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Teaching Socioscientific Issues through Scientific Scenarios: A Case Evaluation Based on Secondary School Students' Views

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ABSTRACT

The aim of this study is to make a situation assessment of student views on the processing of socioscientific issues through scientific scenarios.As a sample of socioscientific issues, the 'DNA and Genetic Code' unit, which is included in the secondary school science curriculum, was taken as the basis. The study was conducted with 8th grade students in a public school. As a method, a case study was used, which allowed the students' views to be examined in depth. The data were collected with an opinion form and semi-structured interviews. The opinion form data were analysed by content analysis, and semi-structured interviews were analysed by descriptive analysis. At the end of the study about the teaching of the socioscientific issues of 'DNA and Genetic Code' unit through scientific scenarios, it was revealed that the students thought that their academic achievement increased, scientific scenarios provided permanent learning, scientific scenarios were effective in associating lessons with daily life, and their awareness of social issues increased. According to the findings obtained from the students, the teaching of socioscientific issues through scientific scenarios increases the interest and motivation towards the lesson, makes the lesson enjoyable and fun, and facilitates understanding. In line with the experiences and findings obtained from the applications, suggestions were made for the use of scientific scenarios in the teaching of socioscientific issues.

Keywords: DNA and genetic code, scientific scenario, socioscientific issues, student views

Sosyobilimsel Konularının Bilimsel Senaryolarla Öğretimi: Ortaokul Öğrencilerinin Görüşlerine Dayalı Bir Durum Değerlendirmesi

ÖZ

Bu çalışmanın amacı, sosyobilimsel konuların bilimsel senaryolarla işlenmesine yönelik öğrenci görüşlerinden bir durum değerlendirmesi yapmaktır. Çalışmada sosyobilimsel konular olarak ortaokul fen bilimleri dersi öğretim programında yer alan 'DNA ve Genetik Kod' ünitesi temel alınmıştır. Çalışma bir devlet okulunda 8. Sınıf düzeyinde öğrenim gören öğrenciler ile yürütülmüştür. Yöntem olarak öğrenci görüşlerinin derinlemesine incelenmesine imkân veren durum çalışması kullanılmıştır. Veriler görüş formu ve yarı yapılandırılmış görüşmeler ile toplanmıştır. Görüş formu verileri içerik analizi, yarı yapılandırılmış görüşme verileri ise betimsel analiz yöntemiyle analiz edilmiştir. Çalışmanın sonunda DNA ve Genetik Kod ünitesi bağlamındaki sosyobilimsel konuların bilimsel senaryolarla işlenmesi hakkında öğrencilerin; akademik başarılarının arttığını, kalıcı öğrenmeler sağladıklarını, ders ile günlük hayatın ilişkilendirilmesinde bilimsel senaryoların etkili olduğunu ve toplumsal konulara karşı farkındalıklarının arttığını düşündükleri ortaya çıkmıştır. Öğrencilerden elde edilen bulgulara göre sosyobilimsel konuların bilimsel senaryolarla öğretimi; derse karşı ilgiyi ve güdülenmeyi arttırmakta, dersi zevkli ve eğlenceli hale getirmekte ve anlamayı kolaylaştırmaktadır. Bulgular doğrultusunda bilimsel senaryoların sosyobilimsel konularının öğretiminde kullanımına yönelik önerilerde bulunulmuştur.

Anahtar kelimeler: DNA ve genetik kod, bilimsel senaryo, sosyobilimsel konular, öğrenci görüşleri

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INTRODUCTION

One of the main purposes of science education is to enable students to develop skills that are appropriate for the needs of the age in addition to acquisition of knowledge. Especially, providing students with the knowledge, skills and competencies that will enable them to solve problems encountered in real life has a great place in science teaching. At this point, it is important to create rich learning environments and content arrangements for transferring the subjects learned in science classrooms to real life. In this context, it is not possible to consider socioscientific issues separately from science classes, which have subject content related to almost all of daily life. Socioscientific issues (SSIs), which allow the development of skills (Owens et al., 2020) such as solving scientific problems encountered in real life (Proudfoot & Kebritchi, 2017) and beyond that, being able to discuss and make decisions (Dauer et al., 2017; Ladachart & Ladachart, 2021; Ramírez Villarín, 2020) in socioscientific terms, have taken their place in science teaching programs (Ministry of National Education [MoNE], 2018). Therefore, important science research centers around the world also emphasize the necessity to develop students' skills in SSIs in terms of being discussed and analysed with a critical point of view and making informed decisions within the framework of logic (National Research Council [NRC], 1996; Queensland School Curriculum Council, 2001). Hence, it can be stated that students' discussions on science-related issues, using the scientific knowledge they have acquired in their daily life, and continuing to learn science throughout their lives are among the primary goals of science education (NRC, 2012). In this case, it can be said that SSIs, which are considered to be more suitable for discussion in many countries, have become an indispensable part of teaching programs (Dawson & Venville, 2009). It can be stated that SSIs have played an important role as a learning situation among modern science teaching practices in recent years.

In today's world, individuals constantly face with SSIs in life. According to Öztürk and Leblebicioğlu (2015), SSIs can be viewed from different angles, cannot be solved in a single and simple way, and contain especially scientific and ethical dimensions. Türkmen et al. (2017), on the other hand, define SSIs as difficult and controversial issues that societies deal with from different perspectives. Areas related to environmental problems such as cloning, stem cell treatments, biotechnology and genetics such as GMO products, global warming, hydroelectric power plants, and the establishment of nuclear power plants can be given as examples (Chen & Xiao, 2020; Karpudewan & Roth, 2018; Sadler, 2004; Topçu, 2015; Woolley et al., 2018). These issues take their contents from the phenomena that can be encountered in daily life, and the social concerns and ethical dilemmas discussed in this context should not be considered separately from science classes (Sadler, 2011; Sadler et al., 2006). In addition, although they are not independent from the content of science lessons, SSIs, which have both science content and social dimensions, have a great potential to arouse interest among students since they cover different perspectives (Eastwood et al., 2012).

Various teaching methods and techniques are used during the teaching of SSIs that are expected to raise awareness in science classes. While Christenson and Walan (2022), Martini et al., (2021), Rebello et al., (2013) and, Suephatthima and Faikhamta (2018) use argumentation in teaching SSIs, Carson and Dawson (2016), Kinskey & Zeidler (2021) and Ottander and Simon (2021) use scenarios. The use of scenarios is also included in studies using the argumentation method (Dawson & Carson, 2020). Scientific scenarios are among the primary methods that can be used for this purpose when evaluated in the context of their characteristics. It can be stated that it would be more effective to use scientific scenarios that contain examples of life in the teaching of SSIs. Because scientific scenarios include controversial situations that will enable argumentation in the solution process of problems based on daily life examples in the scenario (Rebello et al., 2013; Suephatthima & Faikhamta, 2018). Many researchers (Garrecht et al., 2020; Günter, 2020; Mills et al., 2021; Mio et al., 2019; Sailer et al., 2021; Shen et al., 2021; Zeidler et al., 2019) mention the benefits and effectiveness of using scenarios with different strategies, methods and techniques in education. In this context, scientific scenarios are used in studies such as problem-based teaching (Günter, 2020), online learning (Mio et al., 2019; Sailer et al., 2021; Shen et al., 2021) and socioscientific issues (Garrecht et al., 2020; Zeidler et al. al., 2019). Genetic issues, which we face frequently in daily life, are also discussed within the scope of SSIs. Concepts and phenomena related to genetics, which is a controversial subject, are included in the "Dna and Genetic Code" unit in the Science curriculum (2018). Genetic studies, the relationship between diseases and genetics and the like are among the topics we have heard the most in daily life in the past few years. For this reason, it is very important to use scientific scenarios in the teaching of SSIs (Garrecht et al., 2020; Zeidler et al., 2019) and to connect with daily life in scenarios. Scenarios are learner-centered because they are life-related, that is, they allow information to be associated with daily life. For this reason, it is stated to be one of the ideal methods for secondary school students in the concrete period (Bakaç, 2014). Similarly, Erduran Avci and Bayrak (2013) also see the use of scenarios in science classes as a powerful learning tool, especially for secondary school students. Teaching SSIs including social dilemmas and problems with scientific scenarios helps

to carry daily life to the classroom environment and to develop students' critical thinking skills (Rahayu et al., 2017; Tol, 2018). It also activates mental processes such as questioning, decision making, problem solving, analysis and interpretation, which are closely related to critical thinking (Ertaş, 2012). In addition, in the 2018 Science Lesson Curriculum in Turkey, "Developing reasoning ability, scientific thinking habits and decision-making skills by using SSIs" (MoNE 2018, p.9) is mentioned. Therefore, the use of scenarios for the teaching of SSIs in science education plays an important role in terms of more than one skill acquisition dimensions.

Considering all these, the 'DNA and Genetic Code' unit, which mainly includes SSIs, is taught through scientific scenarios, which is a method suitable for developing high-level skills expected in the student. In addition, according to Yavuz Topaloğlu and Balkan Kıyıcı (2017), the events that SSIs are related to daily life are a situation that individuals of all ages can encounter. But, when the studies on the subject are considered, SSIs are mostly examined with pre-service teachers and their effects on some variables (Evren Yapıcıoğlu, 2016; Sönmez & Kılınç, 2012). However, there are almost no studies done with secondary school students who will be the adults of the future. When the information obtained from the literature is synthesized, it is understood that the use of scientific scenarios that allow association with daily life in teaching socioscientific issues is especially important for secondary school students in the concrete period. In this context, it is thought that the evaluation of the teaching practice on the subject and the students' views on this practice will be a step towards closing this gap in the literature. Students' opinions obtained from this research will contribute to future studies (qualitative, quantitative or mixed) on the teaching of socioscientific issues at the secondary school level. In the literature, socioscientific issues are mostly considered in a transdisciplinary structure. Presenting problem situations gains importance in the learning of socioscientific issues. Scientific scenarios provide an opportunity to present dilemma situations. With the characters in it, students can enter the situation-event-phenomenon and actively participate in problem solving. In addition, scientific scenarios can be associated with daily life. Thus, it becomes easier for students to perceive and comprehend socioscientific issues. This opportunity can be presented with scientific scenarios by putting socioscientific issues that need to be examined from a critical perspective. Considering the local and global importance of socioscientific issues, their effects on the health of living things and global citizenship, they are within the scope of subjects that individuals should especially learn. In addition to learning these subjects, they need to be examined in order to form individual and collective ideas about them. As a result of the synthesis reached from the literature, it is thought that the characteristics of the scientific scenarios and the advantages they provide to the teaching environment will be effective in the perception and teaching of socioscientific issues. In this sense, it is thought that conducting the study with an 8th grade study group will make a significant contribution to the literature by revealing the effectiveness of scientific scenarios in learning with the views of students in terms of age range. For this reason, the purpose of this study is to make a case evaluation from the students' views regarding the teaching of SSIs through scientific scenarios.

METHOD

Research Design

In this study, case study as one of the qualitative research designs was adopted. The case study is a method that allows in-depth analysis within a certain time frame by focusing on real life-related phenomena, event, situation, individual(s) (Creswell, 2003). In case studies, the "case" can be an individual, a situation, an event or the implementation of a specific program (Glesne, 2011, p. 30). In this research, the case is handled as teaching a unit (DNA and genetic code) that includes SSIs in the curriculum with scientific scenarios. Since the case in the research was handled as a single unit (Yıldırım & Şimşek, 2013, p.327), the nested single-case study was adopted (Seggie & Bayyurt, 2015, p. 123). In this design, more than one subunit can take place in a single situation. Therefore, there is more than one analysis unit (Yin, 2003). In this study, this design was used since a situation assessment was made from students' views in the context of teaching a unit that includes SSIs in the curriculum with scientific scenarios.

Study Group

The research was carried out at the xxxx Secondary School in the Aegean Region of Turkey in the 2018-2019 academic year. A random class (8/C) was chosen among the classes studying at the 8th grade level. Purposive sampling method was first adopted in the study. Purposive sampling is seen as useful in explaining facts and events in many situations. It is used when it is desired to work in special situations with certain characteristics (Büyüköztürk et al., 2012), and it allows for in-depth study (Yıldırım & Şimşek, 2013). While the research was being planned, it was decided to implement it in the school where 8th grade students and one of the researchers worked as a teacher. For this reason, purposive sampling method was adopted in the sample selection of the study.

The research was conducted with a total of 18 students in this selected class. Ten of these students were girls and 8 were boys. In this context, the study group has a balanced distribution in terms of gender. Considering the ethical values, the students were coded as S1 (Student 1), S2 (Student 2),…, S18 (Student 18).

Secondly, the stratified purposive sampling method was chosen. This method is preferred because it allows to show and describe the characteristics of certain subgroups of interest (Büyüköztürk et al., 2012). The reason for choosing stratified purposive sampling is that the students to be interviewed in the study are divided into low, middle and high level groups according to their academic achievements. In this context, students were divided into low, medium and high levels according to their academic achievement. Two groups of five were chosen among these students to reflect the whole group. Focus group and individual interviews were conducted in order to reach more student opinions instead of taking the opinions of the students in the whole group. One-on-one interviews were conducted with five students in the first group. A focus group discussion was held with the students in the second group (group of five students). The students who participated in the focus group interview were given the codes FocusA, FocusB, FocusC, FocusD, and FocusE to indicate that they were in the focus group. Therefore, two-level samples (Merriam, 2009; Turan, 2013, 79) were selected in accordance with the nature of qualitative case studies in the research.

Data Collection Tools

In the study, semi-structured interview questions and an opinion form were prepared in order to determine the student views about the teaching of the DNA and genetic code unit with scientific scenarios. Each of these instruments is introduced below.

Opinion Form

As a data collection tool in the study, the 'Opinion Form' was used to determine the student views about the teaching of the DNA and genetic code unit through scientific scenarios. The opinion form consists of seven structured questions. These questions were open-ended and expert view was used to ensure their validity. Two of the experts are lecturers in science education, one has a master degree in science education, and two are experienced science teachers. In addition, the form was used after determining its comprehensibility with a few students at the same grade level outside the sample. As an example of the questions in the opinion form;

Question 3: 'Do you think that the way the lesson is taught in the 'Science and Genetic Code' unit with scientific scenarios helps you to establish a relationship between the science subjects you learn in the unit and daily life? How? Can you explain with an example?' can be given. All of the interview questions are given in Appendix 2.

The opinion form was applied to the entire study group in 30 minutes at the end of the process.

Semi-Structured Interview

In the study, questions created for the opinion form in semi-structured interviews were used. Semi-structured interviews, such as obtaining in-depth information on a specific subject, asking questions again in cases where the answers are incomplete or not clear, clarifying the situation and providing the opportunity to complete the answers (Çepni, 2007) were conducted as individual and focus group interviews. In the study, one-to-one interviews lasted between 13-19 minutes, while the focus group interview lasted 42 minutes. Although interviews are frequently used to obtain detailed and explanatory information, the biggest advantage of interviews with focus group interview is that they are open to in-group interaction and allow innovative ideas to emerge, as a result of group dynamics (Bowling, 2002; Kitzinger, 1994). In addition, the data obtained from the focus group interviews provide a reliable basis for one-to-one interviews (Kitzinger, 1995). The interviews in the study were recorded by obtaining permission from the students and then they were converted into a written document. In the study, it was aimed to ensure data consistency by using both the opinion form and semi-structured interviews (McIlveen et al., 2003). When the opinion forms were examined, it was seen that the students did not express their opinions in some questions. For this reason, it is aimed to confirm the opinions expressed in writing in the opinion form with interviews and to detail them with additional questions. In addition, one focus group interview was also held, taking into account the advantages of focus group interviews with the idea of reaching more student opinions.

Process

The learning-teaching process experienced in the study is seven weeks. In this process, the 'DNA and Genetic Code' unit was taught using scientific scenarios, then the opinion form was applied, and semi-structured interviews were conducted. For the implementation process, nine scientific scenarios were created in total, depending on the conceptual sequence and limitation in the unit. Constructivist approach was taken as a basis in the preparation of these scientific scenarios, and care was taken to construct the roles of plots and characters in a way that allows students to think and structure their own knowledge. In scientific scenarios, socioscientific issues

focus on students' understanding and questioning of complex situations, seeing multiple perspectives, and developing understanding. In addition, the situations in the scenarios are handled by using one or more main scenario characters. Scenarios with global issues affecting the planet were created in line with the scope of the unit. In this context, a sample activity is presented in Appendix 1. These scenarios were developed with the collaborative work of researchers and was used after the expert's view. Before the application, the science teacher, one of the researchers, drew a general framework of the unit to the study group, information was given about the teaching of the lesson with scientific scenarios, and the student questions were answered. The distribution of the scientific scenarios used in the implementation process and the hands-on activities (e.g., doing a science experiment, model building) performed according to the subject and gains are shown in Table 1.

Table 1. Scientific scenarios and activities used in the study process

Duration	Topic	SLC (Science Lesson Curriculum) Learning Outcomes	Scientific Scenarios and Hands-on Activities
1. Week	F.8.2.1. DNA and Genetic Code	F.8.2.1.1. Explain the concepts of nucleotide, gene, DNA and chromosome and establish a relationship between these concepts. F.8.2.1.2. Shows the structure of DNA on the model. F.8.2.1.3. It expresses how DNA matches itself.	1.Learn the DNA Language i.I'm Making My Own DNA Model (Activity) i.DNA Isolation (Activity)
2. Week	F.8.2.2. Heredity	F.8.2.2.1. Defines the concepts related to inheritance. F.8.2.2.2. Comment on the results by solving problems with single character crosses.	2.Who Am I Like? i.What Percent? (Activity)
3. Week	F.8.2.2. Heredity F.8.2.3. Mutation and Modification	F.8.2.2.3. Discusses the genetic consequences of consanguineous marriages. F.8.2.3.1. Explain the mutation based on examples.	3.New Member of Our Family 4.Explosion of Chromosomes
4. Week	F.8.2.3. Mutation and Modification	F.8.2.3.2. Explain the modification based on examples. F.8.2.3.3. Makes inferences regarding the differences between mutation and modification.	5.What's This Colour Change!
5. Week	F.8.2.4. Adaptation (Environmental Adaptation)	F.8.2.4.1. Explain the adaptation of living things to the environment they live in by observing.	6.Visit to Frozen
6. Week	F.8.2.5. Biotechnology	F.8.2.5.1. Associates genetic engineering and biotechnology. F.8.2.5.2. Discusses the useful and harmful aspects of these applications for humanity with the dilemmas created within the scope of biotechnological applications.	7.Small Changes
7. Week	F.8.2.5. Biotechnology	F.8.2.5.2. Discusses the useful and harmful aspects of these applications for humanity with the dilemmas created within the scope of biotechnological applications. F.8.2.5.3. Predicting what future genetic engineering and biotechnology applications might be.	8.Professor's Historical Decision 9.Sleeping Sickness: Huntington

During the implementation, the scenarios were read by the students in question, then by the teacher, paying attention to the rules of sound and intonation. When it comes to the questions at the end of the chapter in scientific scenarios consisting of multiple parts, students are given time to write their ideas under the questions. Then, the

students' views were taken with the questions, prepared in a structure that would create a discussion and interaction environment. No intervention was made to the ideas put forward at this stage. Although there are clear answers to some questions at the end of the scenarios, due to the nature of the unit, some questions do not have a clear answer, causing students to need teacher support. In this context, the lesson teacher combined the answers given by the students to the questions and combined the clear answers and explained that the unclear ones were caused by differences of view. In the process in question, the teacher guided the process based on the students' responses and created a learning environment for students to construct their knowledge themselves.

Data Analysis

In the study, different analysis techniques were used for the data obtained from both measurement tools. In accordance with the qualitative structure of the research, content analysis was used in the opinion form analysis. According to Yıldırım and Şimşek (2006), content analysis enables qualitative interpretation of the data. Content analysis is a process performed by researchers, starting with data collection and ending with category and code extraction, and the interpretation and synthesis of data (McMillan & Schumacher, 2010). In this context, the opinion forms were first subjected to general evaluation, examples regarding the analysis of themes in terms of the way they were formed, and evaluations were made. Then, the two researchers involved in the study examined the data of the questions separately, the codes were extracted and collected under certain themes. Later, the researchers compared the codes they created, and determined both agreed and disagreed codes. The reliability of the coding was calculated according to the formula of Miles and Huberman (1994) and was found as 0.90. Since the value found was greater than 0.70, the coding was considered to be reliable. The obtained findings are presented in tables by calculating the percentage and frequency values. Semi-structured interviews were analysed using descriptive analysis and presented with direct quotations together with the data obtained from the opinion form. Descriptive analysis is used to make complex situations understandable by drawing a picture of what a situation, person or event looks like (Punch, 2005). In this context, the interview data transformed into written documents to increase its validity and reliability, were included in the process of explaining the opinion form tables in the findings section.

Validity and Reliability

The concepts of credibility, transferability, reliability and verifiability used in qualitative research literature correspond to the concepts of internal validity, external validity, reliability and objectivity in quantitative research (Merriam, 2009; Turan, 2013, 201). In qualitative research, validity is the fact that the researcher observes the phenomenon researched as it is and as impartially as possible (Yıldırım & Şimşek, 2013, 289). In this study, different data sources and different data collection methods were used to ensure credibility (internal validity). As another method of providing credibility (internal validity), expert opinion was sought in the formation of the interview questions. In order to reveal various perspectives, both focus group interviews and individual interviews were conducted. In this context, an opinion form was applied to the students and they were asked to answer the questions on paper. Afterwards, semi-structured interviews were conducted with the students on the basis of the same questions. In the semi-structured interviews, more in-depth and detailed information was obtained with additional questions. Focus group interviews were also conducted due to the possibility of interviewing more students and other advantages. It was ensured that the interviews were conducted in a depth that would enable to deal with all aspects of student views on the teaching of socioscientific issues with scientific scenarios. Negative situation analysis was used by including negative explanations among the obtained data. With this negative situation analysis, it was tried to ensure the credibility of the research (Patton 2002) by paying attention to accuracy and honesty. In addition, the consistency of the obtained data with the relevant literature was checked and the credibility of the data was tried to be ensured.

One of the suggested methods to ensure the transferability (external validity) of qualitative research is detailed description (Yıldırım & Şimşek, 2011, 270). In order to ensure external validity in the research, all the features of the research sample, environment and application process are stated in detail. All stages of the research are explained in detail. Preparation of the semi-structured interview form, data collection, analysis and interpretation are clearly stated. In addition, direct quotations from the opinion form and the individuals interviewed are frequently included. In addition, during the analysis of the data, the confirmation process was carried out by turning to the students at the points that were not understood. In this context, the results are explained based on direct quotations.

In the research, the reliability analyses of the data obtained from the opinion form, focus group interview and semi-structured interviews were made. Codification was made by two different researchers and the percentage

of agreement was calculated by finding the consensus-consistency and disagreement among the experts. Miles and Huberman (1994)'s percent agreement was used in these calculations. With all these things done, clear and objective data were presented to the reader in terms of validity and reliability in the study.

Research Ethics

The study was carried out after obtaining the permission of the ethics committee of Manisa Celal Bayar University. In addition, since the participants were between the ages of 12-14, permission was obtained from both the students and their parents. Participants and their parents gave their consent by signing 'parent consent form' and 'voluntary participation form'. Their names have been kept secret.

FINDINGS

In this section, the answers given by the students to the interview questions after the applications were evaluated and presented together, making direct quotations from the interviews.

At the beginning of the interview, first of all, students' opinions/information about whether they had taught a course similar to this method before was received. In this context, the students were asked the question *'Have you ever taught in any lesson using the same method that the 'DNA and Genetic Code' unit was taught?*'. Considering the opinions of the students on this subject, it is seen that 14 (77.8%) students stated that their lessons were not taught with scientific scenarios before and 3 (16.7%) students did not remember. In addition, one student left the question blank. It is thought that students who leave the question blank do not remember or have not previously been taught with scientific scenarios. In both cases, it was understood that a significant part of the study group (f = 14, 77.8%) gave negative answers to the question. The interviews also support this finding. For example, from the students interviewed, S1's answer was

> *"No, and therefore the lessons are very boring. Especially in math, we can have fun. For example, we would never get bored in transactions, no matter how many lessons. The history class is very boring and we would have fun if it were made in this way. In other words, our desire to come to school and our desire to read can increase."*

In this context, it is understood that the student has not been in any lesson environment in which scientific scenarios were used before, but the student would like it to be used in other disciplines.

The effect of scientific scenarios on learning

The opinions of the students on the effect of processing SSIs through scientific scenarios on their learning are given in Table 2.

Table 2. Students' views on the effect of scientific scenarios on their learning

Theme/ Category	Codes	f*	%*	Examples of Student Views
Effects of Scientific Scenarios on Learning	Increase in academic success	11	64.7	*Yes, it happened. We try once a month. Most DNA and Genetic Code units among the units I did right (S2).*
	Increase persistence	2	11.7	
	Gain practicality in solving questions	1	5.9	*I solve the questions I encounter in the tests faster and more practically thanks to the scenarios (S4).*
	Increase interest in lesson	1	5.9	
	Teacher qualification	1	5.9	*Yes, I think it has an impact on our success. Because 'DNA and Genetic Code' is a fun, easy and surprising subject. (S17).*
	Subject being fun/easy/surprising	1	5.9	

f*: It is the frequency of student views. Because a student may have given more than one answer to the same question.

%*: Frequency percentage of student views.

This situation is valid for all opinion form tables.

When Table 2 is examined, all of the students stated that learning the Science course with scientific scenarios contributed positively to their success. The students associate their views concerning the question to their academic achievement with a frequency of 64.7% and with the fact that the class made with scientific scenarios increase its being with a frequency of 11.7%. These views, which are the most common, are parallel to the expressions used by the students in the interviews. For example, Focus B made the following statements in her discourse emphasizing the increase in academic achievement

"For example, the class next door was my previous class, the classes have changed. My friend X (who is in a different class) is smarter and more hard-working than me. Then we solve questions. I saw that I was better than she was. Especially in the unit where our teacher made the scenario."

The thoughts of S10, where one-to-one interviews were held, said

"Yes. Because, for example, you read the question when there is an exam, then you immediately think of a part in the scenario right there. Therefore, even if there are many scenarios, the part there definitely comes to mind. Because as I said, it is more permanent. Therefore, since it always comes to our mind, we can make more markings; correct marking. And so we get points, we get a higher grade in the exam."

In this context, the student finds the teaching of the course effective through scientific scenarios, in that it is associated with increasing academic success, increasing permanence and gaining practice of problem solving.

The effect of scientific scenarios on associating with daily life and perspective on social problems

The students' views on the effect of processing SSIs through scientific scenarios in the research application to establish a relationship between the science topics learned in the course and daily life are given in Table 3.

Table 3. Students' views on the effect of scientific scenarios on associating subjects with daily life

Theme/ Category	Codes	f*	%*	Examples of Student Views
Effect on establishing relationships with daily life	Associating with the immediate environment	4	28.6	*Of course, there is. My parents are even remotely related. They said that my sister would be born disabled until 6 months old. But she did not (S2).*
	Associating the current event with the lesson	3	21.4	
	Change in thinking	2	14.4	*After learning that fruit yogurt is produced with biotechnological methods, I reduced consumption. (S1).*
	Presenting the example used in the lesson	1	7.1	
	consciousness-raising	1	7.1	*I explained the issue of gender determination to my mother. When my mother came across a conversation with her friends related to this, she told them that men, not women, determine gender. (S11).*
	Not using in daily life	3	21.4	*No, I can't explain because we've never experienced it (S15).* *No, I don't think it helps (S17).*

When Table 3 is examined, 78.6% of the students state that they can relate to daily life, while 21.4% of them state that they cannot relate to daily life. The students express their thoughts by associating them with their immediate surroundings at 28.6%. It was found that there were expressions parallel to this situation in the interviews. Accordingly, Focus D used the subject of consanguineous marriage, which she learned in the lesson, while evaluating an event she encountered in her family as follows:

"My sister and I are children born of consanguineous marriage. They even said (for my sister) that she will be born disabled, and then something like a miracle happened. Because my parents are relatives, even if they are not too close relatives. I later learned that if there were no consanguineous marriage, maybe it would not even be possible to be born disabled. I thought about it."

In this question, which questions the relationship established between science subjects and daily life, it was determined that the relation established with the immediate environment according to the frequency of use is followed by explanations such as associating the current event with the lesson (21.4%) and changing their thoughts (14.4%). During the interviews, Focus C and Focus D, who associate the current event with the lesson, give place to the following affirmations

"For example, we have seen the lesson on modification. You go out on the street, for example, the functioning of (genes) changes in summer. You know, I get a little darker in summer. But when winter comes again, it is the same skin colour."

In this case, it can be said that the students explain the colour change in their skin in the summer with the modification concept they learned in the lesson. In addition, it was observed that a student answered the question using the example used in the lesson, while a student answered by expressing that he used what he learned to raise

awareness in his immediate environment. 21.4% of the students stated that the teaching of the 'DNA and Genetic Code' unit with scientific scenarios does not affect the use of science subjects in the unit in daily life. In the interviews, the answer given to the question by a student (S5) who was understood to have the same view is as follows: “So not too much. No.”

The students' views on the effect of processing SSIs through scientific scenarios in the research application on the students' perspective and awareness of social problems are given in Table 4.

Table 4. Students' views on the effect of scientific scenarios on their perspective on social problems

Themes/ Category	Codes	f*	%*	Examples of Student Views
Effect on perspective on social problems	Gain awareness	3	23.1	*Yes. Because my awareness of consanguineous marriages increased. After all, not related couples will suffer from the disease, but their innocent children (S10).*
	Understanding the importance of getting accurate information	3	23.1	
	Create a limited impact	2	15.4	
	Different/ useful way of making the lesson	2	15.4	*Yes. Because, for example, when a pregnant woman gives birth to her baby, the husband scolds because the baby is not a boy. Actually, if someone is going to be angry at, that person is himself. Because it's the male that determines the gender (S4).*
	Acquire critical thinking skills	1	7.7	
	Gaining the ability to empathize	1	7.7	
	Stating that it is not effective	1	7.6	*No, I don’t think so, there is no reason (S18).*

When Table 4 is examined, it is understood that the teaching of the lessons through scientific scenarios mostly increases students' perceptions and awareness of social problems. Students state that teaching SSIs through scientific scenarios with a frequency of 92.4% affects their perspectives on social problems, while it does not affect them with a frequency of 7.6%. It is seen that the students who assert that these activities have positive effects on their perception and awareness of social problems are most frequently defined with expressions in the direction of gaining awareness of social problems (f = 3, 23.1%) and understanding the importance of accessing correct information in social events (f = 3, 23.1%). In the interviews, it was determined that some students had discourses parallel to these findings. For example, the decision given by S10 one of the students regarding social issues, hereditary diseases and consanguineous marriage expresses himself as follows:

“Yes. For example, since both of them have this gene in sickle cells, they should not marry. In the end, they will not experience this disease and the child will live. They should be aware of this. That's why they shouldn't get married. Therefore, if they had known at the beginning, at least they wouldn't have married or had no children. So, the individuals must have children of course, after all. But they have to marry someone who doesn't have this gene. For example, you have a gene and there is the same in the person you will marry so you should not marry. Because there is such a possibility.”

In addition, there were also students who expressed an view (f = 2, 15.4%) that the teaching of the course through scientific scenarios created limited, if not fundamental, changes on students' perspectives and awareness of social problems. On the other hand, the positive responses given to the question in question are also explained with expressions emphasizing different / useful in the teaching of the lesson (f = 2, 15.4%), critical thinking skills (f = 1, 7.7%) and empathy skills (f = 1, 7.7%) codes.

Although a significant majority of the answers received from the students consisted of positive expressions, it was determined that a student expressed that the teaching of the course through scientific scenarios did not affect his perception and awareness of social problems without specifying why. In the interviews, it is seen that S14, who argued that the way the lesson is taught did not change her perception and awareness of social problems, and that they could do anything in line with the wishes of the people, used the following statements:

“I do not think so because they are the same people socially. Nothing has changed, people are the same they are arrogant, they do anything to get what they want, and so it didn't. How can I say? For

instance, some people throw trash on the ground. If we say do not smoke there, they wi2ll smoke purposely."

The student who defends these views does not comment on his own awareness, but on the perspective of the individuals who make up the society.

Limitations of teaching through scientific scenarios

In the study, students' perspectives on the processing of SSIs through scientific scenarios were also discussed in the context of limitations. At this point, in order to enable the students to give more comfortable answers, the difficulties they experienced in the course teaching process and their views on what they wanted to change were discussed with repetitive questions.

The students' views on the problems and difficulties related to the process of SSIs through scientific scenarios are given in Table 5.

Table 5. Students' views about the lessons taught with scientific scenarios in the dimension of problems and difficulties

Theme/ Category	Codes	f*	%*	Examples of Student Views
Problems and difficulties in teaching through scientific scenarios	Being Enjoyable / Fun	2	28.5	*No there was no problem. On the contrary, it was very enjoyable (S5).*
	Encounter any problems	1	14.3	
	Loving the unit	1	14.3	*I had no problem. It was my favourite unit of the science course (S2).*
	Being useful	1	14.3	
	Inability to take notes	1	14.3	*After processing the script, I cannot get much notes. That's why I was afraid if I got a low grade, but I wasn't getting low. Because it was permanent (S10).*
	Inability to understand the subject	1	14.3	

When the opinion form data was examined, it was understood that some of the students did not express any view on this question. The majority of the stated views, on the other hand, are seen to contain ideas that draw attention to the absence of anything missing in the practices and that they do not experience difficulties. Under the theme "I had no problems in teaching with scientific scenarios", 28.5% of the students stated that the lessons were fun. In addition, 14.3% of the students found out that they did not have any problems, 14.3% of the students liked the unit, and 14.3% of the students found it useful to teach the lessons with scientific scenarios. It was found that there were statements in parallel with these findings in the interview data. However, when the opinion form and the interview data are evaluated together, the students stated that they did not experience any problems or difficulties with a frequency of 71.4%, while 28.6% stated that they did. S14's views on the question was as follows: "There is no problem. I think scientific scenarios made all of this easier. There was a problem the first time because I was thinking narrowly, they were wrong. In others, I started to think extensively, while the teacher told us. That is why I didn't have much enthusiasm at first. Then I got enthusiastic. Because strange things have happened (in the scenarios). Let's learn these, maybe it will be useful, it will come from somewhere." In this case, it is understood that the student was not eager to participate to the course with scientific scenarios due to the narrow perspective at the beginning of the applications, but with the effect of the course teacher, he has succeeded in looking at the events in the scientific scenarios in multiple ways. In addition, it can be inferred that scientific scenarios eliminate all difficulties and increase the desire to learn because interesting events are processed according to the student.

In addition, the two students' thoughts on the subject are 'Yes' unlike the others. As the reason for this answer, it was understood that the students used the explanations that they had problems to take notes in the course (f = 1, 14.3%) and could not understand the subject (f = 1, 14.3%). During the interviews, one of the students, S10, expressed this finding with his expressions:

"There was. We work from the script, then, for example, our teacher asked us to take notes. But I think those notes are not enough. In other words, there is definitely a missing subject from the scenario. So I think it's missing. For example, if we work on the board, different things will come to our teacher's mind, who will tell us them or write them, and we will take notes. So, for example, you can open it and look at it, but when you open the scenario and look at it, sometimes you understand the normal classic, but you want to go deeper, you want to go into more detail, but it just doesn't work. You can think of the wrong things.

But over time, all that confusion fits into its place. I thought that way, yes that is true! really and, I was reasoning then, I was thinking was that really wrong? You think about and say was it really like this. Then you just remember it like this. This is fine."

The student thinks that the scientific scenarios used in the course do not provide information about all the topics and states that they need detailed notes. He is also worried about the fact that the contradictory issues covered in the scenarios may confuse him in individual studies. However, it is still seen that the student accepts the effect of the scenarios in terms of permanence. Although it does not appear in the opinion form findings, it was determined that the interviews included another difficulty encountered during the implementation process. One of the students, S16, expressed the difficulty he faced in the process with his solution proposal as follows: "For example, scenarios can be turned into movies. We are studying in class, but if it is made as a movie for example, it might be better, it could be more fun. Reading is more difficult."

It is aimed to obtain data on the limitations of the process of processing socioscientific issues through scientific scenarios. The students' opinions regarding the changes in the teaching process in the process are given in Table 6.

Table 6. Students' Views on Their Suggestions for Changes in Applications

Theme/ Category	Codes	f	%*	Examples of Student Views
Suggestions for changes in teaching through scientific scenarios	Continuity / meaningfulness of the way the lesson is taught	7	41.1	*I wouldn't want to change anything. It can stay that way. I would like the scenarios to be distributed in other courses. (S5).*
	Continuity of scenario usage	6	35.3	
	Use of scenarios in other disciplines	1	5.9	*I don't want to change anything. Because everything is beautiful and more meaningful, it doesn't need to be changed (S8).*
	Ensuring faster understanding	1	5.9	*I wish there was a scenario in each unit. So we understand more and faster (S9).*
	Request not to keep a diary	1	5.9	*Instead of writing a diary, I would talk about scenarios with students as if they were talking during a lecture. (S10).*
	More experimentation request	1	5.9	*I'd shoot videos and put experiments (S14).*

In the sixth question of the opinion form, the aim is to put forward the reasons why students would change or not if they were given the chance to make changes in the practices and studies. In this context, 88.2% of the students stated that they did not want to make changes and they were satisfied with the application, and 11.8% stated that they wanted to make changes. In a total of 15 statements that found the practices and studies sufficient and successful, it was seen that the most frequently stated thought was to ensure the continuity of the teaching style and to find it meaningful (f = 7, 41.1%). It is a striking finding that some of the students who do not want to make changes emphasize the continuity of the use of scenarios in lessons (f = 6, 35.3%). In addition, there are one student who draw attention to the use of scenarios in other disciplines and one on their contribution to faster understanding. In the interview data, there are statements in parallel with the opinion form data. S16 who had one-on-one interviews explained the fact that he does not want any change in the application/work as follows:

"I won't make changes. I wouldn't change a thing. After having read the scenario for instance, if everybody prepared a presentation about it, about what they understood from it, so everybody would show at least what they understood. In the lessons, the teacher only writes on the board, everyone is listening to him. But in this way (with scenarios), for example, everyone is presenting their ideas by raising their finger, it is better."

According to this answer, the student in question did not want to make changes in the practices, but suggested preparing presentations to reveal what was understood after scientific scenarios. In addition, it is seen that the students are pleased to become active participants thanks to the activities used in the implementation process rather than being passive listeners of the course. Another student's reason for not wanting to change the applications is striking. This student (S5) made the following statements in the interviews:

"Scenarios were more effective than normal. Normally, I did not notice much when the teacher told the lesson. Before the scenarios… I was embarrassed when I had to talk to the teacher in case I make a mistake. However, I feel more comfortable as I write in the scenarios. As I was a little bit hesitant when talking to the teacher, I felt more comfortable writing so I wouldn't want any change."

As it can be understood from the statements in question, it is understood that the student avoids communicating with his teacher for the worry of making mistakes, but when the lesson is being taught with scientific scenarios, giving written answers to the questions in the scenario relaxes the student.

DISCUSSION & CONCLUSION

When the findings of this study aiming to determine the views of secondary school students regarding the teaching of the 'DNA and Genetic Code' unit through scientific scenarios of SSIs, the feelings and thoughts of the students regarding the teaching of the unit through scientific scenarios of SSIs were generally positive. By revealing the difficulty of the unit, the students found that teaching SSIs through scientific scenarios contributed to permanence and academic success.

When the literature is examined, there are studies in which scientific scenarios are used in different disciplines and levels such as mathematics, laboratory, undergraduate courses, as well as science courses. Bakaç (2014) stated that scenarios are effective in increasing student achievement in the field of measurement learning in mathematics lesson; Kocayusuf (2014) revealed that a complete learning strategy supported with scenarios increases academic achievement in sixth grade mathematics lesson in primary school. Similarly, Ciraj et al. (2010), in their studies to determine the microbiology field knowledge and the interest in the lesson, concluded that the use of scenarios increases students' interest in the lesson and the permanence of what is learned. Ercan (2019) stated that the use of scenarios that quoted from daily life in experiments positively affected the students' attitudes towards the laboratory and their laboratory use self-efficacy perception increased. In this case, scientific scenarios can be used in the teaching of many courses, including the science course. In addition, this finding reveals that students are satisfied with the use of scientific scenarios. Therefore, it is important to use scientific scenarios that allow the learner to solve any problem by using interdisciplinary knowledge and skills. However, students will be pleased with scientific scenarios containing complex problems related to daily life in order to provide various solutions for the problems related to the goals and achievements in these disciplines, especially in order to integrate disciplines that deal with SSIs. As a matter of fact, an interdisciplinary context emerges by emphasizing the connection between the concepts of environment, health and society in disciplines that deal with SSIs (Alkış Küçükaydın, 2019). When the literature is examined, there are studies in which scientific scenarios are used in different disciplines and levels such as environment (Alkış Küçükaydın, 2019; Dawson & Carson, 2017; Carson & Dawson, 2016), health (Keskin-Samanci et al., 2014; Lin & Hung, 2016; Saad et al., 2017) and social issues (Evren Yapıcıoğlu, 2020).

All of the students participating in the study think that teaching the course through scientific scenarios contributes to their success. These thoughts, on the other hand, were supported by the increase in academic achievement and the increase in remembering the lessons. In the interviews, along with these ideas, it was determined that the method was effective in increasing the problem solving practice. The literature also supports these findings. In fact, Yeniceli (2016) concluded that the use of scenarios has an effect on students' academic achievement and improves their attitudes towards the science course positively. Kocadağ (2010) found that the effects of scenarios on 8th grade students' misconceptions and knowledge deficiencies about heredity, DNA and genetic code were effective in eliminating misconceptions and lack of knowledge.

Teaching of the 'DNA and Genetic Code' unit through scientific scenarios has mostly positive effects on students in establishing a relationship between science subjects in the unit and daily life. The scientific scenarios

used in the study deal with many concepts such as consanguineous marriage, mutation and modification events, cloning, genetic engineering, and biotechnology in the socioscientific issue the content of the unit in question. These concepts are reflected in scenarios that can be encountered in daily life and give students experience, and this provides the connection established with the close environment. Taşkın Can et al. (2006) stated in their study that scenarios play an important role in the student's ability to use information and understanding that knowledge is mixed with life. In this case, including events taken from students' daily life in scientific scenarios contributes to their knowledge structuring and learning. According to Temur and Turan (2018), scientific scenarios enable students to reach a conclusion with possible options by presenting various events. This is an indication that scenarios are a form of experiential learning. In fact, in real life, we come up with choices regarding some events and we enter the decision-making process. Therefore, learning will take place by making the students make decisions. Thus, students learn within the framework of a set of rules and as an experience, without resorting to memorization (Mariappan et al., 2004). In this context, SSIs through scientific scenarios that include events taken from their daily lives will be effective in solving problems by concretizing events, structuring knowledge and providing permanent learning. Therefore, the most important point where SSIs and scientific scenarios intersect is that students can embody real-life events. In this case, the inclusion of realistic scientific scenarios, especially in the teaching of socioscientific subjects, will enable students to be more interested in these subjects and to evaluate events with multiple perspectives.

It was understood that the use of scientific scenarios in the teaching of the unit increased students' perception and awareness of social problems. The students used expressions to gain awareness of social problems, to reach the right information in social events, to acquire critical thinking skills and to gain empathy. It is understood that scientific scenarios involving SSIs positively affect students' perspectives on SSIs. Actually, the nature of the 'DNA and Genetic Code' unit is based on SSIs. These issues are based on society and science, and students can establish relationships between lessons and social problems through scientific scenarios. Simonneaux (2008) affirmed that students need to produce scientific arguments in learning the mutual relationship between society and science. For this reason, discussion and decision-making environments that can provide argumentation such as the use of scientific scenarios in teaching SSIs are also important. In this context, it is thought that issues that create dilemmas and are open to discussion offer students the opportunity to make decisions through scientific scenarios and affect their perspectives on social events. Actually, Sönmez (2020) stated in his study that scenario-oriented activities attracted students' attention and they tended to think with different perspectives that explored and questioned during the lesson. In this case, giving place to scientific scenarios with scientific subject content enables students to gain different perspectives.

The students thought that the lesson was enjoyable and entertaining, and they generally did not encounter any problems or difficulties about the 'DNA and Genetic Code' unit being processed with scientific scenarios. The students liked the unit and found the use of scientific scenarios useful. According to the students, scientific scenarios eliminate all difficulties and increase their desire to learn because they deal with interesting events. However, some students had problems not taking notes in the course and therefore they were not sure that they understood the subject. In this case, some students adhere to traditional teaching and try to create resources by needing detailed notes. There was also a suggestion in the findings that it is difficult to read the scenarios and that it would be better to make scientific scenarios into films. In this case, the importance of gaining the students reading habit emerges. Can et al. (2016) and İşeri (2010) found in their study, that as the grade levels of secondary school students increased, their reading attitudes decreased. When we take into consideration the fact that the sample of the study is at the 8th grade level and that these students prepare themselves to the most important national exam of Turkey which is the 'LGS' (Transition to High School Exam, multiple choice questions decrease reading interest. In addition, Önen Öztürk (2017) states that educational short films ensure that the lesson is fun, relevant to daily life, permanence and better understanding. In addition, while Öztaş (2008) found that the use of films increases students' interest and motivation towards the lesson and encourages them to research, similarly Selanik Ay (2010) states that films are fun and improve their research ability. In this case, educational films that give the same results as scientific scenarios can be used effectively in the teaching process, and transforming the scenarios into films will be effective in terms of teaching. We think that this suggestion of the student should be experienced. We think that it may be important to conduct research in this context.

There are students who stated that the 'DNA and Genetic Code' unit, which is processed through scientific scenarios, provides them with skills such as critical thinking, empathy and expressing their ideas. This is in line with the idea that scenarios offer students the opportunity to develop critical thinking skills for more effective learning (Mostert, 2007). As a matter of fact, individuals who think critically can defend their ideas independently and take an active role in the process (Ersoy & Başer, 2011). These results show similarities with the results of

other studies that the use of scenarios contributes to students' permanence (Parladır, 2004), their ability to develop different thoughts (Kindley, 2002), to express these thoughts. Sadler and Zeidler (2005) determined that students interpreted scenarios on human cloning and genetic engineering morally and were able to incorporate content knowledge into their reasoning patterns. Pehlivanlar (2019), on the other hand, emphasized that the scenarios prepared on the green road, nuclear energy and genetically modified organisms affected the informal reasoning of teacher candidates. Similarly, Khishfe (2012) found that high school students' understanding of the nature of science improved in two scenarios that addressed controversial SSIs related to genetically modified food and water fluoridation. Venville and Dawson (2010) determined that students make intuitive reasoning about biotechnology.

Scientific scenarios involving socioscientific issues play a very important role in increasing students' interest in the lesson, ensuring their meaningful and permanent learning, and improving their moral values, as they include events that can be encountered in daily life (Atabey et al., 2018). Therefore, it can be stated that choosing the content of socioscientific issues from the topics that can be encountered in daily life increases the attitudes, interests and motivations of the students. In addition, it was seen that the data of the opinion form indicated that the students found the scientific scenarios enjoyable and contributed to the visualization of the examples in the scientific scenarios in their minds. In his study, Kemiksiz (2016) states that the scenarios help students to bring the problems of daily life to the classroom and to revive them and to reconstruct the knowledge. Similarly, according to Çenberci and Tol (2019), learning with scenarios supports students' self-efficacy perceptions, as students have the chance to put themselves in the place of the characters in the scenario, connect with real life, and take an active part in the lessons. Considering all these, it is understood that in this study, in line with student opinions, the use of scientific scenarios in the teaching of socioscientific issues allows students to develop positive emotions and thoughts such as attitude, visualization, active participation in the lesson in the teaching process, interest, motivation and success.

According to the data obtained from the opinion form and interviews, the use of scientific scenarios in the teaching of SSIs has positive effects on variables such as students' motivation, attitude, success, argumentation skills, reasoning, decision-making skills, and high-level thinking skills. With the use of scientific scenarios in the teaching of SSIs in the literature, it is seen that studies examining the effect of variables such as argumentation skills (Dawson & Carson, 2020; Karamanlı, 2019; Yalçın, 2018), conceptual understanding (Sönmez, 2020), attitude and motivation (Evren & Kaptan, 2014), reasoning (Dawson, 2015; Kolarova et al., 2013; Özden, 2020; Romine et al., 2020), decision making (Demiral & Türkmenoğlu, 2018; Emery et al., 2017), higher-order thinking (Qamariyah et al., 2021) also support this finding. In this case, within the scope of this study, it is concluded that the use of scientific scenarios in the teaching of SSIs in the direction of student opinions is effective and productive in science lessons.

Conclusions

In the study, the students' discourses on the teaching of the 'DNA and Genetic Code' unit through scientific scenarios were parallel in both data collection tools and were found effective and meaningful by the students. In this context, the use of scientific scenarios increases the academic success of students, provides permanent learning, plays a serious role in the association of lessons with daily life, and increases students' awareness of social issues. In addition, when the social awareness formation process that occurred in students was examined, skills such as critical thinking, decision-making, argumentation, and empathy that students discovered in themselves were encountered. Scientific scenarios have a nature that creates dilemmas and allows discussion to be effective in the development of these skills. In this case, the courses taught with scientific scenarios enable students to develop various skills and these are in line with the requirements of the 21st century.

The students did not encounter any significant problems in the process of teaching the course through scientific scenarios. In this context, students think that scientific scenarios increase interest in the lesson, make the lesson enjoyable and entertaining, facilitate understanding, and increase motivation. However, during the application process, there are also students who are uncomfortable with not keeping systematic notes as in the traditional method and suggesting to converting scientific scenarios into videos / films rather than reading them. In addition, there are also ideas that refer to more experimental activities in the 'DNA and Genetic Code' unit, which is teached through scientific scenarios.

Suggestions

When all the ideas of the students in the research are evaluated together, it is seen that the students are mostly satisfied with the scientific scenarios and the lesson. For this reason, it can be suggested that SSIs should be treated with scientific scenarios in science education. Based on the research findings, it is seen that the students are of the opinion that other units and other lessons should be taught with scientific scenarios. In this direction, studies in which scientific scenarios are used in the teaching of different science units/subjects and other courses

can be planned. Based on the findings obtained from the students' views on the skills, the effects of the teaching practices carried out with scientific scenarios on different skills (thinking skills, critical thinking, problem solving, decision making, etc.) can be tested with quantitative or mixed studies. The scientific scenarios proposed to be designed are more effective in science subjects that are less likely to experiment. In addition, the teaching of socioscientific issues that are included in the science-teaching program and create dilemmas can be provided with scientific scenarios. Considering the references made by students to the increase in their academic achievement, it is recommended that the use of scientific scenarios be widespread at all educational levels, if they are suitable for the subject content.

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There is no conflict of interest in this study.

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REFERENCES

Alkış Küçükaydın, M. (2019). Eighth grade students' views on the socioscientific ıssue and their argument structure. Elementary Education Online, 18(1), 174-189. https://doi.org/10.17051/ilkonline.2019.527195

Atabey, N., Topçu, M. S., & Çiftçi, A. (2018). The investigation of socioscientific issues scenarios: A Content analysis research. OPUS International Journal of Society Researches, 9(16), 1968-1991. https://doi.org/10.26466/opus.474224

Bakaç, E. (2014). The effect of scenario based teaching method to student achievement in mathematic course. Journal of Education and Humanities: Theory and Practice, 5(9), 3-17. https://dergipark.org.tr/en/pub/eibd/issue/22668/242068

Bowling, A. (2002). Research methods in health: Investigating health and health services. McGraw-Hill House.

Can, A., Deniz, E., & Çeçen, M. A. (2016). Reading attitudes of middle school students. Turkish Studies, 11(3), 645-660. http://dx.doi.org/10.7827/TurkishStudies.9311

Carson, K., & Dawson, V. (2016). A teacher professional development model for teaching socioscientific issues. Teaching science, 62(1), 28-35. https://search.informit.org/doi/10.3316/informit.270511920952144

Çenberci, S., & Tol, H. Y. (2019). The effect of scenario-based learning method on students' mathself-efficacy, math attitude and anxiety. Journal of Social Sciences of Mus Alparslan University, 7(4), 149-159. https://doi.org/10.18506/anemon.523065

Çepni, S. (2007). Introduction to research and project studies (8nd ed.). Celepler Publication.

Chen, L., & Xiao, S. (2020). Perceptions, challenges and coping strategies of science teachers in teaching socioscientific issues: A systematic review. Educational Research Review, 32 (2021), 100377. https://doi.org/10.1016/j.edurev.2020.100377

Christenson, N. & Walan, S. (2022). Developing pre-service teachers' competence in assessing socioscientific argumentation. Journal of Science Teacher Education, 1-23. https://doi.org/10.1080/1046560X.2021.2018103

Ciraj, A. M., Vinod, P., & Ramnarayan, K. (2010). Enhancing active learning in microbiology through case based learning: Experiences from an Indian medical school. Indian Journal of Pathology and Microbiology, 53(4), 729-733. https://www.ijpmonline.org/text.asp?2010/53/4/729/72058

Creswell, W. J. (2003). Research design: Qualitative, quantitative, and mixed methods approaches. California: Sage Publications.

Dauer, J. M., Lute, M., & Straka, O. (2017). Indicators of informal and formal decision-making about a socioscientific issue. International Journal of Education in Mathematics, Science and Technology, 5(2), 124-138. https://doi.org/10.18404/ijemst.05787

Dawson, V. (2015). Western Australian high school students' understandings about the socioscientific issue of climate change. International Journal of Science Education, 37(7), 1024-1043. https://doi.org/10.1080/09500693.2015.1015181

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

Dawson, V., & Carson, K. (2017). Using climate change scenarios to assess high school students' argumentation skills. Research in Science ve Technological Education, 35(1), 1-16. https://doi.org/10.1080/02635143.2016.1174932

Dawson, V., & Venville, G. J. (2009). High-school students' informal reasoning and argumentation about biotechnology: An indicator of scientific literacy? International Journal of Science Education, 31(11), 1421-1445. https://doi.org/10.1080/09500690801992870

Demiral, Ü., & Türkmenoğlu, H. (2018). The relationship of preservice science teachers' decision making strategies and content knowledge in socio-scientific issues. Journal of Uludag University Faculty of Education, 31(1), 2018, 309-340. https://doi.org/10.19171/uefad.450141

Eastwood, J. L., Sadler, T. D., Zeidler, D. L., Lewis, A., Amiri, L., & Applebaum, S. (2012). Contextualizing nature of science instruction in socioscientific issues. International Journal of Science Education, 34(15), 2289-2315. https://doi.org/10.1080/09500693.2012.667582

Emery, K., Harlow, D., Whitmer, A., & Gaines, S. (2017). Compelling evidence: An influence on middle school students' accounts that may impact decision-making about socioscientific issues. Environmental Education Research, 23(8), 1115-1129. https://doi.org/10.1080/13504622.2016.1225673

Ercan, E. (2019). The effect of inquiry based laboratory on students' self efficacy, creativity perception and scıence process skills (Unpublished master's thesis). Hacettepe University.

Erduran Avcı, D., & Bayrak, E. B. (2013). Investigating teacher candidates' views related to scenario-based learning: An action research. Elementary Education Online, 12(2), 528-549. https://dergipark.org.tr/en/pub/ilkonline/issue/8585/106658

Ersoy, E., & Başer, N. E. (2011). The position of critical thinking in elementary second stage. Adnan Menderes University Journal of Educational Sciences, 2(1), 1-10. https://dergipark.org.tr/tr/pub/aduefebder/issue/33886/375210

Ertaş, H. (2012). The effects of critical thinking education supported by out-of-school activities on critical thinking disposition and attitude toward physics course (Unpublished doctoral thesis). Hacettepe University.

Evren Yapıcıoğlu, A. (2016). The views and reflections of preservice science teachers regarding implementations of socioscientific issue based instructions. Hacettepe Eğitim Araştırmaları Dergisi, 2(2), 132-151. https://dergipark.org.tr/en/pub/huner/issue/36362/411246

Evren Yapicioğlu, A. (2020). Covid 19 pandemic as a socioscientific issue in science education and suggestions for sample applications. Milli Eğitim Dergisi, 49(1), 1121-1141. https://doi.org/10.37669/milliegitim.787170

Evren, A., & Kaptan, F. (2014). Socioscientific situation-based teaching and its importance in science education. EAB 2014 VI. International Educational Studies, 5-8 June 2014 in (pp. 389-402). Hacettepe University.

Garrecht, C., Eckhardt, M., Höffler, T.N., & Harms, U. (2020). Fostering students' socioscientific decision-making: exploring the effectiveness of an environmental science competition. Disciplinary and Interdisciplinary Science Education Research, 2 (5), 1-16. https://doi.org/10.1186/s43031-020-00022-7

Glesne, C. (2011). Introduction to qualitative research (3rd ed.). (Translated by A. Ersoy and P. Yalçınoğlu). (Original work published in 2003) Anı publishing.

Günter, T. (2020). Effectiveness of a problem-based learning (pbl) scenario for enhancing academic achievement of energy metabolism. Research in Science Education, 50, 1713-1737. https://doi.org/10.1007/s11165-018-9750-7

İşeri, K. (2010). The investigation of the reading attitudes of second grade students. International Journal of Human Sciences. 7(2), 468-487.https://www.j-humansciences.com/ojs/index.php/IJHS/article/view/1267

Karamanlı, E. (2019). Investigation of argumentation levels and informal intelligence patterns of secondary school students on socio-scientific issues through blogs, (Unpublished master's thesis). Mersin University.

Karpudewan, M., & Roth, W. M. (2018). Changes in primary students' informal reasoning during an environment-related curriculum on socio-scientific issues. International Journal of Science and Mathematics Education, 16(3), 401-419. https://doi.org/10.1007/s10763-016-9787-x

Kemiksiz, C. (2016). Effects of using scenario-based learning method in 6th grade science classes on academic achievement, attitudes and permanence (Unpublished master's thesis). Abant İzzet Baysal University.

Keskin-Samanci, N., Özer-Keskin, M., & Arslan, O. (2014). Development of 'bioethical values inventory' for pupils in secondary education within the scope of bioethical education. Eurasia Journal of Mathematics, Science ve Technology Education, 10(2), 69-76. https://doi.org/10.12973/eurasia.2014.1029a

Khishfe, R. (2012). Relationship between nature of science understandings and argumentation skills: A role for counterargument and contextual factors. Journal of Research in Science Teaching, 49(4), 489-514. https://doi.org/10.1002/tea.21012

Kindley, R.W. (2002). Scenario-based e-learning: A step beyond traditional e-learning. ASDT Online Magazine Learning-Circuits, 3(5). https://www.td.org/learning-circuits

Kinskey, M., & Zeidler, D. (2021). Elementary preservice teachers' challenges in designing and implementing socioscientific issues-based lessons. Journal of Science Teacher Education, 32(3), 350-372. https://doi.org/10.1080/1046560X.2020.1826079

Kitzinger, J. (1994). The methodology of focus groups: the importance of interaction between research participants. Sociology of Health and Illness, 16(1), 103-121. https://doi.org/10.1111/1467-9566.ep11347023

Kitzinger, J. (1995). Qualitative research: İntroducing focus groups. British Medical Journal, 311, 299-302. https://doi.org/10.1136/bmj.311.7000.299

Kocadağ, Y. (2010). The effects of case-based learning approach on the elimination of mısconceptions about the subject of genetic (Unpublished master's thesis). Karadeniz Teknik University.

Kocayusuf, A. G. (2014). The effects of learning products of context based scenario accompanied mastery learning strategy (Unpublished master's thesis). Akdeniz University.

Kolarova, T., Hadjiali, I., & Denev, I. (2013). High school students' reasoning in making decisions about socio-ethical issues of genetic engineering: Case of gene therapy. Biotechnology & Biotechnological Equipment, 27(2), 3737-3747. https://doi.org/10.5504/BBEQ.2012.0133

Ladachart, L., & Ladachart, L. (2021) Preservice biology teachers' decision-making and informal reasoning about culture-based socioscientific issues. International Journal of Science Education, 43(5), 641-671. https://doi.org/10.1080/09500693.2021.1876958

Lin, Y. R., & Hung, J. F. (2016). The analysis and reconciliation of students' rebuttals in argumentation activities. International Journal of Science Education, 38(1), 130-155. https://doi.org/10.1080/09500693.2015.1134848

Mariappan, J., Shih, A., & Schrader, P. G. (2004). Use of scenario-based learning approach in teaching statics. [Conference session 2666]. In Proceedings of the 2004 American Society for Engineering Education Annual Conference and Exposition, American Society for Engineering Education. https://www.researchgate.net/publication/237244689_Use_of_ScenarioBased_Learning_Approach_in_Teaching_Statics

Martini, M., Widodo, W., Qosyim, A., Mahdiannur, M. A., & Jatmiko, B. (2021). Improving undergraduate science education students' argumentation skills through debates on socioscientific issues. Jurnal Pendidikan IPA Indonesia, 10(3), 428-438. https://doi.org/10.15294/jpii.v10i3.30050

Merriam, S. B. (2009). Qualitative research a guide to design and implementation. Jossey-Bass.

McIlveen, P., McGregor-Bayne, H., Alcock, A., & Hjertum, E. (2003). Evaluation of a semi-structured career assessment interview derived from systems theory framework. Australian Journal of Career Development, 12(3), 33-41. https://doi.org/10.1177/103841620301200306

McMillan, J.H., & Schumacher, S. (2010). Research in education: Evidence-based inquiry (7th ed.). Pearson Education.

Miles, M. B., & Huberman, A. M. (1994). Qualitative data analysis: An expanded source book (2th ed.). Sage Publications.

Mills, K., Roper, F., & Cesare, S. (2021). Accelerating student learning in communication and research skills: the adoption of adaptive learning technologies for scenario-based modules. Case Studies, Trends and Reflections Chandos Information Professional Series, (p 75-84). https://doi.org/10.1016/B978-0-12-822807-4.00007-5

Ministry of National Education, Board of Education (MoNE). (2018). Primary and secondary schools science course (3rd, 4th, 5th, 6th, 7th and 8th grades) curriculum.

http://mufredat.meb.gov.tr/Dosyalar/201812312311937FEN%20B%C4%B0L%C4%B0MLER%C4%B0%20%C3%96%C4%9ERET%C4%B0M%20PROGRAMI2018.pdf

Mio, C., Ventura-Medina, E., & João, E. (2019). Scenario-based eLearning to promote active learning in large cohorts: Students' perspective. Computer Applications in Engineering Education, 27, 894-909. https://doi.org/10.1002/cae.22123

Mostert, M. P. (2007). Challenges of case-based teaching. The Behavior Analyst Today, 8(4), 434-442. https://doi.org/10.1037/h0100632

National Research Council (NRC). (1996). National Science Education Standards. National Academy Press.

National Research Council (NRC). (2012). A framework for K-12 science education: Practices, crosscutting concepts, and core ideas. National Academies Press.

Önen Öztürk, F. (2017). A study on science-society based educational short films: Example of science education. Mersin University Journal of the Faculty of Education, 13(2), 633-649. https://doi.org/10.17860/mersinefd.336747

Ottander, K., & Simon, S. (2021). Learning democratic participation? Meaning-making in discussion of socioscientific issues in science education. International Journal of Science Education, 43(12), 1895-1925. https://doi.org/10.1080/09500693.2021.1946200

Owens, D.C., Petitt, D.N., Lally, D., & Forbes, C.T. (2020). Cultivating water literacy in STEM education: Undergraduates' socio-scientific reasoning about socio-hydrologic issues. Water, 12(10), 2857, 1-18. https://doi.org/10.3390/w12102857

Özden, M. (2020). Elementary school students' informal reasoning and its' quality regarding socio-scientific issues. Eurasian Journal of Educational Research, 20(86), 61-84. https://doi.org/10.14689/ejer.2020.86.4

Öztaş S. (2008). Teaching history and films. Kastamonu Education Journal, 16(2), 543-556. https://dergipark.org.tr/en/pub/kefdergi/issue/49100/626535

Öztürk, S., & Leblebicioğlu, G. (2015). Investigation of reasoning modes in making a decision about hydroelectric power plants which is a socioscientific issue. Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 9(2), 1-33. https://doi.org/10.17522/nefefmed.88999

Parladır, S. (2004, May 29-30). The place of the scenarios in active education and the features of a good scenario [Conference session]. The First Active Education Congress Proceedings Book, İzmir, Turkey.

Patton, M. Q. (2002). Qualitative research & evaluation methods. Sage.

Pehlivanlar, G. (2019). Preservice elementary and science teachers' informal reasoning about local, national, and global socioscientific issues (Unpublished master's thesis). Recep Tayyip Erdogan University.

Proudfoot, D. E., & Kebritchi, M. (2017). Scenario-based e learning and stem education: A qualitative study exploring the perspectives of educators. International Journal of Cognitive Research in Science, Engineering and Education, 5(1), 7-18. https://doi.org/10.5937/IJCRSEE1701007P

Punch, K. (2005). Introduction to social research quantitative and qualitative approaches (2th ed.). Sage Publications.

Qamariyah, S. N., Rahayu, S., Fajaroh, F., & Alsulami, N. M. (2021). The effect of implementation of inquiry-based learning with socio-scientific issues on students' higher-order thinking skills. Journal of Science Learning, 4(3), 210-218. https://doi.org/10.17509/jsl.v4i3.30863

Queensland School Curriculum Council. (2001). Studies Of Society And Environment [Online]. http:// Www.Cmec.Ca/Science/Framework/İndex.Htm

Rahayu, S., Meyliana, M., Arlingga, A., Reny, R., Siahaan, P., & Hernani, H. (2017, September). Development of lesson plans and student worksheets based socioscientific ıssues on pollution environmental topic. In Journal of Physics: Conference Series, 895, 1, 012150). Iop Publishing. https://doi.org/10.1088/1742-6596/895/1/012150

Ramirez Villarin, L. J. (2020). The relationship between place attachment and socioscientific reasoning among high school students in puerto rico after negotiation with local and foreign socioscientific issues (Unpublished doctoral dissertation). College of Engineering and Science of Florida Institute of Technology Melbourne.

Rebello, C. M., Barrow, L. H., & Rebello, N. S. (2013). Effects of argumentation scaffolds on student performance on conceptual physics problems. In Physics Education Conference Proceedings, 293-296.

Romine, W. L., Sadler, T. D., Dauer, J. M., & Kinslow, A. (2020). Measurement of socio-scientific reasoning (SSR) and exploration of SSR as a progression of competencies. International Journal of Science Education, 42(18), 2981-3002. https://doi.org/10.1080/09500693.2020.1849853

Saad, M. I. M., Baharom, S., & Mokhsein, S. E. (2017). Scientific reasoning skills based on socioscientific issues in the biology subject. International Journal of Advanced and Applied Sciences, 4(3), 13-18. https://doi.org/10.21833/ijaas.2017.03.003

Sadler, T. (2004). Informal reasoning regarding SSI: A critical review of research. Journal of Research in Science Teaching, 41(5), 513-536. https://doi.org/10.1002/tea.20009

Sadler, T. D. (2011). Socioscientific issues in the classroom: Teaching, learning and research. Springer.

Sadler, T. D., & Zeidler, D. L. (2005). The significance of content knowledge for informal reasoning regarding socioscientific issues: Applying genetics knowledge to genetic engineering issues. Science education, 89(1), 71-93. https://doi.org/10.1002/sce.20023

Sadler, T. D., Amirshokoohi, A., Kazempour, M., & Allspaw, K. (2006). Socioscience and ethics in science classrooms: Teacher perspectives and strategies. Journal of Research in Science Teaching, 43, 353–376. https://doi.org/10.1002/tea.20142

Sailer, M., Stadler, M., Schultz-Pernice, F., Franke, U., Schöffmann, C., Paniotova, V., Husagic, L., & Fischer, F. (2021). Technology-related teaching skills and attitudes: Validation of a scenario-based self-assessment instrument for teachers. Computers in Human Behavior, 115, 106625. https://doi.org/10.1016/j.chb.2020.106625

Seggie, F. N., & Bayyurt, Y. (2015). Qualitative research (methods, technical analysis and approaches). Anı Publishing.

Selanik Ay, T. (2010). Social studies course student views on environmental awareness gaining media products to exploit. International Journal of Eurasia Social Sciences, 1(1), 76-93. https://dergipark.org.tr/tr/pub/ijoess/issue/8541/105990

Shen, J., Yang, H., Li, J., & Cheng, Z. (2021). Assessing learning engagement based on facial expression recognition in MOOC's scenario. Multimedia Systems, 1-10. https://doi.org/10.1007/s00530-021-00854-x

Simonneaux, L. (2008). Argumentation in socio-scientific contexts. S. Erduran & M. P. Jimenez Aleixandre (Ed.), Argumentation in science education: Perspectives from classroom-based research (pp. 179-199). Springer.

Sönmez, A., & Kilinc, A. (2012). Preservice science teachers' self-efficacy beliefs about teaching gm foods: The potential effects of some psychometric factors. Necatibey Faculty of Education, Electronic Journal of Science and Mathematics Education, 6(2), 49-76. https://dergipark.org.tr/en/pub/balikesirnef/issue/3375/46580

Sönmez, T. (2020). Evaluating the students' performance via scenarios based on argumentative discourse in science classes, (Unpublished master's thesis). Niğde Ömer Halisdemir University.

Suephatthima, B., & Faikhamta, C. (2018). Developing students' argument skills using socioscientific issues in a learning unit on the fossil fuel industry and its products. Science Education International, 29(3), 137-148. https://doi.org/10.33828/sei.v29.i3.2

Taşkın Can, B., Yaşadı, G., Sönmezer, D., & Kesercioğlu, T. (2006). Do the scenerios and concept maps eliminate the mis-conceptions in science education?. Hacettepe University Journal of Education, 31(31), 133-146. https://dergipark.org.tr/en/download/article-file/87696

Temur, D., & Turan, H. (2018). The effect of scenario based learning approach on solving problems of addition and subtraction of third grade students of primary school. Kocaeli University Journal of Education, 1(2), 72-84. https://doi.org/10.33400/kuje.451771

Tol, H.Y. (2018). The effects of explaining the historical development of mathematics subjects with scenario-based learning method on students. (Unpublished master's thesis). Necmettin Erbakan University.

Topçu, M. S. (2015). Socioscientific issues and their teaching (1th ed.). Pegem Akademi Publications.

Turan, S. (2013). Qualitative research: A guide to design and implementation. Nobel Akademik

Türkmen, H., Pekmez, E. & Sağlam, M. (2017). Pre-service science teachers' thoughts about socio-scientific issues. Ege Journal of Education, 18(2), 448-475. https://doi.org/10.12984/egeefd.295597

Venville, G. J., & Dawson, V. M. (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.https://doi.org/10.1002/tea.20358

Woolley, J. S., Deal, A. M., Green, J., Hathenbruck, F., Kurtz, S. A., Park, T. K. H., Pollock, S. V., Transtrum, M. B., & Jensen, J. L. (2018). Undergraduate students demonstrate common false scientific reasoning strategies. Thinking Skills and Creativity, 27(2018), 101-113. https://doi.org/10.1016/j.tsc.2017.12.004

Yalçın, G. (2018). The effect of social scientific biology conditions on written argumentation skills of science teachers of science, (Unpublished master's thesis). Bartın University.

Yavuz Topaloğlu, M., & Balkan Kıyıcı, F. (2017). Middle school students' opinions about hydroelectric power plants. Ahi Evran University Journal of Kırşehir Education Faculty, 18, 159-179. https://dergipark.org.tr/tr/pub/kefad/issue/59263/851398

Yeniceli, E. (2016). The effect of teaching based on scenario to success of phsyical sciences class and attitude towards the class (Unpublished master's thesis). Gazi University.

Yıldırım, A., & Şimşek, H. (2006). Qualitative research methods in the social sciences. Seçkin Publication.

Yıldırım, A., & Şimşek, H. (2013). Qualitative research methods in the social sciences (9th Edition). Seçkin Publication.

Yin, R. K. (2003). Case study research: Design and methods (3rd ed.). Thousand Oaks, CA: Sage.

Zeidler, D. L., Herman, B. C., & Sadler, T. D. (2019). New directions in socioscientific issues research. Disciplinary and Interdisciplinary Science Education Research, 1(11), 1-9. https://doi.org/10.1186/s43031-019-0008-7

APPENDIX

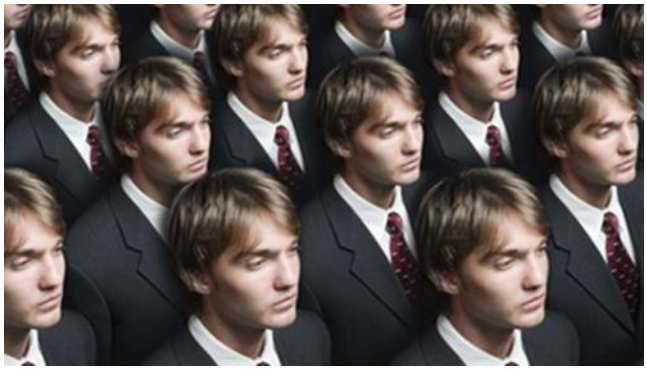
Appendix 1

Scenario -7 (19-25 November 2018)

Small Changes

Mr. R is a 45-year-old genetic engineer. He wants to change gene structures by interfering with the genes of plants, animals and even humans. In this way, he set himself on the mind of being able to add new features to existing creatures and to create gifted creatures by bringing together beneficial genes in different living things. Using various biotechnological methods for this, Mr. R is quite curious about the results. He started his work primarily with strawberries. Strawberry is a very sensitive fruit that can only grow in hot conditions and which deteriorates and rots quickly. However, considering that the population is rapidly increasing, people in every geography need a type of strawberry that can withstand cold weather and transportation in order to eat strawberries. Starting out from this problem, Mr. R took advantage of polar icefish to make this delicious fruit cold resistant. Mr. R succeeded in taking the gene region that enables the ice fish to survive at - 35 degrees and add it to the DNA of the strawberry with biotechnological methods. Thus, strawberries will be able to grow easily in cold weather, the living space will increase and strawberries will be produced as much as all people can eat in all seasons. Mr. R wants to apply this method to many fruits such as kiwi, banana and tomato and to put the seeds of these fruits on the market. But can the strawberry, whose genetics has changed, be harmful to human health even though it positively affects the growing conditions and durability?, he also thought. Mr. R plans to do a study with experimental and control groups to test this idea. Two groups take 10 mice each. He ensures that 10 mice in the experimental group eat the genetically modified strawberries and 10 mice in the control group eat the normal strawberries and observes the results. Although there was no health problem in the control group after a certain period, 1 out of 10 mice in the experimental group had various allergic reactions. Concluding that the genes coming from the ice fish caused this situation, Mr. R was caught between the allergic reactions that occurred with the response of humanity to the nutritional needs and wanted to think a little more before putting the strawberry on the market.

1. If you were Mr. R's, would you put the seeds of this strawberry on the market? Why?



Mr. R wants to continue his work on people. It is seen that people have experienced various tissue, organ losses throughout their lives and that people lost their lives since these tissues, and organs cannot be found afterwards. Knowing that even if a donor is found, the patient's body may not accept the given tissue or organ and that the person's life is in danger, Mr. R thinks why not a replica of the human being either. According to him, a clone of Dolly, who was a sheep before, was made, so man can be made too! Studying the laws on this subject, Mr. R finds that making a human clone is strictly prohibited due to moral values. But the crazy inventor, who takes the certainty that humanity will need cloning for organ needs in the future, wanted to live in those times. Mr. R, who is 45 years old, realizes that he cannot see those days under normal circumstances and immediately gets to work. He prepares and drinks a potion that will awaken him in 2100.

Years pass and Mr. R opens his eyes in the year 2100. Indeed, people can now be cloned and take the necessary organs from their clones when their organs are not functioning. However, Mr. R also faced a situation he had not expected. Because there are individuals with the same genome in the society, he has seen that when a crime is committed, it is not possible to find clear information about whether the truth or the clone did it. He observed that individuals with the same DNA fingerprints feel comfortable by sharing tasks in their work and social lives, and can increase their chances of survival by using the organs of their clones in disease situations, and they create various social problems in order to be individualized. Given these circumstances, Mr. R remained undecided about whether the morally prohibited human clone around 80 years ago had a positive outcome in 2100.

2. If you were Mr. R's place, would you have developed a positive or negative attitude towards human cloning? Do you think human cloning is possible? Do you find this right? Why? Explain.

The pictures used in the scenario are retrieved from the following addresses;

1. https://www.kentharita.com/genetik-muhendisligi-nedir/

2.https://www.express.co.uk/news/science/660058/Top-scientist-warns-thatcloning-could-lead-to-ILLEGAL-black-market on 12 November 2018.

Appendix 2

Interview Questions Used in the Research

1. Have you ever taught in any lesson using the same method that the 'DNA and Genetic Code' unit was taught?

2. Do you think that the course in the 'DNA and Genetic Code' unit of the Science course through such scientific scenarios has an impact on your success? Why?

3. Do you think that the way the lesson is taught in the 'Science and Genetic Code' unit with scientific scenarios helps you to establish a relationship between the science subjects you learn in the unit and daily life? How? Can you explain with an example?

4. Do you think that the teaching of the courses in the 'DNA and Genetic Code' unit of the Science course in this way - through scientific scenarios- affects your perspective / awareness of social problems? Why?

5. In the 'DNA and Genetic Code' unit of the 'Science course', were there any problems and difficulties that you saw lacking in the process of teaching the courses in this way - through scientific scenarios? If yes, could you please explain what happened?

6. If you wanted to make changes in the application / study, what would you continue and change? Can you explain why?