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RESEARCH ARTICLE

Pre-service Biology Teachers' Moral Reasoning about Socioscientific Issues and Factors Affecting Their Moral Reasoning

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ABSTRACT

Besides factors such as emotions, thoughts, and intuitions, moral reasoning is also effective in individuals' decisions, especially on socio-scientific issues. This study aimed to determine the moral reasoning of pre-service biology teachers about some socioscientific issues and the factors affecting their moral reasoning. The study focused on 16 pre-service biology teachers studying in the 4th grade, and this study was customized as a case study from qualitative research methods. While scenarios were used to determine the moral reasoning of pre-service teachers, semi-structured interview questions were used to determine the factors affecting their moral reasoning. In this study, content analysis was used to analyze qualitative data. The statements in the pre-service teachers' responses to the water problem, climate change, and biodiversity scenarios were coded as ecocentric, anthropocentric, and non-environmental moral reasoning. It was determined that the answers given by pre-service biology teachers to the scenario about the water problem were mostly anthropocentric moral reasoning, followed by ecocentric, and least by non-environmental moral reasoning. In the scenario on climate change, it was found that the pre-service biology teachers gave answers mostly following anthropocentric moral reasoning, followed by non-environmental moral reasoning, and ecocentric moral reasoning, respectively. In the last scenario on biodiversity, it was determined that the pre-service teachers' responses were equal in ecocentric and anthropocentric moral reasoning and lower in non-environmental moral reasoning. Looking at the total responses of the pre-service teachers to the three scenarios, it is understood that the moral reasoning with the highest frequency is anthropocentric, while ecocentric and non-environmental moral reasoning are almost equal. Eleven factors affecting the moral reasoning patterns of pre-service biology teachers were identified: impact on human life; experiences; duties, responsibilities, and principles; environmental knowledge and awareness; approach with emotions; universal values; media/popular culture; national values; political, social, and economic balances in the world; religious beliefs; ambivalence and contradiction.

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1. Introduction

Rapidly developing science and technology facilitate the lives of human beings in many areas and contribute to prolonging human life and increasing the quality of life. In addition, many new problems such as the increase in the rate of consumption, the decrease in natural resources, the need for alternative energy sources, climate change, environmental pollution, and the risks of genetic studies and GMO products have become the issues that today's people face. In this way, the issues that society confronts with science fall within the scope of "socioscientific issues". However, these issues included in socioscientific issues represent an excellent social interest, interaction, and outcome (Sadler, 2004a). Socioscientific issues

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are controversial, questionable, and poorly structured issues that involve different values and perspectives in decision-making and require moral judgment (Zeidler et al., 2009). Especially people living in societies where technology is developing rapidly need to be sensitive to the moral and ethical elements of socioscientific issues (Lee et al., 2012). Individuals may experience difficulties especially when evaluating socioscientific issues. This is because socioscientific issues are often controversial, poorly structured, and open-ended problems with many solutions from different perspectives (Sadler & Zeidler, 2005a). While the solutions to a problem are clearer from a scientific point of view, many factors that affect the solution of the same problem in the human-related dimension come into play. In this sense, socioscientific issues are by their very nature an effort to bring science and human beings together. However, while it is not possible to speak of a single direct solution in this endeavor, it is also a search for a process-based solution.

Topics such as global warming, alternative fuels, cloning, stem cells, and genome projects have become part of people's vocabulary and have also been part of political debates. The fact that societies do not consider, deal with, or confront these emerging issues does not mean that these scientific issues will not increase and spread. In fact, environmental problems arising due to the increasing human population and developments in medicine and molecular genetics guarantee that these issues will occupy the agenda both today and in the future (Sadler, 2004a). For this reason, including socioscientific issues in educational content is considered important in terms of broadening individuals' perspectives on issues and adapting to developments. According to Zeidler et al. (2002), socioscientific issues have a larger framework than science-technology-society education because they include both the ethical dimensions of science, students' moral reasoning, and students' emotional development.

In socioscientific issues-based education, it is clearly seen that both the psychological and sociological development of students is prioritized (Zeidler et al., 2005). However, reaching an ethical agreement, especially on controversial science issues, is also a strong feature (Sadler & Zeidler, 2004). Ethical thinking builds bridges between science and non-science and between students and the social, material, organic, and physical world in which they live (Zeidler et al., 2019). Students who encounter socioscientific issues in the classroom have an approach that aims to solve problems. In this process, while revealing their thoughts, they face the reality of how others will have different thoughts. According to Zeidler and Nichols (2009), making use of discussions on socioscientific issues enables controversial socioscientific issues to be handled in a more controlled manner.

A review of the literature shows that students emphasize their moral thoughts in the solution and evaluation of socioscientific issues (Hogan, 2002; Zeidler et al., 2002; Bell & Lederman, 2003; Sadler, 2004b; Sadler & Zeidler, 2004; Sadler & Donnelly, 2006, Lee et al., 2012; Türköz & Öztürk, 2020). In her study with pre-service biology teachers, Kara (2012) emphasized that socioscientific issues should allow candidates to examine and reflect on their own values and especially highlighted the importance of professional development related to controversial social and personal issues, and moral and ethical dimensions of science and technology. This is because socioscientific issues are conceptually related to science content, but also take into account the moral thinking of individuals. Moral thinking here means the individuals' determination of what is right, good, and honest (Sadler & Donnelly, 2006).

The concept of ethics needs to be broadened to encompass the relationship between nature and human beings, and environmental ethics is based on this idea. The most important problems that people have faced in recent years are environmental problems such as endangered species, global warming, land degradation, air, and water pollution. How these problems will be solved depends on how people perceive their relationship with nature (Kortenkamp & Moore, 2001). The concept of "ethics" should be taken into account to find solutions to environmental problems on a global scale. Ethical approaches show the value of the practices proposed to solve environmental problems (Şahin et al., 2017).

According to the environmental ethics literature, the subject to which value is attributed is divided into three. These are; (a) the person themselves, (b) other people other than themselves, and (c) beings other than humans (Stern & Dietz, 1994). Stern et al. (1993) categorized value orientations as social-altruistic, biospheric, and egoistic. In parallel to this, Stern and Dietz (1994) utilized a classification as egoistic, altruistic, and biospheric. Thompson and Barton (1994), who argued that there are at least two values for environmental issues, ecocentric and anthropocentric, used three categories with the repulsiveness/apathetic value. Kahn (1997), on the other hand, mainly emphasized anthropocentric and biocentric judgments and also used subcategories. Amérigo et al. (2007) identified two categories, ecocentric and anthropocentric, based on beliefs about the relationship between humans and the environment. They argued that the combination of egoistic and social-altruistic values is the anthropocentric approach. Karpiak and Baril (2008) used a triple categorization of ecocentric, anthropocentric, and apathetic in their study. Surmeli and Saka (2013) utilized a category according to ecocentric, anthropocentric, and biocentric approaches. When these studies are examined, it is seen that different categories are utilized in parallel with the status of the subject to whom value is attributed. However, it is understood that ecocentric and anthropocentric approaches are the most prominent.

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In ecocentric (nature-centered) moral reasoning, people value and protect nature because of its intrinsic value. In anthropocentric moral reasoning, on the other hand, people want to protect nature to preserve or improve the quality of human life. Both ecocentric and anthropocentric individuals show an effort and environmental interest to protect nature. However, the underlying reasons for this are quite different (Thompson & Barton, 1994). A review of the literature reveals that the anthropocentric approach to moral reasoning emerged from the egoistic and social-altruistic mix, while the ecocentric approach to moral reasoning emerged from the biospheric view (Amérigo et al., 2007).

In the ecocentric approach, nature has a value of its own, apart from being useful to humans. For example, a person may judge that it would not be right to cut down rainforests because many plants and animal species would be harmed (Kortenkamp & Moore, 2001). Because of this value, ecocentric individuals believe that nature should be both admired and respected and cared for (MacKinnon & Fiala, 2014). According to ecocentrism, environmental protection consists of four elements: biodiversity, integrity with nature, a beautiful world, and closeness to nature (Bjerke & Kaltenborn, 1999). Rather than being concerned about protecting their living standards and economies, ecocentric individuals find solutions to environmental problems by seeing protecting nature as protecting the world. In this approach, unlike anthropocentric individuals, they emphasize that natural resources are not only a space that meets the physical needs of human beings and attach importance to the relationships between other elements of nature (ecological systems, animals, etc.) and humans (Thomson & Barton, 1994).

In the anthropocentric approach, humans are the most important life form and other life forms can be important only to the extent that they affect or benefit humans. The degradation or preservation of nature can translate into benefits or harms for humans. For example, a person might judge that it would not be right to cut down the rainforest because of its benefits in curing human diseases (Kortenkamp & Moore, 2001). They evaluate how the environment affects human beings in terms of 'personal interest, well-being, education, judgmental and aesthetic' characteristics (Kahn, 1997). Anthropocentric individuals want the environment to be protected because they think that people's quality of life should be increased or sustained (Thomson & Barton, 1994).

There is a third category that falls outside ecocentric and anthropocentric moral reasoning. According to Kortenkamp and Moore (2001), people approach environmental problems from a non-environmental perspective. They emphasize non-environmental features such as laws rather than threatening situations on the environment or human beings.

There may be different reasons underlying the fact that individuals have different moral judgments according to the issues they encounter. While it is known that factors such as emotions and intuitions are effective in people's decision-making, it has been concluded that the moral interest dimension is effective in deciding about socioscientific issues. For example, people's interest in environmental issues is determined by the degree of influence according to the proximity of the issue to the person (Bamberg, 2003). In parallel to this, Duan and Fortner (2005) identified locality as a variable when choosing environmental problems and found that students are more active in solving local problems that affect them rather than global problems. In addition, Karpiak and Baril (2008) determined that women showed a more ecocentric approach than men in their study. Thus, they concluded that gender is a factor affecting the moral reasoning of individuals. Tuncay (2010), on the other hand, found that the moral reasoning of first-grade students differed compared to other grades and revealed that class level may be an effective factor in moral reasoning.

The study aims to determine the moral reasoning of pre-service biology teachers about some socioscientific issues and the factors affecting their moral reasoning. In line with this purpose, answers to two questions were sought.

1. How are pre-service biology teachers' moral reasoning according to scenarios about water problems, climate change, and biodiversity?

2. What are the factors affecting pre-service biology teachers' moral reasoning in scenarios about water problems, climate change, and biodiversity?

2. Method

2.1. Research Design

Qualitative research method was utilized in this study. The phenomena that are tried to be made sense of according to the perspectives of the participants constitute qualitative research. In qualitative research where both inductive and deductive research strategies are followed, the final product is suitable for descriptions (Merriam, 2002). This study aimed to determine the moral reasoning of pre-service biology teachers about some socioscientific issues and the factors affecting their moral reasoning. The study focused on 16 pre-service biology teachers studying in the 4th grade and this study was customized as a case study. In case studies, where how and why questions are generally emphasized, it is a strategy that is more commonly used when the phenomenon focused on is a current issue and the researcher has little influence on the events (Yin, 2009).

2.2. Participants

The participants of the study consisted of 16 pre-service teachers studying in the 4th grade at the Department of Biology Education of a state university. Criterion sampling, which is

one of the purposeful sampling methods, was used to determine the classes of the pre-service biology teachers in the study. Criterion or criteria can be determined by the researcher or it is possible to utilize a list of criteria prepared in advance (Yıldırım & Şimşek, 2011). Since the socioscientific issues determined in this study were environment-oriented, the first criterion was accepted as the completion of environmental courses by prospective biology teachers. An information meeting was held with the 4th-grade students who met this criterion about the purpose, importance, content, duration of the study, and the importance of confidentiality, continuity, and volunteerism for the participants. Since gender is a discriminating factor in moral reasoning, the second criterion of the study was determined as the equal number of male and female students. For this reason, the number of female students was determined according to the volunteer status of the few males in the class. Accordingly, a total of 16 pre-service teachers, 8 females and 8 males, took part in the study. To ensure the confidentiality of the identity information of the pre-service teachers in the study, the 1st pre-service teacher was coded as A1, the 2nd pre-service teacher as A2, ... and the 16th pre-service teacher as A16.

2.3. Data Collection Tools

While scenarios were used to determine the moral reasoning of pre-service teachers in the study, semi-structured interview questions were used to determine the factors affecting their moral reasoning.

While the scenarios on water problems and climate change were developed by the researchers, the scenario on climate change is the Turkish-adapted version of the scenario prepared by Lee et al. (2012). While preparing the scenarios, care was taken to utilize real-life situations that pre-service teachers experienced or could experience. Thus, it will be easy for them to form ideas on these situations, and their answers will be very close to their real feelings and thoughts. Especially social dilemmas were included in the scenarios. In their study, Kortenkamp and Moore (2001) examined students' moral reasoning through social dilemmas. The draft scenarios were first examined by a field expert and two field educators who had worked on related topics. The scenarios were edited according to the feedback received and submitted to the evaluation of 1 doctoral, 1 master's, and 3 undergraduate students. Before finalizing the scenarios, the field and field educator experts and the researchers came together and made evaluations. To evaluate the scenarios in terms of meaning and writing, they were finally submitted to the opinion of a Turkish language expert, and the scenarios were finalized. To motivate the students and to make the scenarios more visually appealing, scenarios about water problems were printed on blue, scenarios about climate change on yellow, and scenarios about biodiversity on green colored paper. An average of 30-40 minutes was required for the prospective teachers to answer the scenarios.

The protocol originally developed by Sadler and Zeidler (2005b) and named "Moral Decision-Making Interview (MDMI)" was used to determine the factors affecting the moral reasoning of pre-service teachers. The original protocol included 14 semi-structured interview questions for each of the two scenarios on Gene therapy (Huntington's disease) and Cloning (Cloning for reproduction). Through these questions, Sadler and Zeidler (2005b) investigated the factors affecting the participants' moral decision-making processes. In parallel to this, the researchers prepared moral decision-making interview questions for the scenarios on water problems, climate change, and biodiversity. The draft interview questions were presented to two field education experts who have worked on related topics. The questions, which were revised according to the opinions received, were proofread by three pre-service biology teachers to check whether the questions were clear and easy to understand. Accordingly, a Turkish language expert was consulted about the meaning and writing before finalizing the questions. Interviews were conducted with 5 prospective teachers who volunteered. The interviews were conducted in the office of the supervisor and by the first researcher. During the interviews, a quiet and comfortable environment was created where the pre-service teachers felt comfortable. Interview data were recorded using voice recording and note-taking methods together.

2.4. Data Analysis

In qualitative research, large amounts of data collected through various methods such as observation, interview, and document analysis are first analyzed and coded. Then these codes are synthesized and findings are reached (Büyüköztürk et al., 2012). In this study, content analysis was used to analyze qualitative data.

The statements in the pre-service teachers' responses to the water problems, climate change, and biodiversity scenarios were coded as ecocentric, anthropocentric, and non-environmental moral reasoning. The categories used in Kortenkamp and Moore's (2001) study were taken into consideration in coding. After the coding was completed, the frequencies of each category were calculated. A total of 48 scenarios for three subjects belonging to 16 pre-service teachers were evaluated.

A total of 15 interviews with five pre-service teachers lasted 414 minutes and 9 seconds. An interview with each pre-service teacher lasted 27 minutes and 36 seconds on average. In the analysis of the semi-structured interview questions, 'data reduction', 'data display', and 'conclusion drawing and verification' stages were utilized (Miles & Huberman, 1994). Accordingly, student transcripts were read repeatedly and coded to simplify the data. Then a matrix was created to better determine the relationship between them. In the last stage, 11 factors affecting the moral reasoning of pre-service biology teachers were revealed through "factor identification".

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2.5. Validity and Reliability of the Study

Throughout the research, efforts were made to establish good relationships with the participants, and this was supported by the fact that the pre-service biology teachers were familiar with the research. The researchers tried to motivate the pre-service teachers to express themselves more freely. Since the semi-structured interviews with the pre-service biology teachers were repeated separately for the topics of water problems, climate change, and biodiversity, each candidate was interviewed three times, and long-term interaction was ensured. Another expert opinion was used in creating moral reasoning categories according to the statements used by the pre-service biology teachers in the scenarios and the analysis of the semi-structured interview data. The purpose here is to ensure researcher diversification. At the same time, expert opinions were also utilized in preparing scenarios and interview questions. In the semi-structured interviews, attention was paid to whether the pre-service biology teachers understood the questions correctly or not, and when necessary, the questions were explained and confirmed by the participants. All these stages are important for the credibility (internal validity) of this qualitative study.

Detailed descriptions were used throughout the study, including the participants, scenarios, semi-structured interview questions, and data analysis. In addition, the purposeful sampling method in qualitative studies was used in determining pre-service biology teachers following the research problem. These features of the study contributed to its transferability.

Another expert was consulted to categorize the responses of the pre-service biology teachers to the scenarios and analyze the interview questions. For the reliability of the data analysis, the codes used by the two researchers independently of each other were calculated with the formula of Agreement/(Agreement+Disagreement)X100 (Miles & Huberman, 1994). The reliability between the coders was calculated as 82% in the analysis of the scenarios and 84% in the analysis of the semi-structured interview questions. In addition, while writing the findings of the study, direct quotations were made from the statements used by the pre-service teachers in the scenarios. All these are important in terms of supporting the consistency of the research.

The audio recordings taken from the pre-service biology teachers, who were the participants of the study, were first transcribed and then two volunteer candidates were asked to read and confirm their own documents. This contributed to the confirmability of the research.

3. Findings

This study aimed to determine pre-service biology teachers' moral reasoning about some socioscientific issues and the factors affecting their moral reasoning. Following this purpose, answers to two questions were sought.

The first question was "How are the moral reasoning of pre-service biology teachers according to the scenarios about water problems, climate change, and biodiversity?". Accordingly, the distribution of pre-service biology teachers' responses to the scenarios on water problems, climate change, and biodiversity according to their moral reasoning is given in Figure 1.

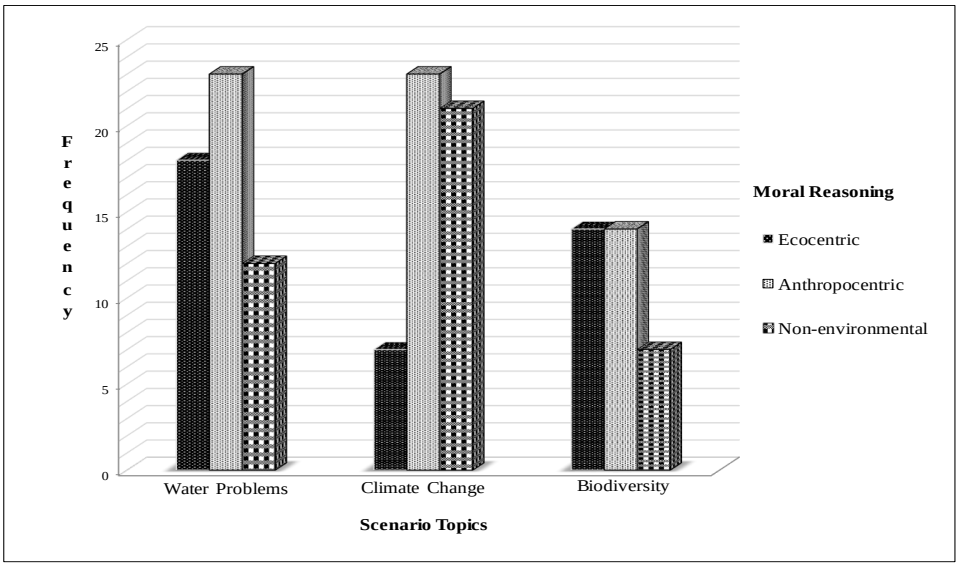


Figure 1. Distribution of prospective biology teachers' responses to the scenarios by moral reasoning.

It was found that pre-service biology teachers' responses to the scenario about water problem were mostly anthropocentric moral reasoning (f=23), followed by ecocentric moral reasoning (f=18), and least by non-ecocentric moral reasoning (f=12). In the scenario on climate change, it was found that the pre-service biology teachers gave answers mostly in

accordance with anthropocentric moral reasoning (f=23), followed by non-environmental moral reasoning (f=21), and ecocentric moral reasoning (f=7), respectively. In the last scenario, the scenario on biodiversity, it was determined that the pre-service teachers' responses were equal in ecocentric (f=14) and anthropocentric (f=14) moral reasoning and lower in non-environmental moral reasoning (f=7) (Figure 1).

The distribution of pre-service biology teachers' total responses to the scenarios on water problems, climate change, and biodiversity according to moral reasoning is given in Figure 2.

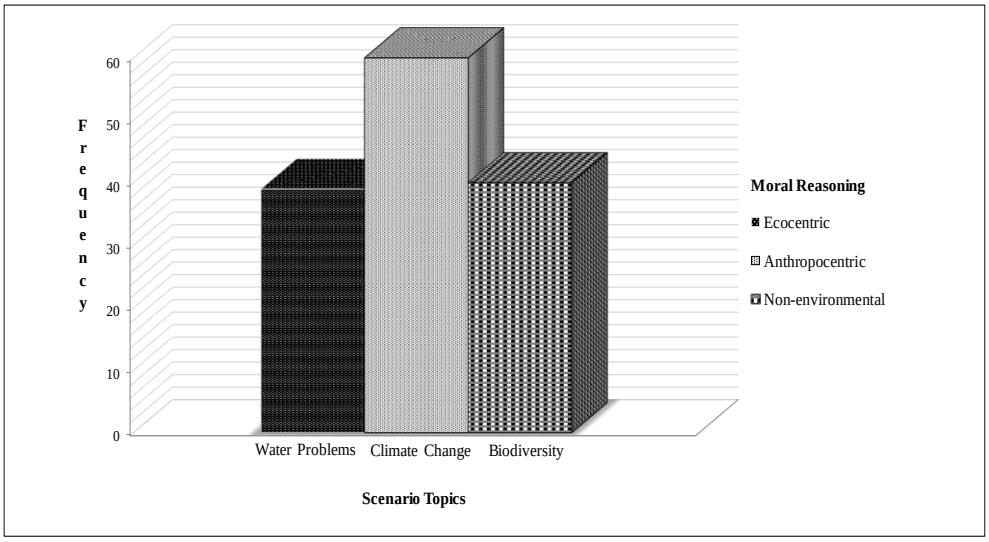


Figure 2. Distribution of biology teacher candidates' total responses to the scenarios by moral reasoning.

Looking at the total responses of pre-service biology teachers to the three scenarios, it is understood that the moral reasoning with the highest frequency is anthropocentric (f=60), while ecocentric (f=39) and non-ecocentric (f=40) moral reasoning are almost equal (Figure 2).

The second question sought to be answered in the study was "What are the factors affecting pre-service biology teachers' moral reasoning in scenarios about water problems, climate change, and biodiversity?". Accordingly, the factors affecting pre-service biology teachers' moral reasoning and sample student statements are given in Table 1.

Table 1. Factors affecting the moral reasoning of pre-service biology teachers and sample statements.

Factor	Sample Statements
Impact on human life	***A9:*** *People irrigate their gardens from the water channels around the factories, and all that water mixes with groundwater and drinking water. People's health deteriorates (Water problem).* ***A10:*** *People have the right to eat healthy vegetables and fruits; they should be organic rather than pesticides and hormones. Everyone wants them to be organic (Biodiversity).*
Experiences	***A1:*** *We read about the Kyoto Protocol when we were in high school. However, when we read it, many countries had accepted it, how many years ago? It seemed very interesting, I mean, it seemed like a dream that states could accept and implement it (Climate change).* ***A9:*** *In Turkey, fields have been harvested with a combine harvester for about 20-30 years. My grandfather did it last year, he mows his fields with a scythe, and he mows wheat and barley (Biodiversity).*
Duties, Responsibilities, and Principles	***A4:*** *The authorities of the state should orient their policies towards farmers. We need to make farmers happy, and we need to make livestock breeders happy. The farmer should be able to tackle how can I get better quality products rather than how can I double the yield of the product (Water problem).* ***A14:*** *The stronger the control and education mechanism, the less need for fines and even the less punishment (Water problem).*

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Table 1. (continued).

Factor	Sample Statements
Environmental Knowledge and Awareness	***A9:*** *Factory waste affects a lot of fish species, it affects a lot of living things rather than plant species. This already affects the ecosystem very much. It causes the death of many creatures and the mutation of many creatures. Because the wastes given are very harmful, some of them accumulate heavy metals. It causes many of them to die, and in such a situation, biodiversity is endangered (Water problems).* ***A1:*** *For example, penguins are becoming extinct because the glaciers are melting. Water levels are rising in certain places. It is very interesting, for example, there is no industrial development there right now. You know, if the gases we extract go there, they affect the living things, water, and ecosystems in another part of the world at another pole (Climate change).*
Emotional Approach	***A10:*** *If it was my brother working there. I thought about the possibility of him being unemployed and his children being affected by this (Water problems).* ***A4:*** *You know, I made it up in my head that their feelings might be in this direction... I mean, I internalized it. Maybe I gave them four units out of pity. That's how my feelings affected me (Climate change).*
Universal Values	***A4:*** *People have no religion or race for me. Again, if I thought that I turned off their names, their Islam would not affect me (Climate change).* ***A9:*** *No one has the right to take away the right to life of those living things. We all have the right to live in this world; it doesn't matter whether they are humans or animals. Every living thing has the right to live. No one has the right to take this away from (Biodiversity).*
Media/Popular Culture	***A4:*** *I watch a lot of movies, usually thrillers and they all seem to come out of nature. There was a movie called 'The Day After Tomorrow', for example, it affected me a lot (climate change).* ***A14:*** *There is a creature called the Anatolian dragon, an endangered species. There is only one documentary about it. Turkey is very poor in this respect (Biodiversity).*
National Values	***A9:*** *I gave a little more to my country out of a sense of nationalism. If Turkey did not exist, then I would make a distribution based on balance and equality since the nationalism factor would disappear (Climate change).* ***A10:*** *There may also be imports, and maybe I think this way because I hope that Turkey's name will come to the agenda on this issue and that we will be the ones to do this business. Our climate, rain, water, everything is already suitable for this. I think why not use this treasure we have (Biodiversity)?*
Political, Social, and Economic Balances in the World	***A9:*** *There will be social problems and unrest due to people being unemployed (Water problems).* ***A10:*** *Every country is already experiencing this problem. I think we can find a solution to this as a world. But I have very clean water, my economy is not strong, and I don't have a very certain place in the world (Water problems).*
Religious Beliefs	***A14:*** *Even our Prophet has a hadith on this issue. He says even if you are by a stream, even if you are in a place where water is very abundant, we should use the water in the direction of the stream flow, that is, we should use the water in the opposite direction and not pollute it too much (Water problem).* ***A9:*** *Actually, the fact that they were Muslim was very valuable to me. It affected my distribution, in fact, I could have given more units if they had not misused religion (Climate change).*
Ambivalence and Contradiction	***A1:*** *Actually, maybe I was being too selfish here. I am not a selfish person, but I guess I was, I don't know (Water problem).* ***A4:*** *I was very indecisive when I gave those four points, I didn't know whether I did something good or bad (Climate change).*

As can be seen from the sample statements of pre-service biology teachers in Table 1, they mentioned the effects of environmental issues on human life, especially on health, economy, and quality of life. These results are in line with the fact that pre-service biology teachers mostly use statements that are in line with anthropocentric moral reasoning. The experience was one of the factors determining pre-service teachers' moral reasoning in the face of environmental issues. When the statements of pre-service biology teachers in Table 1 are analyzed, it is understood how they are influenced by their own experiences or the experiences of people around them in shaping their moral reasoning. Similarly, from the statements of the pre-service teachers, it is revealed that the most emphasized responsibilities of the state, lack of supervision, and the importance given to educating people, especially since punishments are not a solution. Environmental knowledge and awareness was a factor that covered all kinds of environmental problems, endangered or endangered species, relationships between living things, biodiversity, and environmental protection, in addition to the basic knowledge that prospective biology teachers should know about the environment. The pre-service teachers also utilized emotional expressions when approaching the environmental issues they encountered. Therefore, the emotional approach is a factor that meets all kinds of emotional expressions of pre-service teachers, such as empathy, respect, anger, compassion, and conscience. Universal values are another factor affecting pre-service biology teachers' moral reasoning about environmental issues.

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When some statements of the pre-service teachers given as samples are examined, it is understood that they do not see themselves as the owners of the world, but as guests and they do not classify people according to their religion, language, and race. In the media factor, there are movies, TV series, documentaries, commercials, photographs, magazines, newspapers, posters, etc. that pre-service teachers watch. Pre-service teachers can be influenced by all kinds of information, situations, or events that they see, hear, or read through popular culture. While forming their moral reasoning on environmental issues, pre-service biology teachers were influenced by the values and interests of the country they live in. In addition, while shaping their moral reasoning on environmental issues, pre-service biology teachers took into account the problems that would occur in their countries as well as their impact on the world balance. Pre-service biology teachers expressed their views about their religious beliefs, but in small numbers. In other words, religious beliefs were a factor affecting pre-service biology teachers' moral reasoning. While forming their moral reasoning about environmental issues, pre-service teachers sometimes could not give an obvious reason or explanation. Ambivalence and contradiction were identified as the last factor shaping pre-service teachers' moral reasoning.

When the factors are evaluated in general, it is noteworthy that there are both mutually supportive and contradictory factors This point indicates the depth of the data collected from pre-service biology teachers, considering that three separate interviews were conducted with the pre-service teachers, and a systematic data collection process was taken into account. Approaching the same questions on different topics to reveal the factors affecting students' moral reasoning again supports this factor diversity.

4. Discussion and Conclusion

According to the responses of pre-service biology teachers to the scenarios on water problems, climate change, and biodiversity, it was concluded that the statements belonging to anthropocentric moral reasoning were the highest. However, ecocentric and non-ecocentric moral reasoning are quite close to each other, but the slight difference is in favor of ecocentric moral reasoning.

Another result of this study is that anthropocentric moral reasoning is high in pre-service biology teachers. The factor of impact on human life, identified as one factor affecting the moral reasoning of the candidates, also supports this result.

People's priorities change depending on their conflicting values, thus shaping their moral reasoning (Lee et al., 2012). In this study, prospective biology teachers may have shaped the priority according to their own interests. According to Erten (2008), this may be because the cultural structure of Turkish society is grounded in the belief that human beings are created superior to other living things. In the same study, Erten (2008) aimed to determine the status of environment-centered, human-centered, and repulsion attitudes toward the protection of the environment in different cultures, including Turkish and German teachers. As a result of the study, the author found that the average Turkish teachers' anthropocentric attitudes were higher than the average German teachers' attitudes on the same subject.

Kortenkamp and Moore (2001) investigated the moral reasoning of university students in their study using ecological moral dilemmas. According to the results of the study, it was found that students' nonenvironmental moral reasoning was high. In addition, it was found that nature- and anthropocentric moral reasoning were almost close to each other, but there was an excess in favor of anthropocentric moral reasoning. The high level of non-environmental moral reasoning in the study may be due to the differences between cultures in people's approaches to issues. Tuncay (2010) aimed to determine the moral reasoning patterns of university students towards global and local environmental problems. As a result of the study, the researcher found that students had the most nature-centered moral reasoning and the least nonenvironmental moral reasoning. In parallel to this, Karakaya and Çobanoğlu (2012) conducted a study with senior students studying at the faculty of education and found that students had a nature-centered approach in their perspectives on the environment. Lee et al. (2013) examined the discussion and interview statements of students with high ecological worldview values and found that students exhibited an anthropocentric approach because according to the ecological worldview, students who accepted the close mutual relationship between nature and human beings were worried that the negative consequences would affect them. The research results of Bjerke and Kalterborn (1999) and Lee et al. (2012) reinforce the results of this study.

As a result of the semi-structured interviews conducted to determine the factors affecting the moral reasoning of pre-service biology teachers, 11 factors were identified. These factors are impact on human life; experiences; duties, responsibilities, and principles; environmental knowledge and awareness; emotional approach; universal values; media/popular culture; national values; political, social, and economic balances in the world; religious beliefs; ambivalence and contradiction.

It is understood that many of these factors are in parallel with the results of similar studies conducted previously. Accordingly, Sadler and Zeidler (2004) conducted interviews to determine the feelings, thoughts, and reactions of university students through scenarios about gene therapy and cloning. They concluded that factors such as personal experiences, family prejudices, knowledge, and popular culture were effective in students' moral evaluations. Sadler (2004b) conducted interviews with thirty students on two genetic engineering topics to determine university students' moral

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perspectives on socioscientific issues. According to the student responses obtained as a result of the interviews, categories such as empathy for others, concern for others, moral intuitionism, and protection of the natural order were identified. Sadler and Zeidler (2005b) conducted two-stage semi-structured interviews to determine university students' informal reasoning and the role of moral reasoning in influencing it. Six scenarios on genetic engineering were used and it was found that students used moral perspectives when faced with socioscientific issues. Chang and Lee (2010) found that university students' values, worldviews, emotions, past experiences, and families were effective in their decision-making on socioscientific issues. Similarly, Tuncay (2010) determined the factors affecting the moral reasoning of university students regarding global and local environmental problems as 16 factors, such as the impact on human life, popular culture, knowledge, experiences, locality, and future generations; Tuncay et al. (2012) determined 15 factors affecting the moral reasoning of prospective teachers. Again, Türköz and Öztürk (2020) found that factors such as sociology/culture, environment, economy, economy, science, ethics/morality, and politics influenced pre-service teachers' opinions and decisions, especially on socioscientific issues.

When the factors identified in this study are examined, it is understood that there are common factors (impact on human life factor), as well as new factors (national values factor) or factors that are thought to be similar are combined (universal values factor). In addition, in general, although the factor names differ in some studies, it is seen that there are factors that are the same or similar in terms of content.

The national values factor, which is effective in the views of pre-service biology teachers, especially on the issue of climate change, is parallel to the fact that the candidates approach the issues with a social perspective throughout the study. However, the inclusion of Turkey in the scenario on climate change may have helped the students to reveal their views on national values that affect their decisions. In addition, in the scenario on the water problems, some pre-service teachers emphasized the problems that will be experienced in Turkey due to water shortage or unemployment. Similarly, Duan and Fortner (2005) found in their study that Chinese university students attach more importance to environmental problems that affect them closely. In other words, it is understood that people care about the economic, technological, or political development of their countries, as well as the damage that environmental problems will cause to their countries.

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Conflict of Interest

The authors declare that they have no conflict of interest.

References

Amérigo, M., Aragonés, J. I., De Frutos, B. Sevillano, V., & Cortés, B. (2007). Underlying dimensions of ecocentric and anthropocentric environmental beliefs. *The Spanish Journal of Psychology, 10*(1), 97-103. https://doi.org/10.1017/S1138741600006351

Bamberg, S. (2003). How does environmental concern influence specific environmentally related behaviors? A new answer to an old question. *Journal of Environmental Psychology, 23*(1), 21-32. https://doi.org/10.1016/S0272-4944(02)00078-6

Bell, R. L., & Lederman, N. G. (2003). Understandings of the nature of science and decision making on science and technology based issues. *Science Education, 87*(3), 352-377. https://doi.org/10.1002/sce.10063

Bjerke, T., & Kaltenborn, B. P. (1999). The relationship of ecocentric and anthropocentric motives to attitudes toward large carnivories. *Journal of Environmental Psychology, 19*, 415-421. https://doi.org/10.1006/jevp.1999.0135

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün Ö. E., Karadeniz, Ş., & Demirel, F. (2012). *Bilimsel araştırma yöntemleri*. Pegem Akademi. (In Turkish)

Chang, H., & Lee, H. (2010). College students' decision-making tendencies in the context of socioscientific issues (SSI). *Journal of Korean Association in Science Education, 30*(7), 887-900. https://doi.org/10.14697/jkase.2010.30.7.887

Duan, H., & Fortner, R. W. (2005). Chinese college students' perceptions about global versus local environmental issues. *The Journal of Environmental Education, 36*(4), 23-32. https://doi.org/10.3200/JOEE.36.4.23-58

Hogan, K. (2002). Small groups' ecological reasoning while making an environmental management decision. *Journal of Research in Science Teaching, 39*(4), 341-368. https://doi.org/10.1002/tea.10025

Erten, S. (2008). Insights to ecocentric, anthropocentric and antipathetic attitudes towards environment in diverse cultures. *Eurasian Journal of Educational Research, 33*, 141-156.

Kahn, P. H. (1997). Children's moral and ecological reasoning about the Prince William Sound Oil Spill. *Developmental Psychology, 33*(6), 1091-1096. https://doi.org/10.1037//0012-1649.33.6.1091

Kara, Y. (2012). Pre-service biology teachers' perceptions on the instruction of socioscientific issues in the curriculum. *European Journal of Teacher Education, 35*(1), 111-129. https://doi.org/10.1080/02619768.2011.633999

Karakaya, Ç., & Çobanoğlu, E. O. (2012). İnsanı merkeze alan (antroposentrik) ve almayan (nonantroposentrik) yaklaşımlara göre eğitim fakültesi son sınıf öğrencilerinin çevreye yönelik bakış açıları. *Türk Fen Eğitimi Dergisi, 9*(3), 23-35. (In Turkish)

Karpiak, C. P., & Baril, G. L. (2008). Moral reasoning and concern for the environment. *Journal of Environmental Psychology, 28*, 203-208. https://doi.org/10.1016/j.jenvp.2007.12.001

Kortenkamp, K. V., & Moore, C. F. (2001). Ecocentrism and anthropocentrism: Moral reasoning about ecological commons dilemmas. *Journal of Environmental Psychology, 21*, 261-272. https://doi.org/10.1006/jevp.2001.0205

Lee, H., Chang, H., Choi, K., Kim, S., & Zeidler, D. L. (2012). Developing character and values for global citizens: Analysis of pre-service science teachers' moral reasoning on socioscientific issues. *International Journal of Science Education, 34*(6), 925-953. https://doi.org/10.1080/09500693.2011.625505

Lee, H., Yoo, J., Choi, K., Kim, S. W., Krajcik, J., Herman, B. C., & Zeidler, D. L. (2013). Socioscientific issues as a vehicle for promoting character and values for global citizens. *International Journal of Science Education, 35*(12), 2079-2113. https://doi.org/10.1080/09500693.2012.749546

MacKinnon, B., & Fiala, A. (2014). *Ethics: Theory and Contemporary Issues*. Nelson Education.

Merriam, S. B. (2002). *Case study in education: A qualitative approach*. Jossey-Bass.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis*. Sage Publications.

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

Sadler, T. D. (2004a). Informal reasoning regarding socioscientific issues: 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. (2004b). Moral sensitivity and its contribution to the solution of socio-scientific issues. *Journal of Moral Education, 33*(3), 339-358. https://doi.org/10.1080/0305724042000733091

Sadler, T. D., & Zeidler, D. L. (2005a). 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., & Zeidler, D. L. (2005b). Patterns of informal reasoning in the context of socioscientific decision making. *Journal of Research in Science Teaching, 42*(1), 112-138. https://doi.org/10.1002/tea.20042

Sadler, T. D., & Donnelly, L. A. (2006). Socioscientific argumentation: The effects of content knowledge and morality. *International Journal of Science Education, 28*(12), 1463-1488. https://doi.org/10.1080/09500690600708717

Stern, P. C., Dietz, T., & Kalof, L. (1993). Value orientations, gender, and environmental concern. *Environment and Behavior, 25*(5), 322-348. https://doi.org/10.1177/0013916593255002

Stern, P. C., & Dietz, T. (1994). The value basis of environmental concern. *Journal of Social Issues, 50*(3), 65-84. https://doi.org/10.1111/j.1540-4560.1994.tb02420.x

Surmeli, H., & Saka, M. (2013). Preservice teachers' anthropocentric, biocentric, and ecocentric environmental ethics approaches. *International Journal of Academic Research, 5*(5), 159-163. https://doi.org/10.7813/2075-4124.2013/5-5/B.23

Şahin, B., Kazoğlu, İ. H., & Gerdan, E. (2017). *Çevreye yönelik ekosentrik, antroposentrik ve antipatik tutumlar: Turizm öğrencileri üzerine bir araştırma*. International West Asia Congress of Tourism Research (IWACT). Van. (In Turkish)

Thompson, S. C. G., & Barton, M. (1994). Ecocentric and anthropocentric attitudes toward the environment. *Journal of Environmental Psychology, 14*(2), 149-157. https://doi.org/10.1016/S0272-4944(05)80168-9

Tuncay, B. (2010). *Moral reasoning of pre-service science teachers toward local and non-local environmental problems* (Master'a Thesis, Middle East Technical University).

Tuncay, B., Yılmaz-Tüzün, Ö., & Tuncer-Teksoz, G. (2012). Moral reasoning patterns and influential factors in the context of environmental problems. *Environmental Education Research, 18*(4), 485-505. https://doi.org/10.1080/13504622.2011.630576

Türköz, G., & Öztürk, N. (2020). Fen bilgisi öğretmen adaylarının bazı sosyo-bilimsel konularla ilgili kararlarının çok boyutlu bakış açısı ile incelenmesi. *Cumhuriyet International Journal of Education, 9*(1), 175-197. https://doi.org/10.30703/cije.550533 (In Turkish)

Yıldırım, A., & Şimşek, H. (2011). *Sosyal bilimlerde nitel araştırma yöntemleri*. Seçkin Yayıncılık. (In Turkish)

Yin, R. K. (2009). *Case study research: design and methods*. Sage Publications.

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

Science Education, 86(3), 343-367. https://doi.org/10.1002/sce.10025

Zeidler, D. L., Sadler, T. D., Simmons, M. L., & Howes, E. V. (2005). Beyond STS: A research-based framework for socio-scientific issues education. *Science Education, 89*(3), 357-377. https://doi.org/10.1002/sce.20048

Zeidler, D. L., & Nichols, B. H. (2009). Socioscientific issues: Theory and practice. *Journal of Elementary Science Education, 21*(2), 49-58. https://doi.org/10.1007/BF03173684

Zeidler, D. L., & Sadler, T. D., Applebaum, S., & Callahan, B. E. (2009). Advancing reflective judgment through socioscientific issues. *Journal of Research in Science Teaching, 46*(1), 74-101. https://doi.org/10.1002/tea.20281

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

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