

Analysis of Pre-Service Science Teachers' Biodiversity Images according to Sustainable Environmental Awareness

Nurcan Tekin^{1*}, Oktay Aslan²

¹Aksaray University, Education Faculty, Turkey;

²Necmettin Erbakan University, Ahmet Keleşoğlu Education Faculty, Turkey.

*Correspondence: tekinnurcann@gmail.com; Tel.: +90-382-288-3357 (N.T.)

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Abstract: Biodiversity is discussed in the context of socio-scientific issues, which play an important role in providing science-society interaction in science education. Biodiversity can help the sustainable environmental movement by contributing to the scientific, political and economic development and progress of societies in various social aspects, with its dilemma features by its nature. This study, it is aimed to analysis of pre-service science teachers' biodiversity images according to sustainable environmental awareness levels. The study was designed according to the survey model, which is one of the descriptive research methods. Sixty-three pre-service science teachers participated from two state universities in the Central Anatolia Region. Data were collected through Sustainable Environmental Awareness Scale and drawings on biodiversity. Sustainable Environmental Awareness Scale consists of 10 items and has a single factor. Biodiversity pictures created based on the drawing technique reflect the images of pre-service teachers. The data were analysed based on descriptive statistical methods. As a result, it was concluded that pre-service science teachers have a high level of sustainable environmental awareness. Biodiversity images of pre-service teachers are correct, but they cannot form a comprehensive image in creating biodiversity components and relationships. According to the results obtained, the fact that pre-service teachers exclude these components in their drawings can be associated not only with their lack of knowledge, but also with their drawing skills.

1. Introduction

There is an increasing interest in socio-scientific issues having an important place in ensuring science-society interaction and in educational fields for sustainability. Socio-scientific issues such as global climate change, nuclear power plants, cloning and vaccines are among the scientifically based issues that societies cannot reach consensus on and that concern societies locally or globally (Alcaraz-Dominguez & Barajas, 2021). Biodiversity is also one of these issues (Tal & Abramovitch, 2013; Wang et al., 2018).

The survival of individuals not only depends on their meeting their basic needs such as feeding and shelter but also is closely associated with the ecosystem, habitat and environmental conditions of the region they live in (Türkoğlu & Verdiyeva, 2019). Biodiversity is a broad term that encompasses all living things, from single-celled plants to animals and humans (Polat, 2017). In other words, biodiversity refers to the diversity of terrestrial and aquatic ecosystem communities and the diversity within and between species and their ecosystems (Güler & Mutlu, 2018). As it is a bridge between continents, Turkey has a wide biodiversity with its forest, steppe, mountain, wetland, coastal and marine ecosystems due to its climate change within short distances (Muminjanov & Karagöz, 2018). The increase in population, the growth trends of cities, soil/water

pollution and the acceleration of consumption because of the rapid progress of technology have recently started to seriously threaten biodiversity. Because of a steady decline in species, countries are reconsidering the importance they attach to science, politics and their economic futures (Erten, 2015). Furthermore, using technology to evaluate the positive contributions of biodiversity makes significant contributions to the preservation and sustainability of the diversity of living species with the acceleration of biotechnological developments (Güler & Mutlu, 2018). As it can be seen, biodiversity can help the sustainable environmental movement by contributing to the scientific, political and economic development and progress of societies because it has positive and negative features by its nature. Sustainability embraces the principle of protecting the underground and surface resources needed by future generations by using them efficiently. Sustainable energy, sustainability of water, biodiversity and education for sustainability are also included in this principle (Erten, 2015).

Sustainable development can be achieved on a large scale, through meaningful environmental education and environmentally conscious behaviors of individuals (Gough, 2013). Environmental awareness is not only about protecting the environment and preventing environmental pollution (Erkal et al., 2011). It also requires having social, historical and cultural consciousness. Here, the concept of sustainability is important. Sustainable development has three pillars: meeting human needs, social equality and respecting environmental boundaries (Holden et al., 2017). According to Gedik (2020), ecological and social equality is more important than these three basic components that make up sustainable living because the economy and social development are responsible for the protection and development of the natural environment and social equality. Within the framework of these basic components, sustainability aims at a development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Pitelis, 2013). Sustainable environmental awareness, on the other hand, can be defined as knowing the responsibility for future generations in the relations with the environment, feeling sensitivity and acting with this sensitivity toward the environment (Derman, 2013). It can be argued that individuals with this awareness will be sensitive toward environmental issues (Andries et al., 2012; Turan, 2019). Teachers have a great responsibility for raising awareness of environmental problems that we encounter every day and threaten our quality of life, and for producing solutions to these problems (Nagra, 2010).

Biodiversity, which can be considered as an important component of sustainability and education for sustainability, should be a part of environmental education (Dreyfus et al., 1999). Biodiversity, like many other science concepts, is a difficult subject to learn, as it remains abstract due to inadequate examples given in science education (Kara et al., 2017). However, although teachers argue that they should teach socio-scientific issues in their classrooms, they have limited knowledge and tend to focus on media-directed issues (Macalalag, 2020). Creating awareness of biodiversity in pre-service teachers is important both for raising their awareness of various species in our country and for the survival of these species for future generations. The environmental awareness of students who are aware of the existence of different living things will increase. Sustainable environmental awareness, which can be addressed within the context of citizenship skills, should be given great importance in this respect. Teachers who want to train individuals with this awareness should have competence in these subjects.

The current study includes drawings that teachers use while explaining a subject in science education and that can be used to reflect pre-service teachers' images of biodiversity. Through drawing activities, the use of visual methods besides verbal methods will be possible, which allows exploring multiple perspectives as they will reveal different aspects of experiences (Guillemín, 2004). In this regard, Ainsworth et al. (2011) considered drawings rationally important. According to Ainsworth et al. (2011) drawings can be used to increase participation, to learn to represent in science, to foster reasoning, to promote communication and as a learning strategy. When these

characteristics of drawings are considered, the socio-scientific aspect of biodiversity comes to the fore because biodiversity is a socio-scientific issue that is scientifically based, requires reasoning and has an instructional aspect. In this respect, the subject addressed in the current study complies with the context. When the relevant literature is reviewed, it is seen that there are studies investigating pre-service teachers' biodiversity literacy (Çavuş Güngören & Özdemir, 2020), instructional methods that can be used in the teaching of biodiversity (Yli-Panula et al., 2018), biodiversity for citizenship education (Kelemen-Finan et al., 2018; Echeverria et al., 2021) and pre-service teachers' knowledge about, attitudes toward and awareness of biodiversity (Venuste et al., 2017). There are also many studies conducted on sustainable environmental awareness like the ones investigating sustainable environment in out-of-school learning environments (Karslı, 2019), environmental ethics for sustainable environmental awareness (Heruyono et al., 2021) and the relationships between sustainable environment education and environmental problems (Yıldız et al., 2021). As can be seen, although biodiversity is an important component for sustainability, the studies conducted mostly focus on the educational aspects of these two fields separately. The current study is different in that it brings together these two fields with visual and verbal methods, revealing different perspectives and analysing pre-service teachers' images of biodiversity according to their sustainable environmental awareness.

The purpose of the current study is to analyse the pre-service science teachers' images of biodiversity according to their level of sustainable environmental awareness. To this end, answers to the following research questions were sought:

What is the pre-service science teachers' level of sustainable environmental awareness?

What are the pre-service science teachers' images of biodiversity?

How do the pre-service science teachers' images of biodiversity change according to their environmental awareness level?

2. Methods

2.1. Research Design

As it was determined the pre-service science teachers' level of sustainable environmental awareness and images of biodiversity in the current study, the general survey model, one of the descriptive research methods, was used. In the general survey model, it is reached a general judgment about a universe with many elements (Karasar, 2014).

2.2. Participants

The study group of the current research comprises 2nd, 3rd, and 4th-year students attending the Department of Science Teaching in Education Faculties of two state universities located in the Central Anatolian Region of Turkey. Since it was possible to reach all of the pre-service teachers who were planned to be included in the study, no sampling method was used. The participants were included on a volunteer basis. The demographic information of the participants is given in Table 1.

As can be seen in Table 1, 55 females (87.30%) and eight males (12.70%) pre-service science teachers participated in the study. Of the participating pre-service teachers, 32 (50.79%) are 4th-year students, 26 (41.27%) are 3rd-year students and five (7.94%) are 2nd-year students.

Table 1. Demographic information of the participants

Characteristics	f	%
Gender		
Female	55	87.30

Characteristics	f	%
Male	8	12.70
Grade		
4th year	32	50.79
3rd year	26	41.27

2.3. Data Collection Tools

The data were collected using two different data collection tools. To measure the pre-service science teachers' level of sustainable environmental awareness, the "Sustainable Environmental Awareness Scale" developed by Derman (2013) was used and their drawings were used to determine their images of biodiversity.

The Sustainable Environmental Awareness Scale is a scale including sample cases to be used to elicit information about what the participants would do in specific conditions regarding the environment. In the scale consisted of 10 items, for each sample case, there are three statements to be responded to one of the following options; "expected (3 points)", "partially expected (2 points)" and "unexpected (1 point)." The highest score to be taken from the scale is 30 points, while the lowest score is 10 points. The Cronbach alpha reliability coefficient of the scale having a single factor is 0.87.

The pre-service science teachers were asked to draw pictures to determine their images of biodiversity. To collect data by using the drawing technique, the pre-service teachers were asked "What does the term biodiversity remind you of?" and then they were asked to answer this question by using drawing. The drawing-writing technique is used to reveal the thoughts, feelings and visual images in the mind (Kurt et al., 2014). Guillemin (2004) states that when the drawing technique is used methodically, it also contains meanings as well as visual products. Drawings are about how the artist sees the world in both its simplicity and complexity. In other words, drawings include various experiences of individuals such as social experiences, technological interactions or power relations. Therefore, individuals reflect the information they bring from their socio-ethical world while creating their drawings. In this sense, the drawing technique can be described as the way through which individuals make sense of the world (Guillemin, 2004). Katz (2017) classified drawings as single drawings (e.g. a drawing about anatomy), multiple drawings to explore change (e.g., addressing subjects of energy and chemistry together), drawings illustrating perceived culture of science (e.g. Draw a Scientist Test [DAST]), and drawings for/about a science teacher's identity development. In this study, this technique was used as the data collection tool in the reflection of visual images formed in the minds of the pre-service science teachers about biodiversity. Furthermore, the drawings discussed in the study are handled within the framework of multiple drawings in terms of addressing many aspects of biodiversity and showing the changes that may occur. A few of the pre-service teachers' drawings on biodiversity are given below as examples (Figure 1).

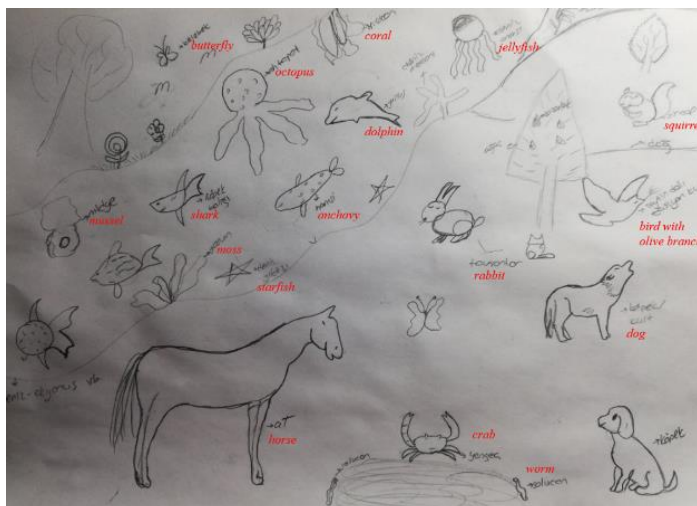
In figure 1, examples of pre-service science teachers' drawings are given. For example, while the first drawing was supported by more descriptive expressions, the third drawing only introduced the subject and the second drawing did not include any writing technique.



(a)



(b)



(c)

Figure 1. Drawing examples created according to the drawing-writing technique (a) descriptive expressions supported drawing; (b) drawing without text; (c) drawing introducing the subject

2.4. Research Process

The current study includes the results of a scientific research project. At the beginning of the project, it was planned to conduct the data collection process face-to-face using paper and pencil. However, with the start of the COVID-19 pandemic, face-to-face education was interrupted and educational activities were started to be conducted at distance; thus, the current study was moved to the online environment. In this connection, data were collected using the Sustainable Environmental Awareness Scale transferred to Google Forms and the drawings were also requested to be uploaded to this platform. Accordingly, the pre-service teachers were told to draw a picture without having access to any information. The pre-service teachers were asked to draw their pictures on the basis of the question "What does the term biodiversity remind you of?"

2.5. Analysis

The data obtained from the Sustainable Environmental Awareness Scale were analysed by using descriptive statistics and descriptive statistics were presented by being classified into high, medium and low levels. Researchers developed a "Biodiversity Image Evaluation Inventory (BIEI)" (Table 2) to analyse the images of pre-service teachers. The BIEI was developed to evaluate the pre-service science teachers' drawings on biodiversity. In the preparation of the BIEI, which was developed by paying attention to the rubric development features recommended by Kan (2007), criteria, levels and definitions of these levels were determined. The BIEI was prepared as an analytical rubric to be used in the higher education level and to make a more detailed evaluation. The levels and categories in the BIEI and definitions of the levels were created by considering the drawing analysis criteria in the studies of Köse (2008) and Reiss and Tunnicliffe (2001) (Table 2).

Table 2. Biodiversity Image Evaluation Inventory

Levels	Categories	Descriptions
Level 1	No drawing	No drawing
Level 2	Nonrepresentational drawings	Drawings do not include elements related to biodiversity.
Level 3	Drawings with misconceptions	Drawings include misconceptions.
Level 4	Partial drawings	All drawings are conceptually correct but drawings partially represent biodiversity components.
Level 5	Comprehensive representation drawings	All drawings are conceptually correct and fully represent biodiversity components.

The level contents in the BIEI were determined based on the definition of biodiversity in the United Nations (UN) Convention on Biological Diversity. According to this definition, biodiversity is the diversity of living organisms found in all sources, including terrestrial, marine and other aquatic ecosystems and the ecological components of which they are a part and the diversity within species and between species (United Nations, 1992). According to this definition, the contents of the levels in the BIEI are as follows:

Level 1 (No drawing): Students replied, "I don't know," or no response was given to the statement.

Level 2 (Nonrepresentational drawings): Drawings do not include elements related to biodiversity or includes diagrams or schematics about biodiversity concept.

Level 3 (Drawings with misconceptions): These types of drawings represent some degree of understanding of biodiversity concept but also demonstrated some misconception.

Level 4 (Partial drawings): The drawings in this category are demonstrating partial understanding of the biodiversity concept. All drawings are conceptually correct but drawings partially represent biodiversity components (e.g. species, intra-species, inter-species and inter-ecosystem relationships are represented, while habitats are not).

Level 5 (Comprehensive representation drawings): Drawings in this category are the most competent and realistic drawings of biodiversity. All drawings are conceptually correct and fully represent biodiversity components (These components include living species in land, sea and all aquatic ecosystems, intra-species, inter-species and inter-ecosystem relationships, and the habitats).

After the BIEI was developed, the opinions of one academician specialized in the field of measurement and evaluation, one academician specialized in the field of science education and one academician specialized in the field of biology were taken. The final version of the inventory was formed as a result of the consensus reached among the experts. To ensure coding reliability in the analysis of the data, separate analyses were conducted by the researchers and it was concluded that an acceptable level of agreement was achieved.

3. Results

In this study, in which pre-service science teachers' images of biodiversity were examined according to their level of sustainable environmental awareness, the findings obtained in line with the research questions are given below.

3.1. Sustainable Environmental Awareness of Pre-Service Science Teachers

In this section, the findings obtained from the descriptive analysis of the data collected through the Sustainable Environmental Awareness Scale are presented. As different cases are given in each item of the scale, the data were analyzed for each individual item and for the whole scale. The pre-service science teachers' responses to the scale items regarding their sustainable environmental awareness are presented in the forms of frequencies and percentages in Table 3. For each item, responses given by pre-service science teachers were scored and the number of pre-service teachers responding to each item is shown.

Table 3. Pre-service Science Teachers' Sustainable Environmental Awareness Levels Frequency Analysis

Items	Unexpected		Partially Expected		Expected	
	f	%	f	%	f	%
1	-	-	26	41.3	37	58.7
2	1	1.6	15	23.8	47	74.6
3	3	4.8	25	39.7	35	55.6
4	-	-	36	57.1	27	42.9
5	2	3.2	18	28.6	43	68.3
6	-	-	19	30.2	44	69.8
7	-	-	32	50.8	31	49.2
8	1	1.6	26	41.3	36	57.1
9	-	-	36	57.1	27	42.9
10	-	-	30	47.6	33	52.4

As can be seen in Table 3, pre-service science teachers gave responses to most items in the Sustainable Environmental Awareness Scale (except for the items 4, 7 and 9) at the expected level. Additionally, unexpected responses were not given to some items (items 1, 4, 6, 7, 9, and 10). Information about the descriptive statistics findings related to the pre-service science teachers’ level of sustainable environmental awareness is given in Table 4.

Table 4. Pre-service Science Teachers’ Sustainable Environmental Awareness Levels Descriptive Statistics Results

Sustainable Environmental Awareness	N	Min	Max	\bar{X}	SD
	63	20	30	25.69	2.33

As can be seen in Table 4, the lowest score taken from the scale by the 63 pre-service science teachers participating in the study is 20, while the highest score is 30. Moreover, the mean score of the participants is 25.69. From the table, the participants’ level of sustainable environmental awareness is high in general.

3.2. Biodiversity Images of Pre-Service Science Teachers

In this section, the findings obtained through descriptive analysis of the data collected using the biodiversity image evaluation inventory are given. Frequencies and percentages calculated for pre-service science teachers’ images of biodiversity are given in Table 5.

Table 5. Pre-service Science Teachers’ Biodiversity Images

Levels	Categories	f	%
Level 1	No drawing	1	1.59
Level 2	Nonrepresentational drawings	5	7.94
Level 3	Drawings with misconceptions	4	6.35
Level 4	Partial drawings	47	74.60
Level 5	Comprehensive representation drawings	6	9.52

As can be seen in Table 5, the great majority of the drawings produced by the participating pre-service science teachers on biodiversity (74.60%) can be classified as partial drawings. As can be seen from the sample drawings of the pre-service teachers classified at this level, the drawings are conceptually correct yet they partially represent the components of biodiversity. Six of the participating pre-service science teachers came to the fore with their comprehensive drawings (9.52%). While four of pre-service teachers (6.35%) produced drawings including misconceptions, five of them (7.94%) produced drawings not representing biodiversity. One of the pre-service teachers (2.59%) was found to have not produced any drawing. For the identified levels, sample drawings are given below.

A sample drawing is given for Level 2 (Nonrepresenting biodiversity) in Figure 2. In this drawing, the pre-service science teacher represented the concept of biodiversity with schemes and diagrams. Therefore, since it does not include any themes related to biodiversity, it has been evaluated in this category.



Figure 2. Level 2- Nonrepresentational drawings

A sample drawing is given for Level 3 (Including misconceptions) in Figure 3. In this drawing, the pre-service science teacher included endemic species rather than biodiversity. This drawing shows that the pre-service science teacher mistook endemic species for biodiversity. Therefore, it is considered as a misconception.



Figure 3. Level 3-Drawings with misconceptions

A sample drawing is given for Level 4 (Partial drawings) in Figure 4. While this drawing shows the species and relationships between the species, it does not include the habitat.



Figure 4. Level 4 - Partial drawings

A sample drawing is given for Level 5 (Comprehensive drawings) in Figure 5. The pre-service science teacher illustrated all the elements related to biodiversity in his/her drawing. For example, terrestrial life, aquatic life and various creatures living in these habitats are shown in this drawing. In this respect, this drawing has been evaluated as comprehensive drawings.



Figure 5. Level 5-Comprehensive representation drawings

3.3. Pre-Service Science Teachers' Biodiversity Images According to Sustainable Environmental Awareness

In this section, the pre-service science teachers' sustainable environmental awareness levels are classified to analyse their biodiversity images according to their sustainable environmental awareness level. Accordingly, the pre-service teachers with a total score of 10–16 are considered to have a low level of sustainable environmental awareness, the pre-service teachers have a total score of 17–23 is considered to have a medium level of sustainable environmental awareness and the pre-service teachers having a total score of 24-30 are considered to have a high level of sustainable environmental awareness. The images of biodiversity were compared according to these total scores (Table 6).

Table 6. Pre-service Science Teachers' Biodiversity Images according to Sustainable Environmental Awareness Levels

Biodiversity Images	Sustainable Environmental Awareness			
	L	M	H	T
No drawing	0	0	1	1
Nonrepresentational rawings	0	1	4	5
Drawings with misconceptions	0	1	3	4
Partial drawings	0	8	39	47
Comprehensive representation drawings	0	0	6	6
Total	0	10	53	63

L: Low, M: Medium, H: High, T: Total

As can be seen in Table 6, the biodiversity images of the great majority of the pre-service science teachers having medium and high levels of sustainable environmental awareness are partial drawings. However, while the pre-service science teachers having a medium level of sustainable environmental awareness were observed to have not been able to produce comprehensive drawings, the pre-service science teachers having a high level of sustainable environmental awareness were observed to have reflected their images of biodiversity with their comprehensive drawings. Generally, it is seen that the biodiversity images of pre-service science teachers having a high level of sustainable environmental awareness are more comprehensive.

4. Discussion

In this study, in which the biodiversity images of pre-service science teachers were analysed according to their level of sustainable environmental awareness, the following results were obtained.

It was found that most pre-service science teachers participating in the study responded to the items in the Sustainable Environmental Awareness Scale at the expected level. Furthermore, the pre-service science teachers' sustainable environmental awareness mean scores were found to be high. Thus, it can be said that the pre-service science teachers have a high level of sustainable environmental awareness. Akçay and Pekel (2017) compared the environmental awareness and sensitivity of pre-service teachers from different departments and concluded that pre-service biology teachers have a high level of environmental sensitivity. According to Akçay and Pekel (2017), high environmental awareness and sensitivity of the pre-service biology teachers was an expected result since many interdisciplinary connections had been established in relation to the environment throughout their education processes.

Amran et al. (2019), concluded that more than half of the high school students studying science has medium and high levels of environmental awareness. According to Amran et al. (2019), this situation can be associated not only with the environmental courses that they have taken but also with the cultural background they have established in their lives. In this study, the fact that pre-service science teachers received training on the fields in which they could establish connections with the environment and were in an environmentally conscious cultural environment may have contributed to their high level of sustainable environmental awareness. For this reason, the drawings of the pre-service teachers about the biological creatures of various species that they encounter in their environment are important in the current study. The following results are considered in this respect.

The pre-service teachers' images of biodiversity are conceptually correct, but since they do not contain all of the biodiversity components, it is possible to consider them as partial drawings. The most remarkable finding of the study is that the biodiversity components and the relationships between these components in the pre-service teachers' images of biodiversity are not reflected in their drawings. When the drawings are examined in general, it can be said that the elements that provide the connections of biodiversity are not fully illustrated. Moseley et al. (2010) stated that although their students made informative drawings about marine life, they were insufficient in reflecting many interconnected components such as the ocean, people, the physical structure of the sea and its environment. Liu et al. (2020) similarly used drawings to explore high school students' mental models of the marine ecosystem. They concluded that the students have a high level of awareness about the problems at sea. However, the students stated that these problems are caused only by the pollution created by the garbage. Therefore, it is very difficult to establish high-level connections and reflect the image of biodiversity in a drawing, as is the case in similar studies. The reason for this result may be the insufficient cognitive knowledge of the pre-service teachers about the components of biodiversity, or the difficulty in illustrating such abstract connections in a drawing. In addition, it is noteworthy that the "diversity" feature of biodiversity is emphasized in the drawings of the pre-service teachers and that the drawings host various plant/animal species. This showed the researchers that diversity is not only the coexistence of various species, but also the importance of the relationship of these species with each other. Therefore, researchers suggest educators to give importance to the characteristics of biodiversity related to intraspecies and interspecies relations and habitats.

When pre-service science teachers' images of biodiversity are examined according to their level of sustainable environmental awareness, it is seen that the drawings of most pre-service teachers with high and moderate levels of sustainable environmental awareness partially reflect biodiversity. This shows that the pre-service teachers' images of biodiversity are conceptually correct, but they could not form a comprehensive image in terms of the creation of the components and relationships of biodiversity. However, it is remarkable that illustrations that cannot be classified as drawing was performed by some pre-service teachers with a high level of sustainable environmental awareness. Additionally, another remarkable finding of the current study might be that pre-service teachers having a medium level of sustainable environmental awareness did not produce comprehensive drawings to reflect their image of biodiversity. As a result, it can be argued that the biodiversity images of the pre-service teachers having a high level of sustainable environmental awareness are more comprehensive. Liu et al. (2020) stated that students established a relationship between the marine ecosystem and the problems in marine life. According to them, students who reflected the marine ecosystem more fully and systemically in their drawings perceived the related problems in a wider context. Morón-Monge et al. (2021) examined primary school students' drawings about their perceptions of biodiversity in their immediate environment. As a result, they stated that the students did not have enough information about biodiversity, and they also did not give enough space to the biodiversity elements in their environment in their

drawings. They drew particular attention to the fact that the students did not include geological features that affect biodiversity in their drawings. In this regard, Morón-Monge et al. (2021) suggested that students should be involved in scientific processes such as making observations to reflect the elements of biodiversity in their environment. In this study, the fact that the drawings of the students with a high level of sustainable environmental awareness are more comprehensive indicates that pre-service teachers who can observe their environments can create more comprehensive drawings. Therefore, it is thought that the drawings supported by elements such as knowledge, observation and cultural heritage that contribute to the formation of a high level of sustainable environmental awareness can be more comprehensive.

High environmental awareness alone not be sufficient to exhibit ecological behaviours. Sustainability-related topics concern a range of academic disciplines, from natural sciences to social sciences and humanities. Its interdisciplinary nature is central to sustainability (Yarime et al., 2012). For this reason, it can be recommended to support sustainability with studies that deal with its social, cultural or ethical aspects. This point of view can be considered as a limitation of the research. For this, researchers can support the research with questions that will reveal the social, ethical and cultural backgrounds of pre-service teachers. Establishing connections between the components of biodiversity can also be seen as another important point to be considered. In the objectives related to biodiversity in the science curriculum (Ministry of National Education of Turkey, 2018), plants and animals that are endangered and the factors that threaten biodiversity are emphasized. Therefore, pre-service teachers need additional materials other than the ones focused on these objectives so that they can enable their students to establish these connections. It can be recommended to develop activities directed to this area in future studies. Additionally, the fact that the pre-service teachers did not include these elements in their drawings can be associated not only with their lack of knowledge but also with their drawing skills. For example, in an aquatic ecosystem, it is very difficult to illustrate the intraspecies and interspecies relationships. For this reason, the participants may not have included these components in their drawings. To minimize such constraints, it can be recommended to conduct interviews with participants in future studies. Interviews to be held can also help to reveal the socio-cultural aspects of pre-service teachers. In this way, the sources of deficiencies or errors can be found more easily and solutions can be found.

5. Conclusions

According to the current study, the pre-service science teachers have a high level of sustainable environmental awareness. This result can be explained by the fact that they have received training to establish connections between the elements of the environment and that they have been in environmentally conscious cultural settings. The pre-service teachers' images of biodiversity are conceptually correct, but the components of biodiversity and their relationships within themselves or with each other are not reflected in the drawings. This might be because of the difficulties in transferring higher-order connections into a drawing because the transfer of the relationships between the components of biodiversity can be abstract. However, the biodiversity images of the pre-service teachers with a high level of sustainable environmental awareness are also more comprehensive. Environmental awareness kept high with elements such as knowledge, observation and cultural heritage of individuals observing their environment is also reflected in their drawings.

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