tekbiyik, 2015), scientific journals (TÜBİTAK), news and scientific journals websites. To verify whether the scenarios prepared by the researcher were sufficient in terms of subject context and language and expression, three different experts who completed their doctorate in the field of SSI, and a language expert were consulted. After the feedback from the experts, the scenarios were finalized.

Implementation

The research was carried out in an environment where argumentation applications based on SSI were taken as the basis within the scope of the Nature of Science and History of Science courses. The research was planned for seven weeks. To show candidate teachers how the process will work, the preparatory stage "a mysterious event" activity was carried out with the whole class. First, the script text was distributed to all teacher candidates individually, and then the teacher candidates were asked to form groups of 4-5 people and put forward a claim by adhering to the text regarding the death of Mr. Yıldız in the script. Thus, it was tried to ensure that students understand the process and justify the question-claim-evidence triangle solidly. The process of discussions about the SSI, the final form of seven different topics given by the researcher after intensive field research and expert evaluations, started with the distribution. Teacher candidates were asked to read at least 3 articles on the topic to be discussed before coming to the class so that they would not have preliminary information about the topics discussed. Regarding the SSI's added to the scenarios, candidate teachers were asked to answer questions that would enable them to formulate their own claims, justify the claims, and refute the counter-situation arguments, and then they were allowed to participate in small and then large group discussions.

Data Analysis

In the analysis of the data, far beyond simple word counts, content analysis was used, which revealed trends and patterns and is a reliable method of coding as well as classification of data (Stemler, 2000).

Yıldırım & Şimşek (2016, p. 243) stated that content analysis is carried out in four steps. These steps are coding of data, finding themes, organizing codes and themes, defining and interpreting findings. In line with these steps, firstly, the coding of the opinions expressed by the candidate teachers in journals was made. Later, the accuracy of these encodings was reviewed. After making sure of the accuracy of the encodings, the first categories were formed under the main ideas. Finally, it has been switched from the created categories to themes. A second coding was carried out by the researcher sometime after the themes were created. Thus, content analysis reliability was achieved by coding the same text in the same way at different times by the same coder (Bilgin, 2016, p. 16).

Limitations

The results of this research are limited to the scenarios created by the researchers and created for the selected topics and the experiences and observations of the participants.

FINDINGS

Table 1. CST's Opinions on Animal Experiment Activity

What do you think about the lesson held today?	f
Ensuring new knowledge learning	10
Ensuring the ability to defend ideas	5
Endearing discussion	5
Presenting different perspectives	4
Endearing the course	4
Being interesting	3

When opinions on animal experiments activity were examined, about a third of teacher candidates stated that the event helped them learn new knowledge of the subject. At the same time, having an opinion about animal experiments has been another expressed view.

Student-6. "*I think that our class today has added a lot to me and that this course has been very productive for me. Having an opinion on a subject, I did not have an idea about making me happy. Seeing that this lesson contributed to our ability to express and to think positively enabled me to have a positive attitude towards the lesson."*

Student-14. "*... We tried to explain and impose our ideas. It was a big discussion lesson. It was busy, and everyone defended their opinions.*

When student journals were examined, discussions about animal experiments in the context of the text created by the researcher allowed teacher candidates to learn new information about the subject, defend their ideas, and participate actively in the process.

Table 2. CST's Views on The Change Carried Out by Animal Experiments Activity

What changes did the lesson today make for you?	**f**
Being conscious	6
Noticing that animal experiments are harmful	5
Noticing that animal experiments are useful	3
Respect different ideas	3
To be able to create strong arguments	2
Understanding that mistakes can happen in science	1

In the context of this question, "*being conscious," "realizing that animal experiments are harmful,"* and*" realizing that animal experiments are useful"* were the most repeated themes. Some of the candidate teachers' views on this situation are as follows:

Student-7 "*Now I am more conscious of animal experiments. There was no change in my thoughts on animal experiments. As long as it is beneficial to humans, it can be continued with the least harm to animals. In some cases, it can be used with alternative methods."*

Student-3: "*Considering the suffering of animals, I want other methods to be found and animals not to be harmed. "*

Thanks to the discussions about animal experiments, the teacher candidates expressed their consciousness of animal experiments. Some teacher candidates stated that alternative ways should be produced instead of using animals in the studies to be carried out in the field of medicine, and some stated that the experiments on animals should continue within ethical limits for science to progress. The findings regarding the discussions on the hybrid embryo are given below.

Table 3. CST's Opinions on Hybrid Embryo Activity

What do you think about the lesson held today?	**f**
Ensuring the ability to learn new information	10
The inability to continue the discussion	8
Efficient	5
Being interesting	4
To be able to defend ideas	4
Ensuring meaningful-permanent learning	3
Ensuring empathy	3

The most expressed views by the candidate teachers were learning new information and being unable to continue the discussion. Statements regarding this situation are as follows:

Student-19: " *Some friends confused the lesson today with cloning, and that's why some arguments were inadequate. He wanted an atmosphere of discussion. But it did not happen. Because we didn't respect each other in class. Our goal was to defend the arguments we created and the decisions we reached, but we couldn't make it happen.*"

Student-18: "*The lesson today was about a subject I had never heard of until now. I was surprised when I read the hybrid embryo. I asked myself questions like how this happens and how it happens. I realized that I lacked in some scientific matters.*"

The candidate teachers stated that the activity carried out on the hybrid embryo topic enabled them to learn new information on the subject, while on the other hand, they stated that it created awareness that they did not have sufficient skills regarding discussion skills. Also, the teacher candidates stated that they could not manage the process of discussion about the hybrid embryo well.

Table 4. CST's Views Regarding the Change Carried Out by Hybrid Embryo Activity

What changes did the lesson today make for you?	**f**
Experiencing a change of mind	8
Being conscious	7
Recognizing different perspectives	3
Being curious	2
Uncertainty	2

When the opinions of the teacher candidates were examined, "being conscious" was a frequently expressed situation. Statements regarding the hybrid embryo are given as follows:

Student-14: *"I thought the hybrid embryo was cloning. Thanks to the discussions we held in this lesson, I learned that they are different methods. At first, I opposed the use of hybrid embryos, but after this lesson, I support the use of this method*."

Student-21: "*It has been a thought-provoking lesson in terms of whether I should approach things emotionally or logically on these types of issues."*

Teacher candidates stated that they had several incorrect information on the subject of the hybrid embryo, but thanks to this activity, they have accurate knowledge about the subject.

Findings of another scenario, "*technology from the future* CRISPR-Cas9", are presented in Tables 5 and 6.

Table 5. CST's Opinions on Technology from the future CRISPR-Cas9 Activity

What do you think about the lesson held today?	**f**
Ensuring new knowledge learning	16
Being interesting	8
Raising awareness of insufficient information	3
Efficient	2
Changing perspective	2
To be able to think creatively	2
Ability to think versatile	2

The theme "Ensuring the ability to learn new knowledge" was the opinion most frequently expressed by teacher candidates, while "being interesting" was the second most frequently repeated opinion.

Student-7: *"This lesson was related to the CRISPR/Cas9 system. This system was a topic I didn't know about before. That's why I started with more curiosity and excitement. This issue fascinated me. I was very surprised to know how advanced genetic engineering has reached. It also enabled me to have a positive attitude toward the lesson. The course was discussed with the method of discussion, and different aspects related to the topic were discussed. Creative thinking was useful in terms of empathy."*

Student-24: *"In general, I think that our ideas change as we discuss, and the exchange of information is carried out by discussing. Especially I had no idea what we discussed today. Thanks to this lesson, I learned."*

After the activity, the candidate teachers stated that they had information about the CRISPR-Cas9 system, which they did not know about before. Also, it was interesting for candidate teachers to have discussions on a subject they had not been informed about before.

Table 6.Technology from the Future - CST's Opinions Regarding the Change Carried Out by the Crispr Activity

What changes did the lesson today make for you?	f
Willingness to research	4
Being conscious	3

What changes did the lesson today make for you?	f
Being curious	3
Respect different ideas	3
Thinking that science is progressing	2
To be able to support claims with evidence	2

"Willingness to do research," "being conscious," "curiosity," and "respecting different ideas" were the most expressed themes by the teacher candidates. Opinions on this situation are as follows:

Student-8: "*I started doing research, thinking that there was such a system and that such systems should be known as a science teacher candidate. I also wondered why scientists feel the need to find such a system."*

Student-5: "*I realized I didn't have enough knowledge of this technology and decided that I should better investigate this issue."*

The discussions of the candidate teachers about CRISPR-Cas9 had a positive effect on their desire to research since they did not have an idea about this issue before. Also, this activity was among the opinions expressed that it enabled them to be aware of the innovations in technology and knowledge, that science is in continuous progress; that is, it was effective in raising awareness about the dynamic structure of science.

Findings regarding the benefit/loss balance GMO effectiveness are presented in Tables 7 and 8.

Table 7. CST's Views on the Benefit / Loss Balance GMO Effectiveness Activity

What do you think about the lesson held today?	f
Ensuring new knowledge learning	10
Performing effective discussions	10
Efficient	4
Entertaining	4
Ensuring empathy	4
Experiencing a change of mind	3
Provide discussion using reference	3

When the opinions of the candidate teachers about the lesson were examined after the lesson on GMO, it was seen that the most expressed theme was "ensuring new knowledge learning" and "having an effective discussion." Some of the opinions on this situation are as follows:

Student-2: *"The discussions we had within the scope of the course were very productive, as it enabled the discussion and information on a problem that has become a global problem."*

Student-19: *"It can be said that the discussions taking place in today's lesson have fully achieved their purpose. Discussions were made about GMOs. Discussions took place over how long it has been in our lives, what the consequences are, and whether to continue using it or not. Some groups said no. I attended a nice lesson and enjoyed it. "*

The candidate teachers stated that depending on the progress of the process, and they could adapt to the argumentation activities and have effective discussions on GMOs.

Table 8. CST's Opinions Regarding the Change Caused by the Effectiveness of the Benefit / Loss Balance GMO Activity

What changes did the lesson today make for you?	f
Being conscious	5
Experiencing a change of mind	5
To be able to support claims with evidence	3
Willingness to conduct research	2
Recognizing different perspectives	2
To be able to present evidence	1

"Being conscious" and "experiencing a change of opinion" were the most expressed themes by candidate teachers regarding the change that occurred in them at the end of the lesson.

Student-16: *"This lesson made me conscious. Because we have a garden, we used this kind of implementation. When we discussed the negative aspects of GMOs in the lesson, I could see more clearly that it is harmful*."

Student-7: "*I didn't know much about the benefits of GMO products. I just knew it was harmful, and I was too biased. Now, while having an idea about something in scientific matters, I will investigate topics from different sources. I will not think one-sided."*

The candidate teachers stated that they were more conscious about GMOs after the lesson and experienced a change of opinion about GMOs.

The analysis of the findings obtained for genetic replication technology is given below.

Table 9. CST's Views on Genetic Replication Technology Activity

What do you think about the lesson held today?	**f**
Ensuring the ability to learn new information	8
Entertaining	6
Productive	5
Providing an effective discussion environment	5
Providing a change of mind	4
Ensuring permanent learning	3

It is possible to express the views about the course conducted on genetic replication technology under 6 different titles. The statements of candidate teachers regarding some of these themes are given as follows.

Student-17: "*Our course was productive enough as it allowed me to learn all the mistakes I had about genetic replication technology. Having a discussion environment that leaves no question marks in my mind also made it a fun lesson."*

Student-20: "*The course that we have conducted today has led to differences in individual opinions, as well as differentiation as a group. The use of these practices has caused moral controversy. This method created a good discussion environment in the classroom and supported us for more permanent learning."*

The candidate teachers stated that the lesson on genetic replication enabled them to learn new information on the subject and found the lesson fun and efficient.

Table 10. FBOS's Views Regarding the Change Carried Out by Genetic Replication Technology Activity

What changes did the lesson today make for you?	**f**
Experiencing a change of mind	6
Being conscious	3
Recognizing different perspectives	3
Finding it not effective	2

Change of opinion on the subject has often been expressed. The opinions of the teacher candidates regarding this situation are as follows:

Student-21: "*While thinking about a topic, I decided to think more broadly, considering every possibility. I have noticed that if I approach issues with my personality, I will approach other opinions negatively."*

Student-14: "*I was opposed to genetic replication at first. But I opposed human cloning. However, my opinion has changed that if genetic replication is used for therapeutic purposes and not in the form of copying an individual, it should be done."*

The preservice teachers stated that they opposed this technology because they thought of genetic replication technology only as human cloning, but learning that genetic replication technology could be used for treatment purposes in the direction of the scenario caused them to experience a change of opinion on the subject.

The content analysis results of the findings for biofuels, which were carried out as one of the last two activities, are expressed as follows.

Table 11. CST's Opinions on the Activity "Are Biofuels Problems or Solutions"

What do you think about the lesson held today?	f
Ensuring the ability to learn new information	10
Providing an effective discussion environment	9
Entertaining	3
Productive	2
Ensuring the ability to defend ideas	1

"*Ensuring new knowledge learning" and "providing effective discussion environment"* were the most recurring themes, while the other three themes can be sorted as follows:" *entertaining," "productive,"* and "*ensuring the ability to defend ideas."*

Student8: "*In our lesson today, we discussed whether biofuels are problems or solutions in our lives. The atmosphere of discussion was provided very well. There was no bad argument because the groups respected each other."*

Student-12: "*Thanks to the discussions on biofuels in the lecture, I learned different things I didn't know before. I also realized that we had a lot to learn."*

Biofuels are another of the issues that is not known much about. For this reason, it was determined that the teacher candidates experienced knowledge acquisition on the subject in the biofuels course.

Table 12. CST's Opinions on the changes the Activity "Are Biofuels Problems or Solutions" brought

What changes did the lesson today make for you?	f
Being conscious	4
Ensure the ability to make inquiries	3
Not experiencing a change	3
Respect for different ideas	3
Increased interest	2
To be able to support claims with evidence	2
Uncertainty	2

It was found that "*being conscious"* was the most expressed theme by teacher candidates. Testimonials are as follows:

Student-4: "*I learned to listen to my groupmates and other groups, to look at things from different perspectives, and to respect the opinions of my other friends, even if I disagree*."

Student-17: "*Our lesson has added a lot to our teaching field. It made me approach positively to biofuels, gain the knowledge that production could be in different areas, and have the opinion that the application area should increase. It also made us think deeply. "*

Being conscious about biofuels has been expressed as one of the changes occurring in discussions. Also, candidate teachers stated that they were more understanding about listening to the ideas of different groups.

The tables on the findings obtained from teacher candidates for the future use of CRISPR-CAS9 technology are presented below.

Table 13. CST's Opinions on Your Order Baby Ready-2030 Activity

What do you think about the lesson held today?	f
Ensuring the ability to learn new information	6
Providing an effective discussion environment	5
Being interesting	3
Ensuring versatile thinking	3
Uncertainty	2
Entertaining	2
Ensuring meaningful-permanent learning	1

"*Ensuring the ability to learn new knowledge*" and "*provide an effective discussion environment*" had been frequently expressed opinions by teacher candidates. Opinions on this situation are as follows:

Student-7: "*Today, we have debated a very interesting, surprising topic in the lesson. Everyone made his claim and presented their evidence so that we had permanent learning. An interesting topic has allowed many different ideas to be born. The debate made it possible to look at the issues from different perspectives. Thus, we developed different thinking skills.*"

Student-20: "*Today's lesson was pretty fun because we actively participated. Therefore, the discussion was duly conducted. The small number of people in the classroom was a factor in this. It was an environment where we respected each other's views and debated accordingly."*

The scenario named "Your ordered baby is ready-2030" is a scenario that is about the future implementation of the CRISPR-Cas9 system. In this context, just as in the discussions on the CRISPR-CAS9 system, these discussions have been effective in learning new information about the subject. Also, it has been observed that discussions on the possibility of applying the subject in the future have an impact on the multidimensional thinking of the prospective teachers.

Table 14. Opinions of CST Regarding the Change Carried Out by the Activity "Your Ordered Baby is Ready-2030"

What changes did the lesson today make for you?	f
Ensuring the ability to learn new information	8
To understand the relationship between science and society	6
Recognizing that there is progress in science	6

As a result of the analyses regarding the scenario, your ordered baby is ready-2030, it was seen that the opinions of the teacher candidates were collected under three different themes. Views on these themes are as follows:

Student-1: *"I have seen that technology is advancing rapidly and that human beings can do even the things that are imagined to come true and thus always improve themselves. I have seen that science is always a progressive concept, it contains new information, and this situation will continue forever."*

Student-17: "*In our lesson today, we learned that DNA could change with the CRISPR-CAS9 method by changing genetic codes. In this way, I learned that it is possible to have genetically modified babies in the future, and even bad genes that are inherited from people can change before babies are born. The waste of money and time can be avoided by this method, but I think this will lead to social problems as well as individual problems."*

The candidate teachers' expressing that they have learned new information thanks to this activity has also been voiced in the previous weeks. It was stated that there was an awareness that a change in the field of science can affect society and, therefore, the individuals in society.

DISCUSSION and CONCLUSION

Within the scope of the study in which views on socioscientific practices are examined, candidate teachers stated that being involved in these practices led to several experiences. The first of these experiences is that the knowledge on the subject under discussion has been increased. The candidate teachers stated that they had changed their content knowledge, particularly because of the discussions on CRISPR-Cas9 and biofuels that they did not know about before, which was accepted as a reflection of this change. When the definitions made for SSI are examined, it is possible to state that it creates a change in the content knowledge of the subject that is discussed due to its nature, the fact that it is based on science (Sadler, 2004; Sadler & Zeidler 2004a; Kolstø, 2001; Dawson & Carson, 2020; Fang, et. al., 2019), often within scientific knowledge (Ratcliffe & Grace, 2003) and has a scientific basis. Increasing knowledge on the subject, being conscious, frequent expression of ideas about the benefit (advantage) and harm (disadvantage) can be shown as an example of the change in content knowledge. The results that the practices carried out based on the SSI affect the content information of individuals are similar to some studies in the relevant literature (Cetin, 2014; Venville & Dawson, 2010; Zohar & Nemet, 2002; Tekin, 2018).

Another experience that emerged as a result of the discussions based on SSI was related to the argument skills of the teacher candidates. Teacher candidates frequently stated that they did not participate in the discussion process on which SSI was based on and therefore had difficulties during implementation. The candidate teachers stated that they could not manage the discussions that took place in the first weeks and they were experiencing difficulties during the discussions, but as time passed, they were able to defend their ideas, present evidence, refute opposing ideas, and developed an awareness of the characteristics of evidence and claim. This can be explained by the impact of discussions in the relevant literature on the development of argument skills of teacher candidates, such as the ability to produce claims, justifications, evidence, opposing claims, and rebuttals (Kaya, 2005; Zengin, Keçeci & Kırılmazkaya, 2012). Also, over time, being able to actively participate in the process, researching topics they did not know before, expressing their thoughts comfortably, and defending their ideas resulted in having positive thoughts about SSI, such as its' being fun, efficient, and interesting. This had a positive effect on the participation of the individuals in the process and the comprehensibility of the lesson. A similar adaptation process emerged in the study carried out by Koçak (2014).

Candidate teachers stated that lessons became entertaining and provided meaningful and lasting learning by researching SSI before the debate, actively participating in the process, and being able to defend their claims on the topics they were interested in. This has been interpreted as developing a positive attitude towards the lesson, as well as an increase in motivation for the lesson. Teacher candidates are able to approach events from different perspectives, empathize, multifaceted thinking, respect for different ideas in the decision-making process of the SSI, express content information of decisions made regarding the SSI, as well as the old information that individuals have, personal experiences (Topçu, 2008), interest and emotion. It can be said that the factors (Sadler & Zeidler (2004b) are due to the fact that they are effective. A similar situation emerged in the results of the study conducted by Khishfe (2012) with eleventh-grade students. A study conducted by Khishfe (2012) found that as a result of discussions of 219 students studying in eleventh grade on GMO and water fluoridation, a correlation was found to be between their understanding of the nature of science and some components of the discussion. Khishfe (2012) stated that the experiences, previous knowledge, and personal interest that he included in contextual factors were effective in the argument formation process. Gürbüzkol & Bakırcı (2020) stated that SSI gave students characteristics such as decision making, interpretation, empathy, self-defense, critical thinking, changing opinions, and problem-solving.

This study aimed to present the experiences of the teacher candidates participating in SSI practices and the opinions formed within these experiences. When the process is evaluated from the perspective of teacher candidates, it can be said that they have positive opinions about SSI. However, it was determined that the teacher candidates experienced several difficulties in the discussion process regarding SSI. As the reasons for these difficulties, it can be said that candidate teachers did not experience the lessons in which such argumentation practices were previously based, and for the first time, encountered the context of SSI. Also, the passive attitude of teacher candidates in the debate on SSI, especially in the first weeks, may be due to their inability to structure the triangle of question-claim-evidence on the topics of discussion well. This is an important case that shows the necessity of thinking on the argumentation skills of candidate teachers. In this context, it can be said from the student journals that there has been an improvement in the candidate teachers' ability to make arguments. This suggests that for those who practice teaching, individuals can think of SSI as a context in acquiring the skills to manage and follow such discussions.

As teachers actively participate in the process, the level of motivation for the lesson with the SSI increased, and they tended to have a positive idea about the course they had. This has led to the multifaceted and detailed planning of their research on the SSI, where discussions will be carried out. Detailed research, on the other hand, explains the view of increasing knowledge provided by the SSI, which is often expressed by teacher candidates. This shows that SSI can be structured as a context for teachers in terms of supporting the increase in knowledge about SSI-based topics in the classroom environment and providing motivation for the lesson.

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Statements of publication ethics

We hereby declare that the study has not unethical issues and that research and publication ethics have been observed carefully.

Researchers' contribution rate

The study was conducted and reported with equal collaboration of the researchers.

Ethics Committee Approval Information

The Ethics Committee approved this study in 2017 by the chairmanship of the Ethics Committee for non-interventional research of Firat University. The application number is defined as 208735.

REFERENCES

Bilgin, N. (2006). *Sosyal Bilimlerde İçerik Analizi: Teknikler ve Örnekler Çalışmalar*. (3.baskı). Ankara, Siyasal Kitabevi.

Cetin, P. S. (2014). Explicit argumentation instruction to facilitate conceptual understanding and argumentation skills. *Research in Science & Technological Education*, *32*(1), 1-20. https://doi.org/10.1080/02635143.2013.850071

Dawson, V., & Carson, K. (2020). Introducing argumentation about climate change socioscientific issues in a disadvantaged school. *Research in Science Education*, *50*(3), 863-883. https://doi.org/10.1007/s11165-018-9715-x

Demiral, Ü. (2014). *Fen bilgisi öğretmen adaylarının sosyobilimsel bir konudaki argümantasyon becerilerinin eleştirel düşünme ve bilgi düzeyleri açısından incelenmesi: GDO örneği.* Yayınlanmamış Doktora Tezi, Karadeniz Teknik Üniversitesi Eğitim Bilimleri Enstitüsü, Trabzon.

Durmaz, H., & Karaca, H. S. (2019). Sosyobilimsel konulara dayalı fen eğitiminin 7. sınıf öğrencilerinin sosyobilimsel konulara bakış açıları, bilimsel ve yansıtıcı düşünme becerileri üzerine etkisi. *Anadolu Üniversitesi Eğitim Fakültesi Dergisi*, *4*(1), 21-49. https://doi.org/10.34056/aujef.607651

Erkol, M., & Gül, Ş. (2020). Fen bilgisi öğretmen adaylarının sosyobilimsel konulara yönelik tutumları. *PESA Uluslararası Sosyal Araştırmalar Dergisi*, *6*(1), 9-21. https://doi.org/10.25272/j.2149-8385.2020.6.1.02

Evren Yapıcıoğlu, A. (2016). *Fen Bilimleri öğretmen eğitiminde sosyobilimsel temelli yaklaşım uygulamalarının etkinliğine yönelik bir karma yöntem çalışması.* Yayınlanmamış Doktora Tezi, Hacettepe Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Fang, S. C., Hsu, Y. S., & Lin, S. S. (2019). Conceptualizing socioscientific decision making from a review of research in science education. *International Journal of Science and Mathematics Education, 17*, 427–448. https://doi.org/10.1007/s10763-018-9890-2

Gürbüzkol, R., & Bakırcı, H. (2020). Fen bilimleri öğretmenlerinin sosyobilimsel konular hakkındaki tutum ve görüşlerinin belirlenmesi. *Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi*, *17*(1), 870-893. https://doi.org/10.33711/yyuefd.751857

Jho, H., Yoon, H. G., & Kim, M. (2014). The relationship of science knowledge, attitude and decision making on socio-scientific ıssues: the case study of students' debates on a nuclear power plant in Korea. *Science & Education*, *23*, 1131–1151. DOI 10.1007/s11191-013-9652-z

Kaya, O. N. (2005). *Tartışma teorisine dayalı öğretim yaklaşımnın öğrencilerin maaddenin tanecikli yapısı konusundaki başarılarına ve bilimin doğası hakkındaki kavramlarına etkisi.* Yayınlanmamış Doktora Tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Khishfe, R. (2012). Relationship between nature of science understandings and argumentation skills: a role for counterargument and contextual factors. *Journal of Research in Science Teaching, 49*(4), 489–514. DOI 10.1002/tea.21012

Khishfe, R. (2020). Explicit ınstruction and student learning of argumentation and nature of science. *Journal of Science Teacher Education*, 1-25. DOI: 10.1080/1046560X.2020.182265

Kinskey, M., & Zeidler, D. (2020). Elementary preservice teachers' challenges in designing and ımplementing socioscientific ıssues-based lessons. *Journal of Science Teacher Education*, 1-23. DOI: 10.1080/1046560X.2020.1826079

Koçak, K. (2014). *Argümantasyon tabanlı bilim öğrenme yaklaşımının öğretmen adaylarının çözeltiler konusunda başarısına ve eleştirel düşünme eğilimlerine etkisi.* Yayınlanmamış Yüksek Lisans Tezi. Hacettepe Üniversitesi. Hacettepe Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Kolstø, S. (2001). Scientific literacy for citizenship: Tools for dealing with the science dimension of controversial socioscientific ıssues. *Science Education, 85*(3), 291-310. https://doi.org/10.1002/sce.1011

Kutluca, A. Y. (2016). *Fen Bilgisi öğretmen adaylarının sosyobilimsel argümantasyon kaliteleri ile bilimin doğası anlayışları arasındaki ilişkinin incelenmesi.* Yayınlanmamış Doktora Tezi, Kastamonu Üniversitesi Fen Bilimleri Enstitüsü, Kastamonu.

Macalalag, A. Z., Johnson, J., & Lai, M. (2019). How do we do this: learning how to teach socioscientific issues. *Cultural Studies of Science Education*, *15,* 389–413. https://doi.org/10.1007/s11422-019-09944-9

Özcan, C., & Kaptan, F. (2020). 2008-2017 yılları arasında sosyobilimsel konulara ilişkin yapılan çalışmaların incelenmesi. *Muallim Rıfat Eğitim Fakültesi Dergisi*, *2*(1), 16-36.

Presley, M. L., Sickel, A. J., Muslu, N., Merle-Johnson, D., Witzig, S. B., Izci, K., & Sadler, T. D. (2013). A framework for socio-scientific ıssues based education. *Science Educator*, *22*(1), 26-32.

Ratcliffe, M., & Grace, M. (2003). Science education for citizenship: teaching socio-scientific issues. (1.edition). Philadelphia, Open University Press.

Sadler, T. D. (2004). Informal reasoning regarding socioscientific issues: a critical review of research. *Journal of Research In Scıence Teachıng 41*(5), 513-536. DOI 10.1002/tea.20009

Sadler, T. D., & Zeidler, D. L. (2004a). The morality of socioscientific issues: Construal and resolution of genetic engineering dilemmas. Science Education, *88*(1), 4-27. https://doi.org/10.1002/sce.10101

Sadler, T. D., & Zeidler, D. L. (2004b). The significance of content knowledge for informal reasoning regarding socioscientific ıssues: applying genetics knowledge to genetic engineering ıssues. *Science Education*, *89*(1), 71-93. DOI 10.1002/sce.20023

Sakmen, G., Genç, M., & Arslan, H. Ö. (2020). Ortaokul 6. sınıf öğrencilerinin bir sosyobilimsel konu olan organ bağışı hakkındaki görüşleri. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi, 33*(2), 346-371. DOI: 10.19171/uefad.620652

Sicimoğlu, B. (2020). 7. sınıf öğrencilerinin bilimsel okuryazarlık düzeylerinin sosyobilimsel konu temelli informal akıl yürütme düzeylerine göre incelenmesi: bir karma yöntem araştırması. *Marmara Üniversitesi Atatürk Eğitim Fakültesi Eğitim Bilimleri Dergisi*, *52*, 137-158. DOI: 10.15285/maruaebd.674490

Stemler, S. (2000). An overview of content analysis. *Practical Assessment, Research, and Evaluation*, *7*(7),1-6. https://doi.org/10.7275/z6fm-2e34

Tekbiyik, A. (2015). The use of jigsaw collaboratıve learning method in teaching socioscientific issues: The case of nuclear energy. *Journal of Baltic Science Education*, *14*(2), 237-253.

Tekin, N. (2018). *Fen bilgisi öğretmen adaylarına yönelik sosyobilimsel konular temelli geliştirilen bir modülün konu alan bilgisi* ve *argümantasyon kalitesi bakımından değerlendirilmesi.* Yayınlanmamış Doktora Tezi, Aksaray Üniversitesi Fen Bilimleri Enstitüsü, Aksaray.

Topçu, M. S. (2008). *Preservıce science teachers' ınformal reasoning regarding socioscientific ıssues and the factors ınfluencing their ınformal reasoning*. Yayınlanmamış Doktora Tezi, Orta Doğu Teknik Üniversitesi Sosyal Bilimler Enstitüsü, Ankara.

Türksever, F., Karışan, D., & Türkoğlu, A. Y. (2020). Öğretmen adaylarının sosyobilimsel konular hakkındaki görüş ve tutumları ile dünya vatandaşlığına dair değer yargılarının incelenmesi. *Başkent University Journal of Education*, 7(2), 339-354.

Venville, G. J., & Dawson, V. M. (2010). The impact of a classroom ıntervention on grade 10 students' argumentation skills, ınformal reasoning, and conceptual understanding of science. *Journal of Research in Science Teaching*, 47(8), 952-977. https://doi.org/10.1002/tea.20358

Yıldırım, İ., & Bakırcı, H. (2020). Ortak bilgi yapılandırma modeline dayalı fen öğretiminin sekizinci sınıf öğrencilerinin sosyobilimsel konular hakkındaki görüşlerine yansımasının incelenmesi. *İnönü Üniversitesi Eğitim Fakültesi Dergisi, 21*(2), 1051-1070, DOI: 10.17679/inuefd.735702

Yıldırım, A. & Şimşek, H. (2016). *Sosyal Bilimlerde Nitel Arastirma Yöntemleri*. Ankara, Seçkin Yayıncılık.

Zengin, F., Keçeci, G., & Kırılmazkaya, G. (2012). İlköğretim öğrencilerinin nükleer enerji sosyobilimsel konusu online argümantasyon yöntemi ile öğrenmesi. E- *journal of new world Science Academy*, *7*(2),647-65.

Zohar, A., & Nemet, F. (2002). Fostering students' knowledge and argumentation skills through dilemmas in human genetics. *Journal of Research in Science Teaching, 39*(1), 35-62. DOI 10.1002/tea.10008