Determination of Argumentation Quality of Science Teacher Candidates in the Context of the Human Reproductive System Subject

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Abstract: This study aims to determine teacher candidates' written argumentation quality with the help of various socio-scientific issues in the context of the human reproductive system subject. For this reason, a case study was conducted with 24 science teacher candidates studying at a state university in Turkey. Data were collected with a questionnaire involving five open-ended questions. The questions interrogated testing for genetic diseases before marriage, sugar-loading tests during pregnancy, designer babies, surrogacy, and consanguineous marriage. In the data-gathering process, the participants were asked whether they supported the given socio-scientific issue and to provide written arguments for each question. Data were analyzed using the content analysis and the framework introduced by Sadler and Fowler (2006). According to the results, teacher candidates' support and argumentation levels varied with respect to the issue. The teacher candidates' arguments dominated in justification with elaborated grounds level for the second and fifth issues whereas justification with elaborated grounds and a counter-position level was observed in a higher rate for the third and fourth issues. For future studies, it is recommended to design an instruction period to develop teacher candidates' argumentation qualities on the issues addressed in this study paper.

Keywords: Arguments, socio-scientific issues, teacher candidates.

Fen Bilgisi Öğretmen Adaylarının Üreme Sistemi Konusu Bağlamında Argümantasyon Kalitesinin Belirlenmesi

Öz: Bu araştırma, insanda üreme sistemi konusu bağlamında çeşitli sosyobilimsel konular yardımıyla öğretmen adaylarının yazılı argümantasyon kalitesini ortaya çıkarmayı hedeflemektedir. Bu doğrultuda, Türkiye'de bir devlet üniversitesinde öğrenim görmekte olan 24 fen bilgisi öğretmen adayı ile bir durum çalışması gerçekleştirilmiştir. Araştırmanın verileri, beş adet açık uçlu sorudan oluşan bir anket yardımıyla toplanmış olup bu sorularda evlilik öncesinde genetik hastalıkların tespiti için test yapılması, gebelikte şeker yükleme testi, tasarım bebekler, taşıyıcı annelik ve akraba evliliği ele alınmıştır. Veri toplama sürecinde, katılımcılardan her bir sosyobilimsel konuyu destekleyip desteklemediklerini belirterek bunlara yönelik yazılı argümanlar oluşturmaları beklenmiştir. Toplanan veriler, içerik analizi ile Sadler ve Fowler (2006) tarafından ortaya konulan çerçeve yardımıyla analiz edilmiştir. Araştırma sonuçlarına göre, öğretmen adaylarının kendilerine sunulan sosyobilimsel konuları destekleme durumları ile argümantasyon seviyelerinin konuya göre değişiklik gösterdiği belirlenmiştir. Buna göre ikinci ve beşinci konularda

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oluşturulan argümanlarda ayrıntılı temelle gerekçelendirme öne çıkarken, üçüncü ve dördüncü konularda ise ayrıntılı temelle gerekçelendirme ve karşıt görüş seviyesi daha yüksek oranda tespit edilmiştir. Gelecekte yapılacak çalışmalarda, öğretmen adaylarının bu araştırmada ele alınan konulara ilişkin argümantasyon kalitesinin geliştirilmesi için uygun bir öğretim süreci tasarlanması önerilmektedir.

Anahtar kelimeler: Argümanlar, öğretmen adayları, sosyobilimsel konular.

Introduction

As in other fields, it is important to train teachers equipped with the 21st-century skills in science education. Thinking skills such as critical thinking and divergent thinking, cultural awareness, and the ability to express it, being a responsible citizen, and social and individual competencies are among these skills (Chalkiadaki, 2018). Additionally, these skills can make students use their content knowledge more effectively. Especially when the controversial issues in science education are considered, the importance of these skills become more obvious. These controversial issues, called socio-scientific issues, are generally defined as problems that involve scientific products and processes, are open-ended, are not well structured, and are open to multiple perspectives and solutions (Sadler & Zeidler, 2005a). Unlike other ordinary problems, socio-scientific issues involve ethical dimensions, either explicitly or implicitly, and require moral reasoning for their solution (Kolarova et al., 2013). Today's rapidly changing conditions cause an increase in the number of these issues. In addition, with the COVID-19 Pandemic, new socio-scientific issues have entered our lives, causing different opinions to emerge in different segments of society (Bostan Sarıoğlan & Ürek, 2022).

Socio-scientific issues require individuals make decions to adapt them in their daily lives. Hence, making the right decisions on socio-scientific issues is important because the results of those decisions concern the whole society. Therefore, it is important to raise scientifically literate individuals. With scientific literacy, individuals gain at least partial ability to interpret relevant evidence and draw conclusions by discussing socio-scientific issues (Sadler & Zeidler, 2005a). In this process, argumentation and decision-making are often utilized to handle socio-scientific issues in science education (Wu & Tsai, 2007). According to Sadler and Zeidler (2005b), argumentation implies informal reasoning. In this context, informal reasoning is explained as cognitive and affective processes that contribute to the solution of complex problems (Sadler & Zeidler, 2005a) and includes reasoning about the causes-consequences, advantages-disadvantages, and pros-cons of a proposition or decision (Zohar & Nemet, 2002). So, this process ends with several products. The products generated by students as a result of the argumentation process are called arguments (McDonald, 2014) which form the basis of science and scientific discourse (Simon, 2008).

The literature introduces different argumentation models (such as Toulmin Model, Giere Model, Zohar and Nemet Model, Kelly and Takao Model, Lawson Model, Sandoval Model) which are used in science education (Aktamış & Hiğde, 2015). Toulmin's Argumentation Model can be stated as the most common argumentation model. The students' argumentation quality can be determined with several instruments which have been developed according to these models. In this context, the instruments proposed by Sadler and Fowler (2006), Venville and Dawson (2010), Erduran et al. (2004) consider Toulmin's Argumentation Model.

According to Toulmin's Argumentation Model, the components of an argument are claim, data, warrant, backing, qualifier, and rebuttal (Toulmin, 2003). In this model, the basic components of a simple argument are stated as claim, data, and warrant. The addition of the components such

as backing, qualifier and rebuttal are asserted to make the structure of an argument more complex and improve its quality. Although Toulmin's Argumentation Model has been criticized for analyzing arguments in terms of structure rather than content and therefore has limitations (Simon, 2008), it is seen that this model provides an important basis for researchers. The model is asserted to make students mentally active due to the power of the claim to represent the data and assert the strong and weak aspects of the claim (Gülen, 2020). Besides, the frameworks based on this model may provide details to the researchers about how the students engage in argumentation process and how they structure their arguments (Yıldırır, 2013). In line with the objectives of the present study, the framework proposed by Sadler and Fowler (2006) based on Toulmin's Argumentation was utilized in this study. This framework allows the students to provide a justification, to detail this justification and add counter positions as cited in Atasoy and Yüca (2021). Thus, the argumentation levels of the students are identified to be higher as they use justifications and counter-positions in their arguments (Isbilir et al., 2014).

There are various studies based on determining the argumentation quality of primary school students (Kara et al., 2020), middle school students (Akbaş & Çetin, 2018; Atasoy & Yüca, 2021), high school students (Çetin et al., 2014; Gümrah, 2013) and teacher candidates (Demircioğlu & Uçar, 2014; Isbilir et al., 2014; McDonald, 2014; Okumuş, 2022; Robertshaw & Campbell, 2013; Tunç Şahin, 2022). In addition, Simon (2008) discusses the argumentation quality of in-service science teachers while Tunç Şahin (2022) includes graduate students as well as undergraduate students in her study. It is seen that different studies focus on the impact of teaching implementations on students' argumentation quality (Atasoy & Yüca, 2021; Çetin et al., 2014; Demircioğlu & Uçar, 2014; Gümrah, 2013; Kara et al., 2020) whereas several studies address detecting the current situation (Akbaş & Çetin, 2018; Isbilir et al., 2014; McDonald, 2014; Okumuş, 2022; Robertshaw & Campbell, 2013; Tunç Şahin, 2022). The study results show that the teaching implementations cause an improvement in the participants' argumentation quality (Atasoy & Yüca, 2021; Çetin et al., 2014; Demircioğlu & Uçar, 2014; Gümrah, 2013; Kara et al., 2020). Also, it is underlined that focusing on such implementations in teacher education is very important to raise individuals who are competent to make decisions on various socio-scientific issues in the future (Cebesoy & Rundgren, 2023).

The use of argumentation has a key role in science classrooms (Zohar & Nemet, 2002). It makes various contributions to the students and learning process in terms of science education. Osborne et al. (2004) state two functions of the argumentation as it engages learners in the coordination of conceptual and epistemic goals, and it makes student scientific thinking and reasoning visible to enable formative assessment by teachers or instructors. Besides, Wu and Tsai (2007) signify that argumentation presents students the opportunity to apply their scientific knowledge for solving daily life problems. Another advantage of using argumentation is that it facilitates students' comprehension of the nature of science (Akbaş & Çetin, 2018) because students cannot be simpliy informed that a model of science as the accumulation of certain knowledge is incorrect (Kuhn, 2010). In this process, socio-scientific issues provide a context for the learners.

Several socio-scientific issues in science education can be associated with the human reproductive system within the scope of the systems in our body subject. Considering that one of the main purposes of human life is to transfer genes to future generations (Hamalosmanoğlu, 2017), it is realized how important the opinions and decisions to be taken in society are. Therefore, science teacher candidates who will teach this subject at the middle school level in the near future need to

develop a perspective on the controversial issues in this context, support their opinions with scientific knowledge, and evaluate the issue from different perspectives.

In the context of the human reproductive system, one of the most frequently covered topics in the media can be stated as the sugar-loading tests performed during pregnancy. However, there is no consensus among experts regarding the best screening and diagnostic method for detecting gestational diabetes (Türkyılmaz et al., 2016). Also, socio-scientific issues such as testing for genetic diseases before marriage, designer babies and surrogacy have become part of our lives due to technological developments. Among these issues, genetic tests are used to determine susceptibility to genetically transmitted diseases and to predict diseases that will negatively affect a person's own health and reproductive cells in the future (Lederman et al., 2014). On the other hand, there are social concerns about performing such tests due to false-positive results, excessive demand for genetic testing, changing understanding of the concept of health, and the psychosocial effects of knowing the genetic status (Boerwinkel et al., 2014).

The issue of designer babies, which emerged due to developments in biotechnology, initially provided hope for parents who could not have babies, but later reached the dimension of selecting various features that are desired to be present in the offspring (Sas & Lawrenz, 2017). Moreover, rapid developments in this field have brought the concept of mitochondrial donation to the agenda, which has brought about several social and ethical concerns (Diamond, 2015). Another socio-scientific issue that arises in the subject of reproductive system is surrogacy. Although this concept is explained as "partial" or "full" surrogacy according to social and legal bases as well as scientific knowledge (Vlaardingerbroek, 2018), there are different regulations on this subject in different countries (Armour, 2012). In addition, researchers emphasize cross-border surrogacy and draw attention to the negative ethical consequences of this situation (Blazier & Janssens, 2020). In addition to the mentioned socio-scientific issues related to biotechnological developments, it can be stated that consanguineous marriage is an issue that continues culturally in several societies and the effects are felt especially on the children. While the rate of such marriages remains low in developed countries, they are more common in countries such as Africa, the Middle East, and India (Alp & Şen, 2020). As can be seen, there are different implementations and perspectives for all those issues among socities and individuals should have sufficient level of scientific literacy to make effective decisions for integrating those issues in their lives.

The Aim and Significance of the Research

The aim of this research is to determine the written argumentation quality of science teacher candidates about socio-scientific issues related to the human reproductive system. It is thought that research is important in terms of addressing some prominent issues which are directly related to human health and human life. Besides, the study focuses on the argumentation skills of individuals who will teach this subject in the near future. Thus, this study is believed to make contributions to the argumentation quality studies by bringing together several issues related to the human reproductive system in a single paper in addition to widely discussed issues in the literature such as nuclear power plant construction (Cenk & Ercan Yalman, 2022; Demircioğlu & Uçar, 2014; İsbilir et al., 2014), hydroelectric power plant construction (Akbaş & Çetin, 2018; Atasoy & Yüca, 2021) or global climate change (Cenk & Ercan Yalman, 2022; McDonald, 2014). Therefore, the study is believed to be original, and the issues considered in this paper are expected to provide examples to the literature in terms of Turkish science teacher candidates context.

The research questions aimed to be answered in this research are as follows:

1. What are the teacher candidates' opinions about supporting the socio-scientific issues presented to them?
2. What are the argumentation levels of teacher candidates regarding the socio-scientific issues presented to them?

Methodology

Study Design

This research was conducted as a case study, one of the qualitative research designs, and in this context, the holistic single case design was used. In this design, there is a single unit of analysis (Yıldırım & Şimşek, 2016). In this research, the analyses include a group of teacher candidates studying in the same program.

The Study Group

The study group consisted of 24 teacher candidates studying at the senior level in the Science Teaching Program at a state university in the west of Turkey. There were 3 male and 21 female candidates in the study group. Their average age was 22. The purposive sampling approach was used to determine the study group. In this context, all of the teacher candidates took the course called "Scientific Reasoning Skills", which was given in the sixth semester of the eight-semester program. Additionally, all of the participants took a field education elective course called "Human Anatomy and Physiology" during this research process. Thus, it was aimed that the individuals forming the study group would provide rich data within the framework of the research (Büyüköztürk et al., 2010).

Data Gathering Instrument

The data of the study were collected with a questionnaire structured by the researcher as a result of the literature review. The instrument consisted of five open-ended questions. The questions in the questionnaire were developed considering the socio-scientific issues that can be associated with the "Human Reproductive System" subject of the "Human Anatomy and Physiology" course given within the scope of field education elective courses in the Science Teaching Program. In each question, firstly the teacher candidates were asked whether they supported the issue and then they were asked to express their opinions in the form of written arguments.

The questions in the questionnaire were as follows:

1. Do you support testing for genetic diseases before marriage? Why or why not?
2. Do you support sugar-loading tests during pregnancy? Why or why not?
3. Do you support designer babies? Why or why not?
4. Do you support surrogacy? Why or why not?
5. Do you support consanguineous marriage? Why or why not?

The instrument was presented to two science education and two biology education experts to ensure the validity. The application of the instrument was on a voluntary basis within one class hour. Also, the research was carried out within the framework of ethical rules.

Data Analyses

The data obtained were evaluated within the scope of qualitative analysis. First, content analysis was used to determine the teacher candidates' opinions about supporting the socio-scientific issues discussed in the questions. Accordingly, the responses of the participants were evaluated under three categories: those who support the issue, those who do not support the issue, or those who partially support it/are undecided. A similar evaluation process is also encountered in the previous studies on argumentation (Öztürk & Yenilmez Türkoğlu, 2018; Türköz & Öztürk, 2020). Secondly, the framework put forward by Sadler and Fowler (2006) was taken as a basis in determining the argumentation levels of teacher candidates. Accordingly, the argumentation levels of teacher candidates were examined in five categories: no justification (NJ), justification with no grounds (JwNG), justification with simple grounds (JwSG), justification with elaborated grounds (JwEG), and justification with elaborated grounds and a counter-position (JwEG/CP). The frequency of teacher candidates falling into each category was visualized in the form of tables. In this process, teacher candidates were coded as P1, P2… to show the participants in each category. If the participant did not support the issue given in the question, - sign was placed next to the code (e.g. P1⁻), if the participant was undecided about the issue or supported it under a certain condition, * was placed next to the code (e.g. P2*). If the participant supported the issue, no sign was used. Besides, quotations from participants' written arguments were presented to increase the internal validity of the research. In addition, the analysis results related to the argumentation levels of the teacher candidates were summarized in the form of a line graph.

To ensure the reliability of data analysis, another researcher also conducted data analyses and the consistency between two researchers was checked. As a result of all analyses, the consistency coefficient between the researchers was calculated according to Miles and Huberman' formula (1994) and was determined to be .94. Since this value is above .70, the data analysis can be concluded to be reliable (Yıldırım & Şimşek, 2016).
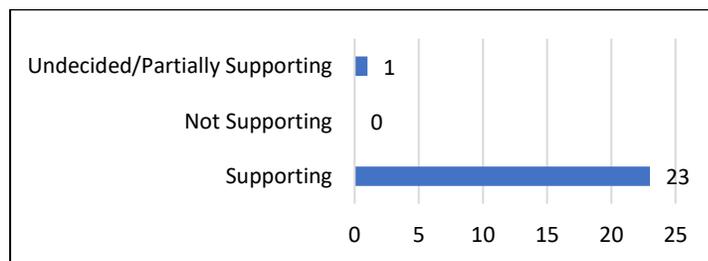
Findings

Findings on Arguments Regarding Getting Tested to Detect Genetic Diseases Before Marriage

Teacher candidates' opinions on supporting getting tested to detect genetic diseases before marriage are shown in Figure 1.

Figure 1

Opinions of Teacher Candidates regarding the First Socio-scientific Issue

According to Figure 1, the majority of teacher candidates support testing for genetic diseases before marriage (f = 23). On the other hand, it is noticed that only one candidate remains

in the category of undecided/partially supportive on this issue. The argumentation levels of teacher candidates on this issue are presented in Table 1.

Table 1

Teacher Candidates' Argumentation Levels regarding the First Socio-scientific Issue

Levels	NJ	JwNG	JwSG	JwEG	JwEG/CP
Teacher Candidates	-	P10, P12, P20	P2, P5, P11, P13, P15, P17, P18, P19, P22, P24	P1, P4, P6, P7, P8, P9, P14, P16, P21, P23	P3*
f	-	3	10	10	1

According to Table 1, the highest rates of teacher candidates' arguments are at the levels of JwSG (f=10) and JwEG (f=10). No candidate is encountered at the NJ level.

The teacher candidates at the JwNG level state that such tests should be performed. They mention SMA disease and children in the respect. However, they add no grounds to their justification. The teacher candidates at the JwSG level also support these tests by adding simple grounds to their justification. They approve of these tests to prevent several problems, to take necessary preventions or not to take any risks. Besides, teacher candidates at the JwEG level approve of these tests by adding elaborated grounds to their justification. They talk about the advantages of these tests. They mention the characteristics of several genetic diseases and discuss the impacts of having a child with a genetic disease from the perspectives of parents. Besides, they talk about the difficulties which may be experienced by the child throughout his/her life. They approach the issue materially, economically, and sipiritually. On the other hand, at the highest level, JwEG/CP, one teacher candidate approaches the issue from both sides. The teacher candidate supports the test by talking about its advantages as well as mentioning the problems which it may cause in terms of ethical, legal, and practical aspects. Thus, the candidate remains undecided.

Examples from written arguments on testing for genetic diseases before marriage are as follows:

P10: *It should definitely be mandatory because it affects the lives of children born with SMA.* (JwNG)

P11: *Tests for this should definitely be made widespread. Because some genetic diseases are very difficult to treat. The unborn child and its parents do not need to experience this. I think this should be prevented before marriage.* (JwSG)

P4: *Testing for genetic diseases before marriage should be mandatory in order to have children. Because when individuals carrying the disease have children, sick children may be born. Individuals with genetic diseases such as SMA experience a very difficult process (both psychological and financial difficulties) for both the newborn baby and their parents. If both individuals are carriers of a genetic disease, a healthy embryo can be transferred to the mother's womb and they can have a healthy child, thanks to the in vitro fertilization method.* (JwEG)

P3: *I am undecided about this issue. Because, on the one hand, genetic diseases can be detected and prevented in advance. But on the other hand, such tests can violate people's personal rights. Additionally, requiring such tests may also raise ethical and legal issues. Therefore, I think there is a need for discussion and consensus in society on this issue.* (JwEG/CP)

Findings on Arguments regarding Sugar-Loading Test During Pregnancy

Teacher candidates' opinions on supporting the sugar-loading test during pregnancy are shown in Figure 2.

Figure 2

Opinions of Teacher Candidates regarding the Second Socio-scientific Issue
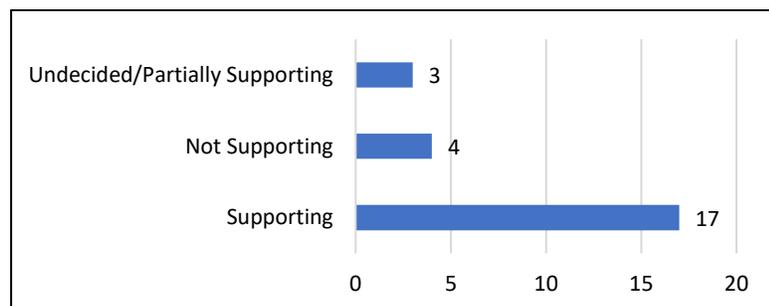
When Figure 2 is examined, it is seen that the majority of teacher candidates support the sugar-loading test during pregnancy (f= 17). On the other hand, only four candidates do not support this test. Also, it is noticed that three candidates are in the undecided/partially supportive category. The argumentation levels of teacher candidates regarding this issue are presented in Table 2.

Table 2

Teacher Candidates' Argumentation Levels regarding the Second Socio-scientific Issue

Levels	NJ	JwNG	JwSG	JwEG	JwEG/CP
Teacher Candidates	P14*, P22*	P5⁻, P12, P20⁻	P3, P11, P15, P16, P17, P19, P21, P24	P1, P2, P4, P6⁻, P8, P9⁻, P10, P13, P18, P23	P7*
f	2	3	8	10	1

According to Table 2, various opinions are encountered at all levels. However, the highest rate of the teacher candidates' arguments is at the level of JwEG (f=10).

Table 2 shows that teacher candidates at the NJ level are undecided about the issue. They do not provide justification in their arguments. At the JwNG level, two teacher candidates disapprove of these tests since they think that there is no need for such a test. Also, one teacher candidate supports these tests since there may be a need to use it. These candidates do not provide any grounds for their justifications. At the JwSG level, the candidates approve of these tests by adding a simple ground to their justification. They generally mention the advantages of these tests as detecting gestational diabetis and treating this disease. At the JwEG level, the teacher candidates approve or disapprove of these tests by adding elaborated grounds to their justification. They discuss all the advantages or disadvantages of sugar-loading tests on the health status of mother and baby. On the other hand, at the highest level, JwEG/CP, one teacher candidate approaches the issue from both sides. The teacher candidate supports the test for mothers who have diabetis. However, the candidate also talks about the negative aspects of sugar-loading on the health status of the baby. Thus, the candidate is determined to be undecided about the issue.

Example arguments on sugar-loading tests during pregranancy are as follows:

P14: *If necessary, it can be supported under medical supervision.* (NJ)

P12: *Yes, it should be supported because all kinds of discomfort can occur during pregnancy. No matter how much the baby protects the mother, there may be situations that could harm the mother.* (JwNG)

P15: *It should be supported. Because if the expectant mother has gestational diabetes, this disease can be detected and diseases that will seriously affect the baby can be prevented.* (JwSG)

P18: *Sugar-loading tests should be supported during pregnancy because it is important for detecting and treating diabetes. Thus, blood sugar levels are kept under control during pregnancy and the risks that may occur are proportionally reduced. Otherwise, some negative situations may occur. These conditions may negatively affect the pregnancy of the expectant mother, such as premature birth, miscarriage, and high blood pressure.* (JwEG)

P7: *I think it can be supported for people with pre-existing diabetes, but I do not find this test necessary for an expectant mother who has no disease. While there are those who recommend the sugar-loading test to determine the sugar level during pregnancy, there are also those who reject this test. But I think it is not necessary for a mother who eats a balanced and healthy diet. Because the sugar-loading test may have negative results on the baby's life in the future.* (JwEG/CP)

Findings on Arguments regarding Designer Babies

Teacher candidates' opinions about supporting designer babies are shown in Figure 3.

Figure 3

Opinions of Teacher Candidates regarding the Third Socio-scientific Issue
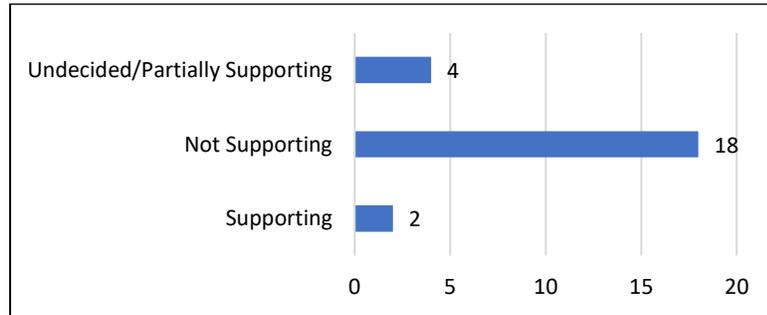
According to Figure 3, the majority of teacher candidates do not support designer babies (f=18). On the other hand, it is found that two candidates support this issue, while four candidates are in the undecided/partially supportive category. The argumentation levels of teacher candidates on this subject are presented in Table 3.

Table 3

Teacher Candidates' Argumentation Levels regarding the Third Socio-scientific Issue

Levels	NJ	JwNG	JwSG	JwEG	JwEG/CP
Teacher Candidates	P19[-]	P12[-], P15[-], P20[-], P22[-]	P24[-]	P3[-], P7[-], P9[-], P11[-], P16, P17*, P21[-], P23	P1*, P2[-], P4[-], P5[-], P6[-], P8*, P10*, P13[-], P14[-], P18[-]
f	1	4	1	8	10

Considering Table 3, various amounts of arguments are encountered at all levels. The highest rate of the teacher candidates' arguments is at the level of JwEG/CP (f= 10).

According to Table 3, one teacher candidate at the NJ level disapproves of the designer baby issue with no justification. At the JwNG level, the teacher candidates also find this issue unacceptable with no grounds. They assert negative opinions and add that this should be a natural process and genes should not be manipulated. At the JwSG level, one candidate is against this issue by adding a simple ground to his/her justification. The candidate states that such a design may harm the baby since there is manipulation on the genes of the baby. At the JwEG level, the teacher candidates show a variety of opinions towards the issue. They give elaborated grounds and mention ethical, legal, social concerns or practical aspects of the issue in their arguments. Also, two candidates focus on the benefits of this technology on the intelligence level and health status of the baby and humanity. On the other hand, at the highest level, JwEG/CP, the teacher candidates are determined as undecided or unsupportive about the issue. In this level, the candidates approach the issue from both sides in their arguments. They approve of this issue by talking about eliminating genetic diseases and adding desirable characteristics to babies. However, they also state their concerns about the potential risks of such manipulations on society for the future generations. As a result, several of them are undecided about the issue whereas several of them disapprove of it.

Examples of teacher candidates' arguments on designer baby issue are as follows:

P19: *I think it should not be supported.* (NJ)

P12: *I think it should not be supported, because raising such a robotic child should not be subject to choose, it is not right for families to do this.* (JwNG)

P24: *Designer babies should not be supported. Because this design is genetically modified for babies, it may harm the baby.* (JwSG)

P9: *Should not be supported. I don't think it is ethically appropriate. A seamless baby design may exclude or humiliate other parents or babies. It causes the genetic diversity factor to disappear. Families having children according to their own wishes makes the world uninhabitable. It causes chaos in society.* (JwEG)

P8: *My thoughts on this issue are not very clear. It sounds good that technology has developed so much and hereditary diseases have been removed from DNA in advance. But it's not just about manipulating disease genes. We can create a child with the characteristics we want. Having a child is a different privilege and everyone's child is a completely different person depending on the characteristics of their parents. I think it should stay like this. In short, when I think about this part, I don't find it very logical to support it. But I think its use for genetic diseases might be supported.* (JwEG/CP)

Findings on Arguments regarding Surrogacy

Teacher candidates' opinions on supporting surrogacy are shown in Figure 4.

Figure 4

Opinions of Teacher Candidates regarding the Fourth Socio-scientific Issue
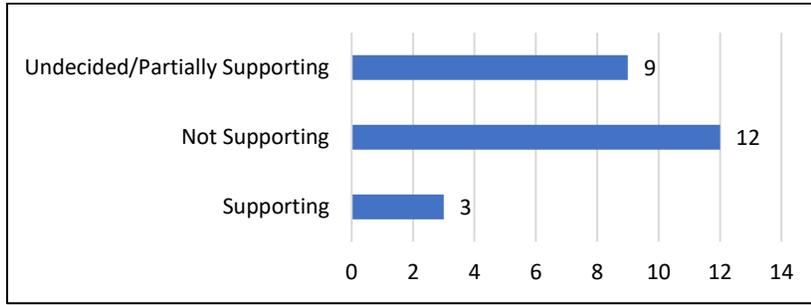
According to Figure 4, it was determined that half of the teacher candidates do not support surrogacy (f= 12). In addition, nine candidates are among those who are undecided/partially supportive of this issue; however, only three candidates are found to support this issue. The argumentation levels on this subject are presented in Table 4.

Table 4

Teacher Candidates' Argumentation Levels regarding the Fourth Socio-scientific Issue

Levels	NJ	JwNG	JwSG	JwEG	JwEG/CP
Teacher Candidates	-	P6⁻, P15*, P18⁻, P19	P11, P16⁻, P17*, P24⁻	P2⁻, P4⁻, P9, P12⁻, P13⁻	P1⁻, P3*, P5*, P7⁻, P8*, P10*, P14*, P20*, P21⁻, P22*, P23⁻
f	-	4	4	5	11

When Table 4 is examined, the highest rate of teacher candidates' arguments is at the level of JwEG/CP (f=11). On the other hand, no argument has been determined at the NJ level.

The teacher candidates at the JwNG level have different viewpoints towards surrogacy. They all add no grounds to their justification. The teacher candidates at the JwSG level also have different viewpoints towards surrogacy by adding a simple ground to their justification. For example, one candidate approves of this issue since it may provide a gleam of hope for the parents who cannot have a baby naturally. On the other hand, another candidate signifies that such a procedure may create an emotional gap between the mother and the baby. The teacher candidates at the JwEG level support or do not support this issue by adding elaborated grounds to their justification. Four candidates discuss the negative effects of surrogacy on the baby and surrogate mother in detail. However, one candidate accepts surrogacy and addresses the reasons of parents who want to have a child through surrogacy in detail. At the highest level, JwEG/CP, the teacher candidates approach the issue from both sides. At this level, the teacher candidates are undecided or disapprove of the issue by talking about its advantages as well as mentioning the problems which it may cause from the ethical, legal, practical, and financial aspects.

Example arguments on surrogacy issue for each level are as follows:

P6: *I think it should not be supported. Because I believe that in such a case, there will be no emotional bond between the child and its biological mother.* (JwNG)

P24: *Should not be supported. Because it is inevitable to establish a bond between the mother and her baby during pregnancy. Therefore, after the pregnancy, the baby may start to see the surrogate mother as its real mother. This may be harmful to the baby.* (JwSG)

P4: *Surrogacy should not be supported. Because the mother of the newborn child appears to be the surrogate mother who gave birth to her, which brings various problems. Problems may arise for the child, the surrogate mother and genetic mother. If the child is born with a sickness, the child's genetic parents may not want to take it. And the child may be negatively affected by this situation. If the mother cannot get pregnant, there is no need to have a child with her own genetic characteristics. They can take a child from a welfare institution and take care of it. If she wants a child with her own genetic characteristics, she can undergo in vitro fertilization treatment, but the development of the embryo must be ensured in her own womb, not through surrogacy.* (JwEG)

P23: *I think surrogacy should not be supported. If a woman cannot become a mother through medical means, the family does not have to have a baby that carries her own genes. They can also have a baby by adoption. Although the person described as a surrogate mother does this only for financial gain, she bonds with the baby through the placenta, feels every movement in the womb, establishes an emotional bond, her body becomes ready to secrete milk for the baby with oxytocin, and then she gives birth to the baby, even if it is not genetically hers. But the baby is taken from her arms. I don't find this ethical. (JwEG/CP)*

Findings on Arguments regarding Consanguineous Marriage

Teacher candidates' opinions on supporting consanguineous marriage are shown in Figure 5.

Figure 5

Opinions of Teacher Candidates regarding the Fifth Socio-scientific Issue
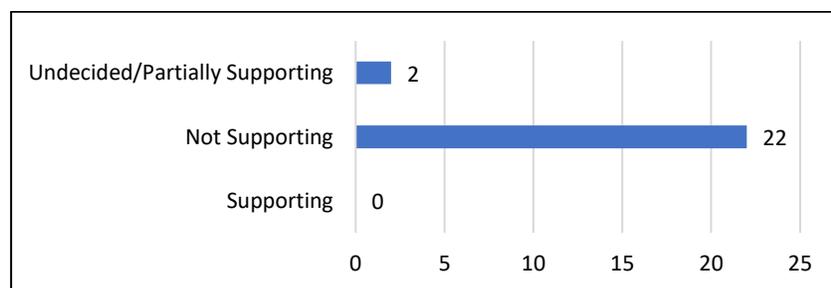
According to Figure 5, the majority of teacher candidates do not support consanguineous marriage (f=22). On the other hand, two candidates are undecided/partially supportive on this issue. The argumentation levels of teacher candidates on this issue are presented in Table 5.

Table 5

Teacher Candidates' Argumentation Levels regarding the Fifth Socio-scientific Issue

Levels	NJ	JwNG	JwSG	JwEG	JwEG/CP
Teacher Candidates	-	P17[-], P24[-]	P12[-], P22[-]	P1[-], P2*, P6[-], P7[-], P8[-], P9[-], P11[-], P14[-], P15[-], P16[-], P18[-], P20[-], P23[-]	P3[-], P4[-], P5[-], P10[-], P13*, P19[-], P21[-]
f	-	2	2	13	7

According to Table 5, the highest rate of the teacher candidates' arguments is at the level of JwEG (f=13). On the other hand, no argument was determined at the NJ level.

The teacher candidates at the JwNG level disapprove of consanguineous marriages. They mention that genetic diseases are transmitted to future generations with such marriages with no grounds for their justification. At the JwSG level, they also disapprove of those marriages by adding a simple ground to their justification. They talk about the problems that children and society may have in the future due to genetically transmitted diseases. At the JwEG level, most of the candidates are against such marriages by giving elaborated grounds to their justification in their arguments. They mention the details of genetic diseases, how these diseases are transmitted to the genes and how society gets affected. Besides, one candidate at this level is undecided about the issue and signifies that genetic tests may allow the parents to be aware of the situation regarding their future baby. On the other hand, at the highest level, JwEG/CP, teacher candidates generally disapprove of the issue by talking about its disadvantages as well as explaining the common reason to perform such marriages as strengthening family relationshios. Also, one teacher candidate is undecided about the issue and mentions both disadvantages and reasons to perform such a marriage. This candidate asserts that such marriages can be accepted after detailed genetic scans and a guarantee is taken that there will be no health problems in the baby.

Examples of the arguments are as follows:

P17: *It should not be supported. Because many diseases are transmitted to future generations due to consanguineous marriages.* (JwNG)

P12: *It should definitely not be supported. When such individuals marry each other, it becomes easier for their children to carry the diseases that are in the family's genetics. In this case, genetic diseases put the unborn child and its descendants in trouble.* (JwSG)

P1: *I do not support consanguineous marriages. Because consanguineous marriage is risky. The probability of diseases occurring in children born from these marriages is very high. Since genes are transferred to the baby from related parents, there is a similarity between the genes. When such marriage occurs, the probability that both mother and father carry defective genes increases, and therefore the risk of the disease in the newborn increases. It is very likely for those children to have diseases such as hemophilia, color blindness, visual and hearing impairment, physical limb disability, mental retardation, and heart disease.* (JwEG)

P4: *Consanguineous marriage should not be supported. Because if individuals have a recessive genetic disease, there is a risk that their relatives will be carriers of this genetic disease, and the babies of individuals carrying these two genes may be born with the disease. However, consanguineous marriage is common in Turkey. Because people know each other well in a consanguineous marriage and the inheritance is not divided. However, for children to be healthy, consanguineous marriages should not be supported. Thus, individuals who are more compatible with the environment are created.* (JwEG/CP)

Findings on Teacher Candidates' Argumentation Levels Determined in the Study

In this part, the teacher candidates' argumentation levels are displayed in the form of a single line graph in Figure 6 to summarize the findings obtained from the whole study.

Figure 6

Summary of Frequency Distribution of Teacher Candidates' Argumentation Levels
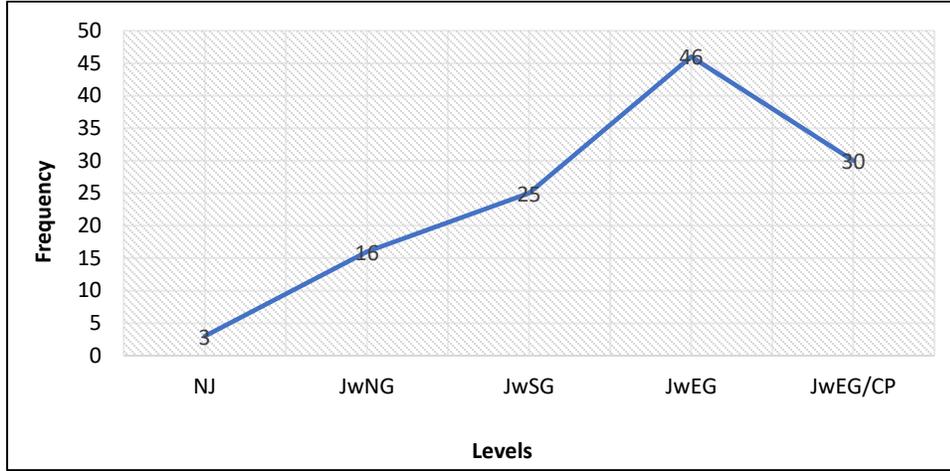
Figure 6 depicts that teacher candidates generate a total of 120 arguments in the study. The highest rate of their arguments is at the level of JwEG (f=46). Besides, they generate 30 arguments at the highest level, JwEG/CP. Also, 25 of their arguments are at the level of JwSG and 16 of their arguments are at the level of JwNG. On the other hand, three arguments are found to be at the lowest level, NJ.

Discussion and Conclusion

This study showed that the quality of written argumentations of teacher candidates in the context of this research varies depending on the issue. Sadler and Zeidler (2005b) signify that there is a connection between informal reasoning skills regarding a socio-scientific issue and content knowledge. Similarly, different contexts considered in this study might have caused differences in the argumentation qualities of the participants. Also, considering that the study group consists of individuals who will teach science to middle school students in the future, these results are thought to be very important. Previous research conducted with middle school students showed that the main factor that makes students aware of socio-scientific issues related to genetic diseases, biotechnology, and genetic engineering applications was "teacher" (Genç & Evren Acar, 2021). Additionally, despite the highlight in the international literature for integrating socio-scientific issues into science education (Berne, 2014), it is pointed out that these issues are not sufficiently included in the curriculum (Kolarova et al., 2013), and there is a need for argumentation research and teacher training for teaching such issues (Özbuğutu, 2022). Hence, the results of the research are expected to make contributions to literature.

The results obtained from the present study are evaluated under two parts such as teacher candidates' opinions on supporting the socio-scientific issues and their argumentation levels. These results are discussed by relating those two parts with each other. Firstly, it was found that almost all teacher candidates supported getting tested before marriage to detect genetic diseases. The participants approved the use of genetic tests which are produced with the help of scientific and technological knowledge on such a social issue. This result is similar to Archila et al.'s (2023) research findings. The researchers investigated the effect of the drama-based teaching-learning sequence method on university students' opinions about genetic testing and their research consisted of five stages. As a result of the research, the participants' opinions were in favor of supporting these tests in each stage. When the participants' argumentation levels in this study are examined, the arguments for getting tested before marriage for genetic diseases mostly remained at the level

of JwSG and JwEG. Besides, only one argument was generated at the highest level, JwEG/CP. Therefore, this result can be interpreted as teacher candidates being limited in creating arguments on this issue. One reason for this situation can be attributed to the fact that the literature on this subject generally highlights the importance of biotechnological applications and the advantages they provide to individuals (Morris, 2014). The biggest benefit of such tests is that they can be performed at any time and determine whether the person has a genetic disease or whether they are carriers, and that the tests performed during the pregnancy give couples information about the health status of their babies and provide them with the opportunity to decide on the continuation of the pregnancy (Lederman et al., 2014). On the other hand, the teacher candidates could not generate arguments involving the negative aspects of such tests considering this issue from a braoder perspective. They could not mention the disadvantages of those tests which might be caused by the awareness they produce in the society. Hence, the study revealed that the teacher candidates had difficulty in including opposing views in their arguments and they experienced insufficiency in creating arguments at the highest level, JwEG/CP.

The current study also indicated that while there was no candidate who supported consanguineous marriage, two candidates were undecided on the issue. This result is believed to be culturally embeddedness of the issue. Additionally, this result is supported by Genç et al.'s (2021) study finding. In their study, all teacher candidates, regardless of whether their scientific attitudes were high or low, reported that their families were the main source where they heard consanguineous marriage. So, families might evaluate this issue from a single perspective, which is reflected in the students' opinions, and therefore students might not include opposing views in their arguments. However, it is important that people not only support their own views, but also be aware of other ideas in society and approach them with respect during the argumentation process (Chung et al., 2016). Besides, in the science education context, it is seen that this issue is investigated especially with Turkish participants. Toraman and Aydın's (2013) research also depicted several teacher candidates who were undecided about consanguineous marriage. This result is in line with the current study. However, these researchers identified a teacher candidate who supported this issue which contradicted this study. The researchers determined that most participants did not find consanguineous marriage appropriate, and the reason for this response was found to be negative consequences of this marriage such as children being born with disabilities (Toraman & Aydın, 2013). When the argumentation levels are examined, it is seen that the level of JwEG came to the fore in the subject of consanguineous marriage. Therefore, teacher candidates' arguments regarding consanguineous marriage should be further developed by considering the opposing views. The literature shows that teaching several socio-scientific subjects, including consanguineous marriage with scientific scenarios caused an improvement in eighth grade students' logical thinking (Şaşmaz-Ören et al., 2022) and an increase in their interest and motivation for the course (Ören et al., 2023). Similar implementations might be conducted with teacher candidates.

Another result of the study was that most participants supported the sugar-loading test during pregnancy. In the field of education, this issue has been discussed within the scope of socio-scientific issues in a limited number of studies. Also, it is noteworthy that these studies were also conducted with Turkish science teacher candidates (Ozturk et al., 2021; Öztürk et al.,2018; Türköz & Öztürk, 2019; 2020). In contrast to the present study results, the pre-tests of previous studies showed that science teacher candidates mostly did not support the sugar-loading test during pregnancy (Türköz & Öztürk, 2020) or were undecided on this issue (Öztürk & Yenilmez

Türkoğlu, 2018). When the argumentation levels are examined, it is seen that the level of JwEG came to the fore in the subject of pregnancy sugar-loading test. On the other hand, there is only one argument at the highest level, JwEG/CP. This result might also be interpreted as there is a need to develop the participants' argumentation level through further studies as in the results regarding consanguineous marriage. In their case study, Ozturk et al. (2021) improved the argumentation quality of teacher candidates regarding several socio-scientific issues, including the sugar-loading test during pregnancy, through discussions on Twitter. However, the researchers identified no argument at the highest level according to the framework introduced by Erduran et al. (2004) both in the pre-test and post-test. In another case study, Türköz and Öztürk (2019) improved the argumentation quality of science teacher candidates about sugar-loading tests with YouTube supported instruction and their post-test analyses indicated a few arguments created at the highest level. Although this issue frequently takes place in the media and different viewpoints are discussed in this context, the participants of the study did not mention opposing views in their arguments sufficiently. This situation might be because sugar-loading tests are not included in teacher candidates' interest area. However, this issue can be addressed in the context of different courses to make them aware of different aspects of the issue.

In the present study, while half of the participants did not support the issue of surrogacy, it was determined that the rate of those who were undecided on this issue was higher than those who supported it. When this result is compared to a study conducted with biology teachers in China, it is noticed that the rate of supporting surrogacy is more common among Chinese teachers (Chen & So, 2017). Additionally, while most participants in this study did not support the issue of designer babies, in Chen and So's (2017) study, most Chinese teachers supported gene therapy to improve the physical characteristics or intelligence level of babies. Also, the highest rate of teacher candidates' arguments constructed about designer babies and surrogacy are at the highest level, JwEG/CP. This result may be because teacher candidates approached these issues emotionally and could easily include different views in their arguments. Besides, the gender of the participants might be another factor which influenced this result. Considering that most of the participants were female students, they might have generated higher level arguments on this issue. Accordingly, Akbaş and Çetin (2018) showed that on socio-scientific issues such as biodiversity and experimental animals, which were directly related to living things, students' informal thinking skills were concentrated in the emotional category on the contrary to the logical category. On the other hand, in the case study conducted by Cenk and Ercan Yalman (2022) with teacher candidates, the quality of the arguments generated on the issue of euthanasia, which is directly related to humans, remained at low levels.

Another factor influencing the result obtained from the current study on designer babies and surrogacy issues might be associated with ethical concerns. As a matter of fact, it is pointed out that the main reason why both surrogacy (Vlaardingerbroek, 2018) and designer baby issues are among the socio-scientific issues is that they include ethical, moral, and legal dimensions (Özbuğutu, 2022). Besides, religious sources are also considered when creating arguments on these issues (Sas & Lawrenz, 2017). So, teacher candidates might mention different aspects in their arguments and these factors might result in higher levels of arguments. The literature involved several implementations of teaching programs considering the designer baby issue which resulted in an increase in the communication skills of high school students (Chung et al., 2016) and improvement in their emotional competence (Gao et al., 2021). Also, as a result of peer discussions conducted by Berne (2014) on students aged 14-16 in Sweden, the students began to evaluate the

issue of designer babies not only in terms of the present time but also in terms of the future and the students approached the issue in terms of ethics, human rights, and duties. Moreover, the same issue was addressed in other studies conducted with high school students (Nielsen, 2012a; 2012b) and science teachers (Minken et al., 2021).

Finally, while teacher candidates had positive opinions towards getting tested before marriage to identify genetic diseases and the sugar-loading test during pregnancy, they had negative opinions towards surrogacy, designer babies, and consanguineous marriage. A higher rate of negative opinions of the participants might be associated with the cultural structure of the society which they live in. On the other hand, a higher rate of positive opinions might be developed due to the science education they receive. When the number of arguments at each level for the entire study is examined, the frequency of arguments at the lowest level (NJ) was only three throughout the research. Considering that the number of arguments created in the entire research was 120, it can be stated that this value is quite limited. Also, no arguments were encountered at the lowest level regarding testing for genetic diseases before marriage, surrogacy, and consanguineous marriage. Similarly, in the literature, it is seen that no arguments were constructed at the lowest level on various socio-scientific issues (Akbaş & Çetin, 2018; Çetin et al., 2014; Isbilir et al., 2014; Kara et al., 2020; Okumuş, 2022) or a limited number of arguments were encountered (Isbilir et al., 2014; Kara et al., 2020; Okumuş, 2022). This result obtained from the current research shows that teacher candidates overwhelmingly justify their arguments. Also, there is an increasing trend in the quality of arguments from the level of NJ to JwEG in the study. However, it is noteworthy that there is a decrease in the number of arguments at the level of JwEG/CP with the transition from the level of JwEG to JwEG/CP. The number of arguments at the level of JwEG/CP is close to the number obtained at the level of JwSG. In contrast, Isbilir et al. (2014) determined that the argumentation quality of science teacher candidates increased gradually from the level of NJ to JwEG/CP for four socio-scientific issues they examined. This result obtained in the current research suggests that teacher candidates had difficulty in creating arguments at the highest level. So, it might be stated that there is a need to enrich science teacher candidates' views and improve their argumentation quality on these issues.

Suggestions

In future studies, it can be suggested that teacher candidates' argumentation skills regarding these issues might be developed through a teaching process. Therefore, a teaching plan suitable for the socio-scientific issues discussed in this study can be designed through further studies. In this process, teacher candidates can be encouraged to ask challenging questions to each other and make opposing claims to support their argumentation skills (Berne, 2014).

In this study, the arguments created by teacher candidates were not analyzed in terms of their content. The study is limited with the analysis of their general opinions and argumentation levels. Therefore, this situation constitutes a limitation of the study. In future studies, more detailed findings can be obtained by performing content analysis on why participants support or do not support the socio-scientific issues examined. In addition, the results can be enriched by identifying the informal thinking skills of teacher candidates.

Ethical Board Permission: This research was approved by the Balıkesir University Science and Engineering Ethical Committee on 28.02.2023 with the meeting numbered 2023/1 (E-19928322-302.08.01-234765).

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Statement of Contribution Rate: There is only one author.

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Geniş Özet

Problem Durumu

Diğer alanlarda olduğu gibi fen bilimleri eğitimi alanında da öğretmen adaylarının 21. yüzyıl becerileri açısından donanımlı bir şekilde yetişmeleri önem taşımaktadır. Eleştirel düşünme, kültürel farkındalık, sorumluluk sahibi bir vatandaş olma, bireysel ve sosyal yeterlikler; bu beceriler arasında sayılmaktadır (Chalkiadaki, 2018). Fen eğitimindeki tartışmalı konular dikkate alındığında, bu beceriler daha da önem kazanmaktadır. Bu bağlamda; açık uçlu, iyi yapılandırılmamış, farklı bakış açılarına ve çözüm yollarına açık olan tartışmalı konular, sosyobilimsel konular olarak adlandırılmaktadır (Sadler & Zeidler, 2005a). Bu tür konuların ele alınmasında çoğunlukla argümantasyondan yararlanılmaktadır (Wu & Tsai, 2007). Alanyazında,

nükleer santral (Cenk & Ercan Yalman, 2022; Demircioğlu & Uçar, 2014; İsbilir vd., 2014) ve hidroelektrik santrali yapımı (Akbaş & Çetin, 2018; Atasoy & Yüca, 2021) gibi konuların sosyobilimsel konular çerçevesinde yaygın bir şekilde incelendiği; buna karşılık insan sağlığı ve yaşamı ile doğrudan ilişkili olan insanda üreme sistemi konusu ile bağdaştırılabilecek bazı sosyobilimsel konulara ise yeterince odaklanılmadığı fark edilmektedir. Bu çalışmada, fen bilgisi öğretmen adaylarının insanda üreme sistemi konusu ile ilgili bazı sosyobilimsel konulara yönelik yazılı argüman kalitesinin incelenmesi hedeflenmektedir. Çalışmanın, yakın gelecekte bu konunun öğretimini yapacak olan genç bireylerin argümantasyon becerilerine odaklanması açısından orijinal olduğu ve önem taşıdığı düşünülmektedir.

Yöntem

Çalışma, durum çalışması desenlerinden bütüncül tek durum desenine göre gerçekleştirilmiştir (Yıldırım & Şimşek, 2016). Çalışma grubu, Türkiye'nin batısında bulunan bir devlet üniversitesinde Fen Bilgisi Öğretmenliği Programı'nda son sınıf düzeyinde öğrenim görmekte olan öğrencilerden oluşmaktadır. Örneklem seçiminde; araştırmaya zengin veri sağlayabilecek bireylerin dahil edilmesi açısından amaçsal örnekleme yaklaşımı kullanılmıştır (Büyüköztürk vd., 2010). Bu bağlamda, katılımcıların tamamı daha önceki dönemlerde verilen "Bilimsel Muhakeme Becerileri" dersini almışlardır. Ayrıca, katılımcılar çalışmanın yürütüldüğü süreçte alan eğitimi seçmeli derslerinden "İnsan Anatomisi ve Fizyolojisi" dersini almaktadırlar.

Çalışmada kullanılan veri toplama aracı, araştırmacı tarafından alanyazın taraması sonucunda oluşturulan beş adet açık uçlu soru içeren bir ankettir. Bu ankette yer alan sorular sırasıyla; evlenmeden önce genetik hastalıkların tespiti için test yaptırılması, gebelik sürecinde şeker yükleme testi, tasarım bebekler, taşıyıcı annelik ve akraba evliliği konuları ile ilgilidir. Veri toplama aracında yer alan her bir soruda katılımcılara, bu konuları destekleyip desteklemedikleri sorularak cevaplarını açıklamaları istenmiştir. Anket hazırlandıktan sonra iki fen eğitimi ve iki biyoloji eğitimi uzmanının görüşüne sunularak geçerliği sağlanmıştır. Çalışma, etik kurallar çerçevesinde gerçekleştirilmiştir.

Veri analizinde; nitel yaklaşımlardan yararlanılmıştır. İlk olarak katılımcıların kendilerine verilen konuyu destekleyip desteklemedikleri üç kategori altında değerlendirilmiştir. Bunlar; destekleyenler, kısmen destekleyenler/kararsız olanlar ve desteklemeyenler şeklindedir (Öztürk & Yenilmez Türkoğlu, 2018; Türköz & Öztürk, 2020). Öğretmen adaylarının argümantasyon seviyeleri ise Toulmin'in Argümantasyon Modeli'ni temel alan, Sadler ve Fowler (2006) tarafından ileri sürülen çerçeveye göre beş kategori altında değerlendirilmiştir. Bunlar; "gerekçe yok", "temelsiz gerekçelendirme", "basit temelle gerekçelendirme", "ayrıntılı temelle gerekçelendirme" ve "ayrıntılı temelle gerekçelendirme ve karşıt görüş" şeklindedir. Veri analizinin güvenirliğini sağlamada araştırma dışından bir analizcinin görüşüne başvurularak araştırmacılar arası uyum katsayısı hesaplanmış (Miles & Huberman, 1994) ve veri analizinin güvenirliği sağlanmıştır.

Bulgular

Çalışmada incelenen ilk sosyobilimsel konudan elde edilen bulgulara göre öğretmen adaylarının 23'ünün evlenmeden önce genetik hastalıkların tespiti için test yaptırılması konusunu desteklediği; sadece birisinin bu konuda kararsız kaldığı belirlenmiştir. Bu konudaki argümantasyon seviyeleri incelendiğinde ise en fazla öne çıkan seviyelerin "basit temelle gerekçelendirme" (f=10) ve "ayrıntılı temelle gerekçelendirme" seviyeleri (f=10) olduğu; en üst seviyede ise yalnızca bir argüman oluşturulduğu tespit edilmiştir.

İkinci sosyobilimsel konudan elde edilen bulgular incelendiğinde; öğretmen adaylarının 17'sinin gebelik sürecinde yapılan şeker yükleme testini desteklediği, 4'ünün desteklemediği, 3'ünün ise bu konuda kararsız kaldığı bulunmuştur. Katılımcıların argümantasyon seviyelerinde; birinci konuya benzer şekilde "basit temelle gerekçelendirme" (f=8) ve "ayrıntılı temelle gerekçelendirme" seviyelerinin (f=10) öne çıktığı; en üst seviyede bulunan argüman sayısının ise bir olduğu görülmüştür.

Üçüncü sosyobilimsel konudan elde edilen bulgulara göre öğretmen adaylarının 18'inin tasarım bebekler konusunu desteklemediği, 4'ünün bu konuda kararsız kaldığı; buna karşılık 2 adayın bu konuyu desteklediği belirlenmiştir. Bu konudaki argümantasyon seviyeleri incelendiğinde, oluşturulan argümanların çoğunluğunun en üst seviyede toplanması dikkat çekmektedir (f=10). Bu seviyenin ardından "ayrıntılı temelle gerekçelendirme" seviyesi gelmektedir (f=8).

Dördüncü sosyobilimsel konudan elde edilen bulgular dikkate alındığında, öğretmen adaylarının yarısının taşıyıcı anneliği desteklemediği, 9'unun bu konuda kararsız olduğu, 3'ünün ise desteklediği belirlenmiştir. Oluşturulan argümanlar incelendiğinde; en üst seviyenin öne çıktığı (f=11); bunu "ayrıntılı temelle gerekçelendirme" seviyesinin (f=5) izlediği görülmektedir.

Son sosyobilimsel konuyla ilgili bulgulara göre katılımcıların 22'si akraba evliliği konusunu desteklememektedirler. Buna karşılık 2 adayın bu konuda kararsız kaldığı belirlenmiştir. Argümantasyon seviyeleri incelendiğinde; "ayrıntılı temelle gerekçelendirme" seviyesinin öne çıktığı (f=13), ardından en üst seviye olan "ayrıntılı temelle gerekçelendirme ve karşıt görüş" seviyesinin geldiği görülmektedir (f=7).

Sonuç ve Tartışma

Bu çalışmadan elde edilen sonuçlar genel olarak değerlendirildiğinde, öğretmen adaylarının yazılı argümantasyon kalitesinin ele alınan sosyobilimsel konuya göre farklılık gösterdiği belirtilebilir. Sadler ve Zeidler'e (2005b) göre alan bilgisi ile bir sosyobilimsel konuya yönelik informal düşünme becerileri arasında bir ilişki bulunmaktadır. Bu sonucun önemli olduğu düşünülmektedir. Nitekim, daha önce ortaokul öğrencileri ile gerçekleştirilen bir araştırmada öğrencilerin genetik hastalıklar, biyoteknoloji ve genetik mühendisliği uygulamaları gibi konulardan haberdar olmalarını sağlayan başlıca etmenin "öğretmen" olduğu bildirilmektedir (Genç & Evren Acar, 2021).

Bu çalışmada, öğretmen adaylarının çoğunlukla evlenmeden önce genetik hastalıkların tespiti için yapılan testleri destekledikleri bulunmuştur (Archila vd., 2023). Katılımcıların çalışmada ele alınan başka bir konu olan gebelikte şeker yükleme testini de çoğunlukla destekledikleri belirlenirken alanyazındaki başka araştırmaların başlangıcında bu durumun tam tersi bir sonuç ile karşılaşılmaktadır (Öztürk & Yenilmez Türkoğlu, 2018; Türköz & Öztürk, 2020). Ayrıca, öğretmen adaylarının çoğu tasarım bebekler ve taşıyıcı annelik konularını desteklemezken Çin'de biyoloji öğretmenleri ile gerçekleştirilen bir araştırmada elde edilen sonuçlar, bu durum ile çelişmektedir (Chen & So, 2017).

Çalışmada tespit edilen argümantasyon seviyeleri genel olarak incelendiğinde her bir seviyede bulunan argüman sayısının "gerekçe yok" seviyesinden "ayrıntılı temelle gerekçelendirme" seviyesine kadar bir artış gösterdiği; ancak bu seviyeden "ayrıntılı temelle gerekçelendirme ve karşıt görüş" seviyesine geçiş ile birlikte bir düşüş gösterdiği görülmektedir. Bu sonuç alanyazında fen bilgisi öğretmen adaylarının argümantasyon kalitesinin giderek

yükseldiğini belirten bir araştırmanın sonuçları ile çelişmektedir (Isbilir vd., 2014). Başka bir ifade ile mevcut araştırmada öğretmen adaylarının en üst seviyede argüman oluşturmada zorlandıkları söylenebilir.

Gelecekte yapılacak araştırmalarda, öğretmen adaylarının bu çalışmada ele alınan sosyobilimsel konulara yönelik argümantasyon becerilerinin geliştirilmesi için bir öğretim tasarımı yapılması ve etkisinin incelenmesi, öğretmen adaylarının argümanlarının içerik açısından ve informal düşünme becerileri açısından da analiz edilmesi, böylece araştırma sonuçlarının daha da zenginleştirilmesi önerilebilir.