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GIFTED STUDENTS' VIEWS AND ARGUMENT STRUCTURES ON A SOCIO-SCIENTIFIC ISSUE: CLONING

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Abstract: The aim of this study is to determine the evaluations of eighth grade gifted students towards cloning and to examine the argument structures formed by gifted students. The study was carried out using a case study design, which is one of the qualitative research method designs. The study group of the research consists of 24 gifted students studying at a Science and Art Center (SAC) in Turkey in the 2019-2020 academic years. Thirteen of these students were girls and eleven were boys. The data of the research were obtained from the answers given to the questions asked within the scope of the bulletin and scenario related to cloning developed by the researchers. The qualitative data collected in the research were analyzed using inductive content analysis. Based on the students' views, the importance of cloning, positive and negative aspects of cloning and the branches of science which are related to cloning were determined in the study In addition, it was seen that gifted students formed generally moderate and high-level arguments related to cloning. Findings obtained as a result of the research were compared with the related literature and discussed. Finally, suggestions were made for teachers, researchers and program developers.

Keywords: socio-scientific issues, gifted students, argument structure

1. Introduction

In today's world, rapid changes are taking place in science and technology. Although it provides many benefits and conveniences to human life, these changes cause some worries due to the risks it poses for humans, the environment and other living organisms (Christensen, 2007). While scientific developments vary according to the needs of societies, societies can respond to these changes in different ways (Topçu, 2015). Advantages and disadvantages caused by new developments in science and technology bring some disagreements and controversial issues in social, scientific and political terms (Levinson, 2006). In this context, controversial issues such as cloning, nuclear energy, stem cell therapy have increased (Zeidler, Walker, Ackett & Simmons, 2002).

Socio-scientific issues have applications in many scientific fields, embodying social dilemmas with no definitive answer (Sadler & Donnelly, 2006). Therefore, these kinds of issues include social and scientific elements. Socio-scientific issues, which have a scientific basis but differ in whether they are accepted by the society or not, lead to the emergence of various perspectives since individuals do not have a definitive solution (Hodson, 2006). In this regard, socio-scientific issues should not be expected to be easily answered and placed on a scientific basis. Socio-scientific issues include both local and global subjects such as biotechnology, cloning and the environment (Yang & Anderson, 2003).

The inclusion of socio-scientific issues that concern science and society in science courses is thought to be important in raising science literate individuals (Driver, Newton & Osborne, 2000). In this context, it is aimed to include these topics in the curriculums in order to develop students' assessment, analyzing and decision-making skills (Zeidler, 2001). In this respect, like other countries, Turkey also made updates in the curriculum in line with this target (Ministry of National Education [MoNE], 2018). Because, it is important for students to gain awareness about socio-scientific issues and to criticize scientific knowledge and to make decisions in this process (Sadler & Zeidler, 2004). In addition, students working on socio-scientific issues may face ethical and moral problems as well as social and scientific perspectives (Zeidler, Sadler, Applebaum & Callahan, 2009). In this regard, students are expected to present their claims on socio-scientific issues and their justification for their claims, and to discuss on a scientific basis by distinguishing the weak and strong arguments (Jiménez-

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Aleixandre, 2007). In this context, Maloney and Simon (2006) stated that it is important for students to know their claims and how to use their justifications in the process of scientific debate on a socio-scientific issue. Additionally, Karpudewan and Roth (2018) stated that socio-scientific issues are effective in revealing different discourses and perspectives among individuals. Therefore, it is important to include socio-scientific issues in curriculums and to create appropriate learning environments for students to create strong arguments on these issues (Küçükaydın, 2019). In these learning environments, one of the components that will help students make decisions about socio-scientific issues and justify their decisions with rational and empirical evidences is argumentation processes (Çapkınoğlu & Yılmaz, 2018; Driver, Newton & Osborne, 2000).

The main components of the argument are data, claims and warrant (Toulmin, 1958). Higher-level arguments include components as backings, qualifiers and rebuttals (Seçkin Kapucu & Türk, 2019). In this context, argumentation can be defined as an activity that occurs as a result of making claims as individuals or groups and evaluating these claims within the framework of theoretical or experimental evidence (Erduran and Jiménez-Aleixandre, 2007). Studies conducted in many fields state that argumentation is important in the structuring of scientific knowledge (Giere, 1991). In addition, it is emphasized in the related studies that students learn the concepts of science in a meaningful way with the constructivist approach together with the argumentation process (Bell & Linn, 2000). In addition, it is stated that argumentation should be used in teaching socio-scientific issues since it creates individual or collaborative discussion environments (Cavagnetto, 2010). For example, Çapkınoğlu and Yılmaz (2018), investigating seventh grade students' arguments about socio-scientific issues, stated that the handling of socio-scientific issues will increase students' participation in the discussions and improve their decision making skills. Likewise, Seçkin Kapucu and Türk (2019), who examined the argument levels of seventh grade students according to the Toulmin argument model, suggested that teachers should take the argumentation-based activities to the classroom environment by making use of written and visual media. In this regard, one aim of this study is to examine gifted students' arguments structure on socio-scientific aspect of cloning which is an important socio-scientific issue.

Cloning is one of the most prominent examples of socio-scientific issues, including products and applications of biotechnology (Sadler & Zeidler, 2005). Although the studies conducted in these areas are important for human health, it is stated that many different problems may arise if the knowledge obtained as a result of these studies is not used correctly (Mae-Wan Ho, 1999). In this context, the topic of cloning has found itself as a socio-scientific issue in which people produce many arguments about its pros or cons (Klop & Severiens, 2007). Even so, in order to produce an argument about a socio-scientific subject such as cloning, it is necessary to have a certain level of knowledge regarding its advantages and disadvantages as well as conceptual information (Kırbağ Zengin, Alan & Keçeci, 2016). Nevertheless, it is stated in the literature that students tend to continue to support their claims despite the rational contradictions in their arguments when discussing socio-scientific issues, and continue to defend their arguments, even though they cannot support their claims with the evidence and justifications (Sandoval & Millwood, 2005). Therefore, it is important to examine the opinions and argument structures of gifted students towards cloning in this context. Therefore, the focus of this study is on gifted students who are expected to produce more sophisticated arguments regarding a socio-scientific issue.

Gifted students are important manpower of societies and they differ from their typically developing peers in terms of sensitivity, creativity, intense motivation, special skills in different subjects and superior mental ability (Şahin, 2015). In addition, these students have the ability to learn faster, produce innovative solutions to problems and prefer challenging tasks (Coleman, Micko & Cross, 2015). Therefore, appropriate learning environments must be created for these students to formulate arguments on controversial issues because these kinds of environments increase gifted students' skills such as scientific discussion, questioning, inference, critical thinking, ethical and moral reasoning (Facione, 2015).

When the literature is examined, it is seen that studies on socio-scientific issues are generally done with high school students, university students and prospective teachers (Atasoy, Tekbıyık & Yüca, 2019; Öztürk & Türkoğlu, 2018; Türkmen, Pekmez & Sağlam, 2017; Yang & Anderson, 2003; Yapıcıoğlu & Kaptan, 2017). Also, it has been determined that there are some studies examining the

knowledge and attitudes of gifted students towards socio-scientific issues (Bilen & Özel, 2012; Öztürk, Eş & Turgut, 2017). Despite these, no study examining the views and argument structures of gifted students for cloning has been found. Thus, it is needed to understand the evaluations and argument structures of gifted students on cloning which has become an increasingly important topic of discussion. This need is not far from scientific literacy. Therefore, this study is expected to contribute to the research on gifted students and socio-scientific issues. Also, students' perceptions and views on socio-scientific issues in general and cloning, in particular, have an influence on their decision-making processes on these issues (Al, 2015). Therefore, determining evaluations provides opportunities to predict the reactions of gifted students to these issues. Moreover, gifted students are expected to develop scientific and sophisticated views on socio-scientific issues. By examining the argument structure of gifted students, their competencies to interpret a socio-scientific issue with all dimensions can be determined. In the light of all these evaluations, the aim of the study is to examine the evaluations and argument structures of gifted students for cloning as a socio-scientific issue. For this purpose, answers to the following questions were sought:

• What are the evaluations of eighth grade gifted students about cloning?

• How are the levels of gifted students' arguments within the framework of a cloning scenario?

2. Method

2. 1. Design of the study

In this research, the case study, one of the qualitative research method designs, was used. Qualitative research method examines the meanings that people attribute to events and how they describe them (Dey, 1993). The case study is a qualitative research design that examines a phenomenon within its real-life framework (Yıldırım & Şimşek, 2013). In the current study, the case study design was used because the aim was to examine the evaluations and argument structures of gifted students for a socio-scientific issue.

2. 2. Study group

The study group of the research consists of 24 eighth grade gifted students studying in a Science and Art Center (SAC) in Turkey in the 2019-2020 academic years. 13 of these students are girls and 11 are boys. The criterion sampling method, which is one of the purposeful sampling methods, was used while determining the study group. Criteria sampling is the inclusion of people who meet the predetermined criteria in the study (Marshall & Rossman, 2014). In this context, the study group consists of eighth grade students diagnosed as gifted. Eighth grade gifted students are preferred because they have learned DNA and genetic code unit. Students are labeled as S1, S2, S3 and so on.

2. 3. Data collection process

The data of the research were collected using a bulletin and a scenario about cloning developed by the researchers. In this context, the data collection process took place in two stages. In the first stage, "A *Monkey Cloned with Dolly's Method"* bulletin was developed. The bulletin explains how a macaque monkey was cloned using the method previously used to clone Dolly, what was done in this process, technical barriers to clone humans and discussions about human cloning. The content of the bulletin is examined by two researchers specialized in science education and by a Turkish teacher in terms of spelling and clarity. After students read and discuss the bulletin, four questions were asked to determine the students' evaluations. These questions are given in Table 1.

Table 1. *Questions to determine students' evaluations about cloning*

	Questions
Question 1	What is new for you in the bulletin you read about cloning? Please explain.
Question 2	What do you think is the most important aspect of cloning? Please explain.
Question 3	In your opinion, what are the positive and negative aspects of cloning? Please explain.

Question 4	Based on the bulletin, what branches of science or disciplines do you think cloning is related to? Please explain with reasons.

In the second stage of the research, the literature was examined (Dawson & Carson, 2017; Küçükaydın, 2019; Mae-Wan Ho, 1999; Sadler & Zeidler, 2005) and a scenario was designed on cloning. While creating the scenario; news, articles and books about cloning were examined and the scenario was created under the title of "A dog is cloned in China". The scenario contains information about the dog being cloned, emerging discussions on human cloning and the views of people who support and oppose human cloning. After students read and discuss about the scenario, students were asked to state their argument for the question "*If studies on human cloning were to be started in your country and you were in management, considering advantages and disadvantages, would you allow such studies to be done? Why? Please explain".*

A pilot study was conducted to check the understandability of the bulletin and scenario. The pilot study was carried out with three ninth grade gifted students who had learned about cloning and participated in argumentation studies. As a result of the pilot study, the content and clarity of the questions, bulletin and scenario was controlled and the time to answer the questions was determined as 30 minutes.

Before the bulletin and scenario were distributed to students, cell and DNA issues were taught in detail. In order for students to understand the structure of DNA, DNA isolation experiment was carried out on bananas and a preparation was examined in a microscope. Then, how Dolly was cloned is explained. These lessons and activities took two hours. In the next week, the bulletin and scenario was distributed to students and data of the study were collected. After data collection, focus group interviews were held to evaluate what students wanted to emphasize in their answers to the questions. The whole process took three weeks. The research process is summarized in Figure 1.

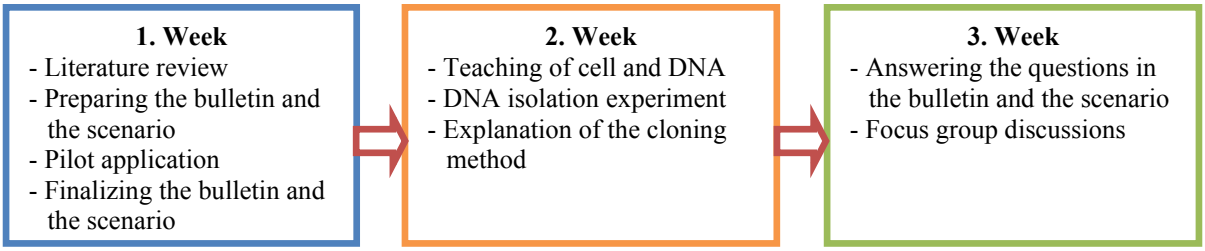

Figure 1. *Data collection process*

2. 4. Role of researchers

Applications of the research were carried out by the researchers. In this regard, during the application, the researchers organized the practices and provided the opportunity for group discussions in order to give the opportunity for students to express their ideas and to strengthen the interaction between the students. After that, the bulletin prepared to determine the student views and the scenario prepared to reveal argument structures were distributed to the students. Also, in the group discussions held at the end of the application, all students were given the opportunity to express clearly about what they wanted to emphasize in their answers. In these processes, statements that directly affect the students' ideas were avoided and researchers tried to increase multi-directional communication.

2. 4. Data analysis

Inductive content analysis was carried out in the analysis of the data. In this context, firstly, students' opinions about cloning were examined by two researchers and codes were determined. Themes have been created for the determined codes. Therefore, small units are evaluated in a general framework and expressed as general units (Tavşancıl & Aslan, 2001). Argument levels were determined to understand the students' argument structures (Venville & Dawson, 2010). This rating was made on four levels. If an argument consists of only claims, it is labeled as level 1, if it contains claims and data, it is labeled as level 2; if the claim is justified with data and warrant, it is labeled as level 3; if the argument contains claim, data, warrant and rebuttals, it is labeled as level 4.

2. 4. Validity and reliability

In a qualitative research, certain strategies should be used to ensure validity and reliability. These strategies are credibility, transferability, dependability and confirmability (Shenton, 2004). Credibility is related to the internal validity of the study (Lincoln & Guba, 2013). In order to increase the credibility of the research, data collection tools were examined by experts from a critical perspective and necessary feedbacks were given. Also, to increase the credibility of the research, the answers of the student are presented directly in the findings. Transferability is related to the external validity of the research (Lincoln & Guba, 2013). In order to ensure the transferability of the research, the purposeful sampling method was used. In addition, the information about the study group, the data collection and analysis processes are explained in detail.

Studies have been carried out to ensure dependability and confirmability of the study. In this context, data are analyzed separately by two researchers, and Miles and Huberman (1994) formula (Consensus / Consensus + disagreement) was used to ensure consistency between the researchers. The reliability coefficient value was calculated as .89 in terms of students' opinions and .92 in terms of argument structures. In addition, the answers of the students were confirmed during the focus group interviews.

3. Findings

3.1. Gifted Students' evaluations on cloning

In the first phase of the research, the bulletin was used to determine the evaluations of the students about cloning. In this context, the themes and codes obtained from the answers given by the students to the question of what they learned from the bulletin are given in Figure 2. Also, the letter "f" indicates the number of respondents in each code.

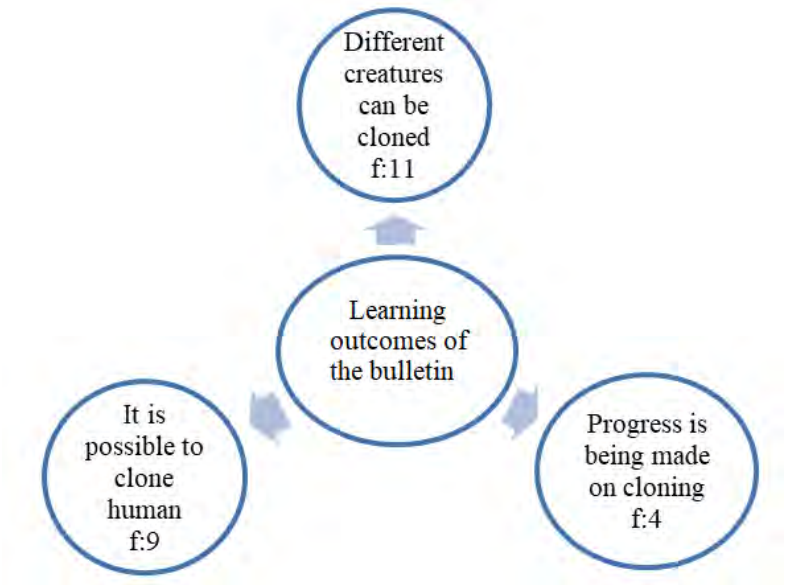

Figure 2. *Codes regarding what was learned from the bulletin*

As seen in Figure 2, the created codes for the first question are determined as "Different creatures can be cloned", "Progress is being made on cloning", "It is possible to clone human". In this context, students stated that different creatures could be cloned, human cloning became possible and there were serious developments in cloning. S14 expressed his thoughts for the cloning of different creatures as "*From this bulletin, I have learned that many living things have actually been cloned and I realized that I have not paid attention before but now I have learned*". On the other hand, in order to emphasize the progress on cloning studies, S11 stated his views as: "*I learned that cloning of living creatures other than Dolly, and serious work has been done in this field*". Another participant, S18, underlined

the human cloning and expressed what he had learned as: "*I learned that human as a primate creature can be cloned*".

In the second question, students were asked to explain what the most important aspect of cloning was according to the bulletin. In the direction of the students' answers, the most important dimensions of cloning are being an indicator of the scientific progress (f:12), the possibility of human cloning (f:6), developing different methods in cloning (f:3) and overcoming some difficulties with cloning (f:2).

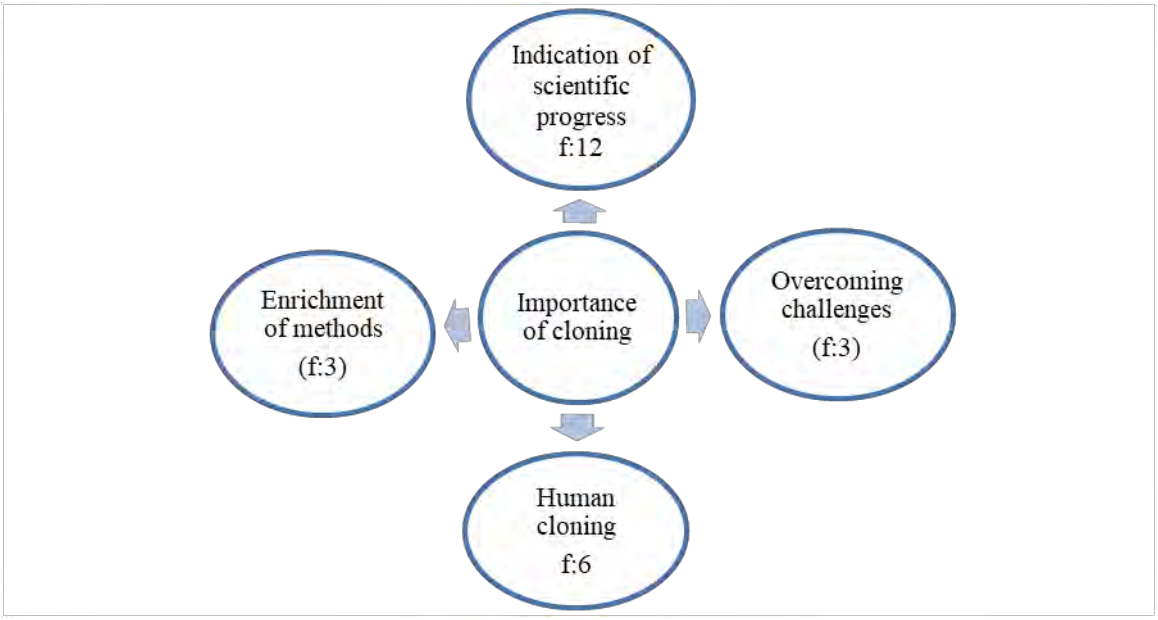

Figure 3. *Codes regarding importance of cloning*

According to a significant number of students (f:12), the most important aspect of cloning is that cloning studies provide important proof of the advancement of science. In this context, S21 expressed his opinion saying: "*In my opinion, two macaque monkeys have been cloned and many scientific applications have been made in this process. This is the most important indicator of the development of science*".

Some of the students stated that the most important aspect of cloning is human cloning. For example S2 expresses his view on this aspect as "*the important part of cloning is the cloning of monkeys because of the similarity between monkeys and humans*".

According to the three participants, the most important dimension of cloning is the enrichment of living creatures and the methods used in cloning, whereas for the two participants, cloning is important because it opens a door to overcome the challenges.

In the third question, students were asked to evaluate the positive and negative aspects of cloning according to the bulletin. A significant part of the participants (f: 15) stated that they had negative opinions about cloning. However, nine participants expressed positive opinions. In this context, negative opinions about cloning were discussed in terms of health, economy and social aspects. The codes and themes regarding the negative aspects of cloning are given in Figure 4.

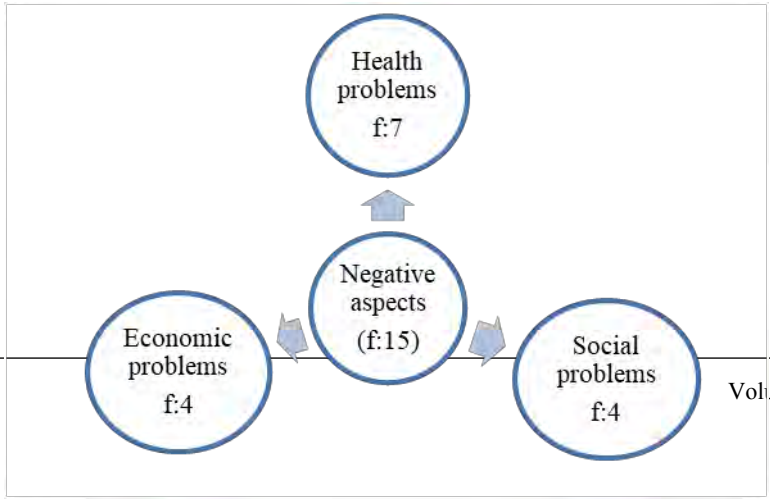

Figure 4. *Codes regarding students' negative opinions*

Participants who evaluated cloning as negative in terms of health stated that cloning, especially on people, would affect human health. For this aspect, S7 stated that *"The bulletin made me feel negative for the future. Because in the future, these experiments can be tested on human and increase the risk of death and mutant humans"*.

Evaluating cloning economically, S23 said that "*I think (the effects of cloning practices) are negative because economic troubles will begin*". S9 who evaluated cloning socially said that "*Cloning is a concern for the future. Increasingly, gene discrimination may emerge in the society"*. Students who have positive views evaluated cloning in terms of the development of science, technological progress, military power and the continuation of the human generation. The codes obtained from the analysis of the opinions and evaluations of students with positive views about cloning are given in Figure 5.

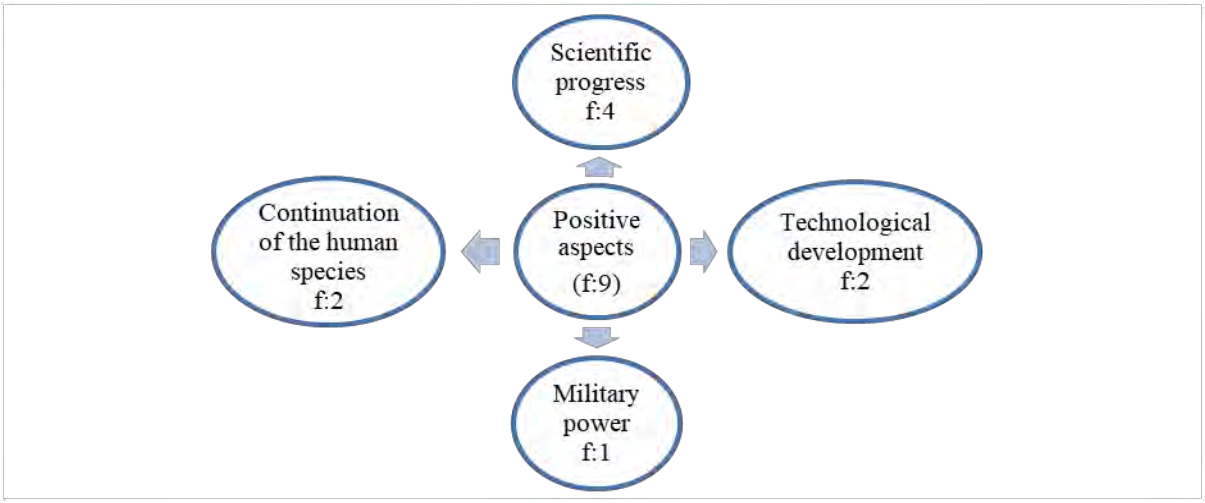

Figure 5. *Codes regarding students' positive opinions*

Participants, who see cloning as a tool of scientific progress, emphasized that science would improve with cloning studies. In this context, S4 said "*Cloning had a positive feeling on me. Because science is developing, so humanity is awakening*".

S14 who holds positive views on cloning in terms of technological developments stated that "*I think it will benefit the development of technological studies. Therefore, I think (cloning) is something positive*". From a different aspect, some participants thought that cloning is important for the continuation of the human generation. For example, S19 expressed that *"in my opinion cloning is positive because the new generation will be more comfortable and will not disappear with the help of cloning in the today's environmental conditions"*. Lastly, some of the participants emphasized the military aspect as a positive dimension of cloning. For example, S18 stated that *"... in a world in war, our army can be managed by stronger and more intelligent people and programmed creatures"*.

In the fourth question, the participants were asked about the relationship between cloning and branches of science/disciplines. The codes obtained from the students' answers are given in Figure 6.

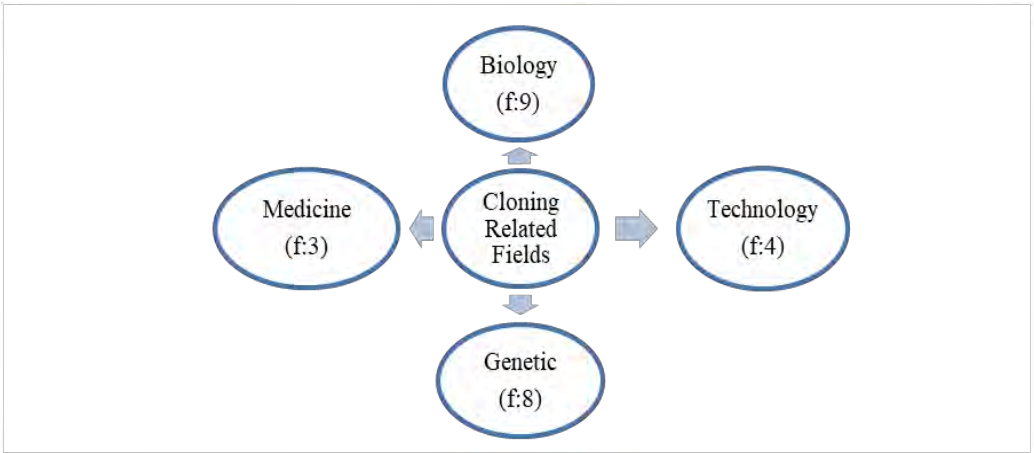

Figure 6. *Codes regarding cloning related areas*

Nine participants associated cloning with biology. In this context, S2 stated that "*Biology is the ancestor of positive sciences. This bulletin is biology itself*". Likewise, eight participants associated cloning with genetics, a sub-branch of biology. For example, S14 said that "*Many experiments have been done on genetically modified living things. I think it's about genetics. I think this science (genetics) will be the science of the future*". Four participants associated cloning with technology. S15, from these participants, said: "*I think if people are more closely interested in science, technology gets better. According to the bulletin we read, many technological tools are used in cloning*". Also, three participants emphasized the relationship between cloning and medicine.

After explaining the findings on the gifted students' understanding of cloning one by one, a synthetic table (Table 2) is presented to show the relationship between the related themes, codes and citations in a holistic way. Each theme, codes and samples codes are shown in Table 2.

Table 2. *Themes, codes and sample quotes regarding the findings*

Themes	Codes	Sample Quotes
Learning outcomes of the bulleting	Different creatures can be cloned	*From this bulletin, I have learned that many living things have actually been cloned and I realized that I have not paid attention before but now I have learned. (S14)*
	Progress is being made on cloning	*I learned that cloning of living creatures other than Dolly, and serious work has been done in this field. (S11)*
	It is possible to clone human	*I learned that human as a primate creature can be cloned.(S18)*
Importance of cloning	Indication of scientific progress	*In my opinion, two macaque monkeys have been cloned and many scientific applications have been made in this process. This is the most important indicator of the development of science. (S21)*
	Overcoming challanges	*Opportunities may arise to solve genetic problems that cannot be solved by current treatment methods. (S14)*
	Human cloning	*The important part of cloning is the cloning of monkeys because of the similarity between monkeys and humans. (S2)*
	Enrichment of methods	*It was seen that after monkey cloning, new methods can be developed that allow many more living things to be cloned. (S12)*
Negative aspects	Health problems	*The bulletin made me feel negative for the future. Because in the future, these experiments can be tested on human and increase the risk of death and mutant humans. (S7)*
	Social problems	*Cloning is a concern for the future. Increasingly, gene discrimination may emerge in the society.(S9)*

	Economic problems	*I think (the effects of cloning practices) are negative because economic troubles will begin. (S23)*
Positive aspects	Scientific progress	*Cloning had a positive feeling on me. Because science is developing, so humanity is awakening. (S4)*
	Technological development	*I think it will benefit the development of technological studies. Therefore, I think (cloning) is something positive. (S14)*
	Military power	*In a world in war, our army can be managed by stronger and more intelligent people and programmed creatures. (S18)*
	Continuation of the human species	*in my opinion cloning is positive because the new generation will be more comfortable and will not disappear with the help of cloning in the today's environmental conditions. (S19)*
Cloning related fileds	Biology	*Biology is the ancestor of positive sciences. This bulletin is biology itself. (S2)*
	Technology	*I think if people are more closely interested in science, technology gets better. According to the bulletin we read, many technological tools are used in cloning. (S14)*
	Genetics	*Many experiments have been done on genetically modified living things. I think it's about genetics. I think this science (genetics) will be the science of the future. (S15)*
	Medicine	*We learned that cloning can be used in the treatment of diseases. Therefore, I think this issue is directly related to medicine.(S22)*

3.2. Gifted students arguments about cloning

The scenario developed for cloning was distributed to the participants. At the end of the scenario, participants were asked to produce an argument about the question. These arguments were analyzed structurally. It was determined that they formed arguments at different levels as seen in Table 3.

Table 3. *Argument levels and sample arguments*

Argument level	Participants	Sample Arguments
Level 1	S2, S20, S21	*I wouldn't allow (S2), Yes, I could (S21).*
Level 2	S1, S4, S7, S12, S13, S14, S17, S22, S24	*Yeah, I could allow it. I could solve the gene and gender problems in my country (S14).*
Level 3	S6, S10, S15, S16, S18, S23	*I'd let it. However, I would take care to comply with all moral and scientific rules under the management of authorized people. Not in those I think will harm humanity; I would generally allow these procedures in the medical field (S6).*
Level 4	S3, S5, S8, S9, S11, S19	*Personally, I would let it. But I would bring a limit. Because I value people and cloning a person makes it worthless. Likewise, the clone is a human after all, so it is morally shameful to see the clone as an object or to abuse it even for scientific health purposes. But the benefit of cloning is too great to ignore. That's why cloning should be done. But a limit should be brought. Rather than a human being; a tissue, an organ, or whatever else is needed can be cloned (S5).*

When the participants' arguments were examined; it was seen that three participants formed Level 1 argument, nine participants formed Level 2, six participants formed Level 3 and six participants formed Level 4 arguments. Seven participants forming Level 2 argument stated that they would not allow cloning and two would. Participants supporting cloning stated that cloning is necessary for the development of the country. Participants, who are against cloning stated that it would have bad results, harm the environment, would not be morally appropriate and create social differences. In this context,

S12 who is against cloning stated that "*I would not allow cloning completely because if it falls into the wrong hands, we may encounter terrible results*".

Five of the six participants who formed level-3 arguments stated that they would allow human cloning. They supported their opinions on economic, health, military and social reasons. In this context, S16 stated that "*I would allow it because it would be an important study for the development of our country. Of course, I wouldn't let cloning be in the hands of the public because there may be malicious people*". On the other hand, stating that he would not allow cloning, S10 said: *"I wouldn't allow it, because let's do not forget that every person is different. Such a study would have created differences among people. Social fragmentation may be experienced"*.

Four of the six participants who formed level-4 arguments stated that they would not allow human cloning, and two of six reported that they would. Participants who formed level-4 arguments against cloning handled it legally, socially, economically and morally. Stating that he would not allow cloning, S11 said to express his point that "*I would not allow it. Because in the medical field, although they thought they might have miraculous results, cloning in social life would be a disaster. Identity frauds occur. Political leaders can practice against human beings. Although it is tried to be limited by strict rules, people with political and economic power can flex these rules as they wish. Here, security of the society is in danger. A society that is not sure of its security, revolts. This situation will be against the power*".

4. Discussion, conclusion and recommendations

In this study, the aim was is to examine the evaluations and argument structures of gifted students for cloning as a socio-scientific issue. In line with this purpose, as a first finding, what was new about cloning in the bulletin was examined. In this context, as shown in Figure 2, gifted students stated that they learned that different creatures other than sheep could be cloned, that human cloning was possible and that there were developments in cloning. Based on the fact that the students stated that they had just learned these issues from the bulletin used in the research, it was thought that cloning was not sufficiently included in the formal education process of the gifted eighth grade students and during their education in SAC. As a matter of fact, when the science curriculum is analyzed (MoNE, 2018), in the whole program, cloning is mentioned once in an objective related to genetic engineering and biotechnology. Hence, a student who completed primary education in Turkey would have superficial knowledge and awareness about cloning. However, it is stated in the literature that socio-scientific subjects should be included more in school curricula in order to raise science-literate individuals (Driver, Newton & Osborne, 2000). Considering that socio-scientific subjects are productive contexts that can be used in science teaching and learning processes (Zeidler, 2014) and that teaching science based on socio-scientific subjects is effective on students' science learning (Herman, 2015; Klosterman & Sadler 2010), it is understood that socio-scientific subjects should be included more in science curricula (Evagorou, 2015). However, it is seen in the current science curriculum of Turkey that there is not enough emphasis on cloning which is a current and important socio-scientific subject.

Another finding obtained in the study is the opinions of the students about why cloning is important. In this context, according to the findings presented in Figure 3, gifted students think that the studies on cloning are an indicator of scientific progress. In other words, it is understood that students attribute importance to cloning as it is a current socio-scientific subject that will contribute to the advancement of science. As the other reasons for attributing importance to cloning, it has been found that overcoming technical obstacles in the cloning of primate organisms, enrichment of human cloning and method-techniques. It is stated in the bulletin that the primary obstacle in primate cloning is the reprogramming of the transferred body cell nuclei to support embryonic development, but these difficulties were overcome. Thus, it is stated that it is possible to produce monkeys as animal models to examine the treatment of human diseases (Liu et al., 2018). Therefore, it can be said that epistemological beliefs and nature of science understandings of gifted students are sophisticated. Because they can deduct from a scientific text that cloning is a research area that provides opportunities for scientific development. As a matter of fact, considering the questions such as "What is science?", "How it works?", "How scientists work?" in terms of the nature of science (McComas &

Olson, 1998), it can be assumed that the gifted students have sophisticated epistemological beliefs and nature of science understandings. Because they could realize that with the cloning of primates scientists were able to solve the problems that could not be solved before. Considering the fact that gifted students who participated in this research did not get an explicit nature of science (NOS) education, being able to develop sophisticated views about how science works is an indication that these students' nature of science understanding has improved in inquiry-based activities. In order to develop students' NOS views, there are two approaches in the literature, namely explicit and implicit approaches. Although there are some studies reporting that students NOS understandings do not naturally develop through implicit approach (Caukin, 2010), there are also some others who assert that students NOS views can be developed implicitly through effective teaching methods (Akerson & Donnelly 2010; Akerson & Volrich 2006; Khishfe & Abd-El-Khalick 2002). Thus, since the gifted students studying at SAC's continuously conduct inquiry-based activities, they could evaluate their learning and make inferences in the context of NOS.

Another finding of the study is that gifted students have positive and negative opinions about cloning. As can be seen in Figure 4, gifted students who have negative views expressed their opinions that health, economic and social problems will arise with cloning practices. On the other hand, gifted students, who reported positive opinions about cloning as seen in Figure 5, stated that they had positive views about cloning for scientific power and technological progress, military power and the continuation of the human generation. In the literature, it is observed that students generally develop negative attitudes or views on socio-scientific issues related to the field of health, such as biotechnology and genetically modified organisms (GMO) (Eş, Işık Mercan & Ayas, 2016; Öztürk & Yenilmez Türkoğlu, 2018). However, it also reported that biotechnology research on medical practices is more accepted (Pardo, Midden & Miller, 2002). The economic factor which emerges as a variable that came to the forefront in research on social-scientific issues (Bilen and Özel, 2012) is also seen as a negative aspect of cloning in the findings of this study. In the literature, for example, in the discussions about GMO, the economic argument is used by the students advocating GMO (Öztürk & Yenilmez Türkoğlu, 2018). However, in the current study, gifted students evaluated the economic factor as a negative aspect of cloning and stated that with the proliferation of cloning studies, economic problems will increase. However, it was observed that the students who advocated this view could not provide a convincing justification for why economic problems would increase. On the other hand, it is seen in the literature that religious arguments come first among the arguments used by those who express negative views on socio-scientific issues in the field of health (Öztürk & Eş, 2017). However, in the current study, it can be seen that gifted students who reported negative views about cloning never used the religious argument, but instead they stated that gene discrimination and social problems may arise in society. The reason for this may be that religious arguments about cloning were not included in the bulletin given to students. This shows that the students did not obtain information about the social, cultural and religious results of cloning in previous educational processes. However, socio-scientific issues should be taught not only with their scientific and technical aspects, but also with an emphasis on factors such as society, culture and religion. Thus, students can evaluate socio-scientific events with a holistic perspective.

As another finding in the research, gifted students were asked to explain which branches of science and disciplines are related to cloning. In this context, as it is seen in Figure 6, gifted students associated cloning with biology, technology, genetics and medicine. When the answers given by the students are examined, it is noteworthy that all the fields they associate with cloning are science-related fields. No student has cited the relation of cloning to social, cultural and religious domains. This may be due to the fact that the social context of cloning was not directly emphasized in the bulletin they read. It is also understood that their awareness of the social context of cloning has not developed during their formal education at school and during their education at SAC.

In the research, the arguments formed by gifted students through a scenario were examined structurally. When the generated arguments are analyzed, it was found that three of the 24 participants formed Level 1, nine students formed level 2 and six students formed Level 3 and six students formed Level 4 arguments. Based on this finding, it can be said that gifted students generally form moderate and high-level arguments. Considering the findings of the research that cloning is not sufficiently

involved in the formal education of the students, it can be interpreted that there is no relationship between the content knowledge and the quality of the argument. As a matter of fact, there are studies in the literature that conclude that students with high level of content knowledge produce more qualified arguments (Bell & Linn, 2000; Driver, Newton & Osborne, 2000; Sampson & Clark, 2011), there also studies (Eskin & Ogan-Bekiroglu; 2009; Hakyolu & Ogan-Bekiroğlu, 2011; Kutluca, Çetin & Doğan; 2014) reporting that there is no linear relationship between argument quality and knowledge level. Although content knowledge is important in creating qualified arguments, it should not be considered as a single factor and individual differences and personal characteristics should also be taken into account (Akbaş & Çetin, 2018). In addition to the content knowledge, it can be said that the students' nature of science understanding as a dimension of their epistemological beliefs (Lederman, 2007) is an effective variable on the quality of the argument produced by the students. As a matter of fact, there are studies in the literature concluding that argumentation processes improve nature of science understanding (Sandoval & Millwood, 2008; McDonald, 2010). There are also some other studies concluding that the nature of science understanding has an impact on argument quality (Kenyon & Reisier, 2006; Sadler, Chambers & Zeidler, 2004; Zeidler et al. 2002). Therefore, as can be seen from the results of the present study, it can be said that gifted students generally have an advanced nature of science understanding. For this reason, students can produce qualified arguments based on the information given to them. When the findings of this study regarding the argument quality are evaluated in this context, it can be said that gifted students can produce high-level arguments because of their sophisticated nature of science understanding and epistemological beliefs.

Based on these discussions, according to the results of the research, the knowledge and awareness of eighth grade gifted students about cloning is not sufficient. In addition, in the justifications of students who hold positive and negative opinions about cloning, emphasis is placed on the economic and health aspects of cloning. However, social, cultural and religious dimensions are not taken into account in their evaluations. When evaluating the quality of the arguments created by gifted students, it can be said that they can generally form moderate and high-level arguments.

Based on the above discussions, the following suggestions can be made regarding the results and limitations of the study:

- More emphasis should be placed on socio-scientific issues such as cloning in the science curriculum.
- While teaching socio-scientific issues, not only technical and scientific aspects but also social, cultural and religious perspectives should be discussed.
- The effect of gifted students' content knowledge on the argument quality should be examined through different socio-scientific contexts.
- In this study, the views and argument structures of gifted students about a socio-scientific issue were examined. Studies comparing views and arguments of gifted and non-gifted students can also be investigated.
- This study employed only a qualitative investigation. Different quantitative instruments can be developed to assess students' views. Thus, in future research, qualitative and quantitative methods can be used cooperatively to develop a wider understanding regarding socio-scientific issues.

References

Acar, O., Turkmen, L. & Roychoudhury, A. (2010). Student difficulties in socioscientific argumentation and decision-making research findings: Crossing the borders of two research lines. *International Journal of Science Education, 32*(9), 1191-1206.

Akbaş, M. & Çetin, P. (2018). The Investigation Of Gifted Students' Argumentation Level And Informal Reasoning Related To Socioscientific Issues. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 12*(1), 339-360.

Akerson, V., & Donnelly, L. A. (2010). Teaching nature of science to K-2 students: What understandings can they attain? *International Journal of Science Education, 32*(1), 97–124.

Akerson, V. & Volrich, M. (2006). Teaching nature of science explicitly in a first-grade internship setting. *Journal of Research and Science Teaching, 43*, 377–394.

Al, S. (2015). *Pre-service science teachers' perceptions of socioscientific issues: global warming as a case.* Unpublished master thesis, Middle East Technical University, Ankara, Turkey.

Atasoy, Ş., Tekbıyık, A. & Yüca, O. Ş. (2019). Determining informal reasoning of students for some local socioscientific issues in the Black Sea Region: HEPP, Organic Tea and Green Road Project. *Hacettepe University Journal of Education, 34*(2), 524-540.

Bell, P. & Linn, M. C. (2000). Scientific arguments as learning artifacts: Designing for learning from the web with KIE. *International Journal of Science Education, 22*(8), 797-817.

Besnard, P., & Hunter, A. (2014). Constructing argument graphs with deductive arguments: a tutorial. *Argument & Computation*, *5*(1), 5-30.

Bilen, K. & Özel, M. (2012). Gifted students' knowledge of and attitudes toward biotechnology. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 6*(2), 135-152.

Caukin, N. S. (2010). *Science Writing Heuristic: A writing-to-learn strategy and its effect on students'science achievement, science selfefficacy, and scientific epistemological view.* (Unpublished doctoral dissertation), Tennessee State University.

Cavagnetto, A. R. (2010). Argument to foster scientific literacy: A review of argument interventions in k-12 science contexts. *Review of Educational Research, 80*(3), 336-371.

Christensen, C. K. (2007). *Waiting for certainty: Young people, mobile phones and uncertain science*. Published PhD thesis, Centre for Learning Innovation, Queensland University of Technology, Brisbane, Australia.

Coleman, L. J., Micko, K. J. & Cross, T. L. (2015). Twenty-five years of research on the lived experience of being gifted in school: Capturing the students' voices. *Journal for the Education of the Gifted, 38*(4), 358-376.

Çapkınoğlu, E. & Yılmaz, S. (2018). Examining the data component used by seventh grade students in arguments related to local socioscientific issues. *Education and Science*, *43*(196), 125-149.

Dawson, V., & Carson, K. (2017). Using climate change scenarios to assess high school students' argumentation skills. *Research in Science & Technological Education*, *35*(1), 1-16.

Dey, I. (1993). *Qualitative data analysis: A user-friendly guide for social scientists*. London: Routledge Publications

Driver, R., Newton, P. & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education*, 84, 287–312.

Erduran, S. & Jiménez-Aleixandre, M. P. (2007). *Argumentation in science education: Perspectives from classroom-based research*. Dordrecht, The Netherlands: Springer

Eskin, H. & Ogan-Bekiroglu, F. (2009). Investigation of a Pattern between Students' Engagement in Argumentation and Their Science Content Knowledge: A Case Study. *Eurasia Journal of Mathematics, Science and Technology Education*, *5*(1), 63-70.

Eş, H., Işık Mercan, S. & Ayas, C. (2016). A new socio-scientific issue for Turkey: Life with nuclear. *Turkish Journal of Education*, *5*(2), 47-59.

Evagorou, M. (2015). Elementary school students' emotions when exploring an authentic socio-scientific issue through the use of models. *Science Education International*, *26*(2), 240-259.

Facione, P. A. (2015). *Critical thinking: What It Is and Whv It Counts.* Hermosa Beach. CA: Measured Reasons LLC Journal

Giere, R. N. (1991). *Understanding scientific reasoning (3rd ed.)*. Fort Worth, TX: Holt, Rinehart & Winston

Hakyolu, H. & Ogan-Bekiroglu, F. (2011). Assessment of Students' Science Knowledge Levels and Their Involvement with Argumentation. *International Journal for Cross- Disciplinary Subjects in Education*, *2*(1), 264-270.

Herman, B. C. (2015). The influence of global warming science views and sociocultural factors on willingness to mitigate global warming. *Science Education, 99*(1), 1–38.

Hodson, D. (2006) Why we should prioritize learning about science, *Canadian Journal of Science, Mathematics and Technology Education,* 6(3), 293-311, DOI: 10.1080/14926150609556703

Jiménez-Aleixandre, M. P. (2007). Designing argumentation learning environments. In S. Erduran & M. P. Jiménez-Aleixandre (Ed.), *Argumentation in science education: Perspectives from classroom-based research* (pp. 91-115). Dordrecht, The Netherlands: Springer.

Karpudewan, M. & Roth, W.M. (2018). Changes in primary students' informal reasoning during an environment-related curriculum on socioscientific issues. *International Journal of Science and Mathematics Education*, *16*, 401-419.

Kenyon, L. & Reiser, B. J. (2006). *A functional approach to NOS: Using epistemological understandings to construct and evaluate explanations.* In annual meeting of the American Educational Research Association, San Francisco, CA

Kırbağ Zengin, F., Alan, B. & Keçeci, G. (2016). The effects of academic controversy technique to preservice science teachers' science self-efficacy and conceptual understanding of cloning. *The Journal of International Social Research, 9*(46), 581-585.

Khishfe, R. & Abd-El-Khalick, (2002). Influence of explicit and reflective versus implicit inquiry oriented instruction on sixth graders' views of nature of science. *Journal of Research in Science Teaching, 39*(7), 551–578.

Klosterman, M. L. & Sadler, T. D. (2010). Multi-level assessment of scientific content knowledge gains associated with socioscientific issues-based instruction. *International Journal of Science Education, 32*(8), 1017–1043.

Klop, T. & Severiens, S. (2007). An exploration of attitudes towards modern biotechnology: A study among Dutch secondary school students. *International Journal of Science Education, 29*(5), 663-679.

Kutluca, A. Y, Çetin, P. S. & Doğan, N. (2014). Effect of Content Knowledge on Scientific Argumentation Quality: Cloning Context. *Necatibey Faculty of Education Electronic Journal of Science & Mathematics Education*, *8*(1), 1-30.

Küçükaydın, M. A. (2019). Eighth grade students' opinions on the socioscientific ıssue and their argument structure. *Elementary Education Online,18*(1), 174-189.

Lederman, N. G. (2007). NOS: Past, present, and future. In S.K. Abell & N.G. Lederman (Eds.), *Handbook of research on science education* (pp. 831–880). Mahwah, NJ: Lawrence Erlbaum Associates.

Levinson, R. (2006). Towards a theoretical framework for teaching controversial socioscientific issues. *International Journal of Science Education, 28*(10), 1201–1224.

Lincoln, Y. S. & Guba, E. G. (2013). *The constructivist credo.* California, CA: Left Coast Press.

Liu, Z., Cai, Y., Wang, Y., Nie, Y., Zhang, C., Xu, Y., Zhang, X., Lu, Y., Wang, Z., Poo, M. & Sun, Q. (2018). Cloning of macaque monkeys by somatic cell nuclear transfer. *Cell*, *172*(4), 881-887.

Mae-Wan Ho (1999). Are economic system like organism?, The Institute of science in society (ISIS), Retrieved from http:// www.i-isis.org.uk/hannove.php

Maloney, J. & Simon, S. (2006). Mapping children's discussions of evidence in science to assess collaboration and argumentation. *International Journal of Science Education, 28*(15), 1817-1841.

Marshall, C. & Rossman, G. B. (2014). *Designing Qualitative Research*. New York: Sage Publishing.

McComas, W. F. & Olson, J. K. (1998). The nature of science in international science education standards documents. In *The nature of science in science education* (pp. 41-52). Springer, Dordrecht.

McDonald, C. V. (2010). The influence of explicit NOS and argumentation ınstruction on preservice primary teachers' views of NOS. *Journal of Research in Science Teaching, 47*(9), 1137–1164.

MoNE [MEB] (2018). *Science course curriculum (Primary and Secondary School 3, 4, 5, 6, 7 and 8th Grades) [Fen bilimleri dersi öğretim programı* (*İlkokul ve Ortaokul 3, 4, 5, 6, 7 ve 8. Sınıflar)]*. Ankara: Board of Education.

Miles, M.B. & Huberman, A. M. (1994). *Qualitative data analysis* (2. Ed). Newbury Park, CA: Sage.

Öztürk, N., & Eş, H. (2017). *Science teacher candidates' decisions and warrants in certain socio-scientific issues*, 2. International Academic Research Congress (Full Text), 18-21 October, Alanya, Turkey.

Öztürk, N., Eş, H. & Turgut, H. (2017). How gifted students reach decisions in socio-scientific issues? Warrants, information sources and role of media. *International Online Journal of Educational Sciences, 9*(4), 1111 -1124.

Öztürk, N. & Türkoğlu, A.Y. (2018). Pre-service science teachers' knowledge and views about several socio-scientific ıssues after peer-led discussions. *Elementary Education Online, 17*(4), 2030-2048.

Öztürk, N., & Yenilmez-Türkoğlu, A. (2018). Pre-service science teachers' knowledge and views about several socio-scientific issues after peer-led discussions. *Elementary Education Online*, *17*(4).

Pardo, R., Midden, C. & Miller, J. (2002). Attitudes toward biotechnology in the European Union. *Journal of Biotechnology*, 98(1), 9-24.

Sadler, T. D., Chambers, F. W. & Zeidler, D.L. (2004). Student conceptualisations of the NOS in response to a socio-scientific issue. *International Journal of Science Education, 26*(4), 387– 409.

Sadler, T. D. & Donnelly, L. A. (2006). Socioscientific argumentation: The effects of content knowledge and morality. *International Journal of Science Education, 28*(12), 1463-1488.

Sadler, T. D. & Zeidler D. L. (2005). Patterns of informal reasoning in the context of socio scientific decision making. *Journal of Research in Science Teaching, 42*(1), 112- 138.

Sadler, T. D., & Zeidler, D. L. (2004). The morality of SSI: Construal and resolution of genetic engineering dilemmas. *Science Education*, 88, 4–27.

Sampson, V. & Clark, D. (2011). A Comparison of the Collaborative Scientific Argumentation Practices of Two High and Two Low Performing Groups. *Research in Science Education, 41*, 63-97.

Sandoval, W. A. (2005). Understanding students' practical epistemologies and their influence on learning through inquiry. *Science Education*, *89*, 634–656.

Sandoval, W. A. & Millwood, K. A. (2005). The quality of students' use of evidence in written scientific explanations. *Cognition and Instruction, 23*(1), 23-55.

Sandoval, W. A., & Millwood, K. A. (2008). What can argumentation tell us about epistemology? In S. Erduran & M.-P. Jimenez-Aleixandre (Eds.), *Argumentation in science education: Perspectives from classroom-based research* (pp. 71–88). Dordrecht: Springer

Seçkin Kapucu, M. & Türk, H. (2019). Analysis of current scientific news according to toulmin argument model and determination of students' argument levels. *Journal of Qualitative Research in Education, 7*(3), 1119-1144.

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, *22*, 63-75.

Şahin, E. (2015). *Gifted students (Primary class level 3,4) (BİLSEM's) opinions regarding the selection process investigation of principals and teachers (Kocaeli İzmit district sample)*. Unpublished Master Thesis. Institute of Social Sciences, Okan University, İstanbul, Turkey.

Tavşancıl, E. & Aslan, E. (2001). *Content analysis and application examples for verbal, written and other materials.* İstanbul: Epilson.

Topçu, M. S. (2015). *Socio-scientific subjects and teaching (Sosyo-bilimsel konular ve öğretimi)*. Ankara: Pegem Academy.

Toulmin, S. (1958). *The uses of argument*. Cambridge: Cambridge University Press.

Türkmen, H., Pekmez, E. & Sağlam, M. (2017). Pre-service science teachers' thoughts about socio-scientific issues. *Ege Journal of Education, 18*(2), 448-475.

Venville, G. & Dawson, V. (2010). The impact of a classroom intervention on grade 10 students' argumentation skills, informal reasoning and conceptual understanding of science. *Journal of Research in Science Teaching*, *47*(8), 952–977.

Yang, F. Y. & Anderson, O. R. (2003). Senior high school students' preference and reasoning modes about nuclear energy use. *International Journal of Science Education, 25*(2), 221-244.

Yapıcıoğlu, A.E. & Kaptan, F. (2017). A mixed method research study on the effectiveness of socioscientific issue-based instruction. *Education and Science, 42*(192), 113-137.

Yıldırım A. & Şimşek H. (2013). *Qualitative research methods in the social sciences* (9. Press). Ankara: Seckin Publishing.

Zeidler, D. L. (2001). Standard F: Participating in program development. E. Siebert & W. Mcintosh (Eds.), *Pathways to the science standards: College Edition* (pp. 18-22). Arlington: VA National Science Teachers Association.

Zeidler, D. L. (2014). Socioscientific issues as a curriculum emphasis: Theory, research and practice. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 697–726). New York: Routledge.

Zeidler, D. L., Sadler, T. D., Applebaum, S. & Callahan, B. E. (2009). Advancing reflective judgment through socioscientific issues. *Journal of Research in Science Teaching, 46*(1), 74-101.

Zeidler, D. L., Walker, K. A., Ackett, W. A. & Simmons, M. L. (2002). Tangled up in views: Beliefs in the nature of science and responses to socioscientific dilemmas. *Science Education*, 86, 343-367.

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