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THE EXAMINATION OF ECOLOGICAL AWARENESS IN TERMS OF RELATIONAL THINKING SKILL IN TEACHER CANDIDATES

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Abstract:
This study examined participants' ecological awareness by predicting their relational thinking skills. The study was conducted on 127 teacher candidates in the Department of Science Teaching on a voluntary basis. It was designed as a case study using phenomenological method. A survey form comprising open-ended questions was used to collect data, and content analysis method was applied to analyse the data based on the process of information coding. The results of the study indicated that the teacher candidates could establish cause and effect relationships with regard to ecological relationships, displayed relational thinking skills and had high ecological awareness.

Keywords: ecological awareness; ecological relations; relational thinking; ecology education; qualitative analysis

1. Introduction

Put forward first by the German scientist Ernst Haeckel in 1869, ecology is the science of activities aimed at ensuring the future of all living beings (Çepel, 2006). Odum and Barret (2008) define ecology as a discipline that studies the integrity of relationships between organisms and environments. In brief, ecology studies ecosystems. An ecosystem is a community of interconnected elements working together for a common purpose with constant inputs and outputs (Yaylı and Yaslıkaya, 2015), and made up of living and non-living components such as plants, animals, microorganisms, soil, stone, air, water and elements. Therefore, we can say that ecology *'explores life with living and non-living organisms and the relationship and interaction between these organisms'*. Ecosystems are living and each component tries to change and transform other components of the system. Ecosystems are self-sufficient, produce their own components and are renewed by their components (Capra, 1997). Thus, each element of this community is in interaction with other elements. In other words, there are complex

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links between ecological components. For example, there is a relationship linking quarks to the jaguar and humans (Gell-Mann, 1994).

Physicist David Bohm asserts that what lies at the bottom of ecological crisis is the assumption that we and our world consist of separate parts and the reflection of this assumption in our living habits. According to Bohm, it is an illusion to see our planet and even universe as a machine made up of independent parts, and this illusion is nothing, but causing endless disorder and conflict (Maxwell, 2003). Albert Einstein states that it is a delusion for human beings to think themselves as separated from universe, this delusion is a kind of prison for us and we must free ourselves by widening our circle of understanding and compassion to embrace all living creatures. Goldstein (1976) maintains that we must discern the unity in parts and perceive the integrity and wholeness of universe. Sterling (2009) makes a very clear diagnosis of the subject saying that *'if we want the chance of a sustainable future, we need to think relationally'*. In a similar vein, Capra (1994) claims that understanding ecosystems depends on understanding relationships. In conclusion, ecological awareness will increase to the extent that relationships between all the components comprising ecosystems are understood.

According to Turkish Language Association, the concept of 'ecological' means *relating to ecology*; and 'awareness' means *the state of knowing things that need to be seen or known, paying attention to things that need to be comprehended.* Based on these definitions, we can define ecological awareness as *the state of being aware of the environment and ecosystems we live in with their living and non-living organisms.* Ecological awareness entails recognizing the cause and effect relationships in ecological events. Human beings must be aware of the environment they live in and of the relationships between living and non-living organisms, with their physical, chemical and biological dimensions. Disturbing the nature of these relationships and interactions has direct implications on human life. Ecological awareness should be raised to see how our vegan, animal or entirely artificial consumptions affect us and the nature of our environment (Cutter-Mackenzie and Smith (2003).

Maxwell (2003 defines ecological awareness as *'becoming beautiful again, healing and balancing our fragmented worldview'.* He maintains that we are in urgent need of such an ecological vision, that it will remedy the illusion of separateness between components comprising ecosystems and help us to discern the unity between diverse forms. Ecological awareness and ecological vision will be wisdom that will naturally embody love and respect in humans for all life forms and heal the feeling of alienation, and make us aware of the deep magnificence of the universe. Capra (1996) calls it 'deep ecological awareness' and his holistic worldview suggests that all phenomena are interconnected and interdependent and we are all embedded in the cyclical processes of nature.

Orr (2005) argues that individuals who have ecological awareness must have the *ability to relate between parts*. People who have ecological awareness know that both biotic and abiotic factors forming ecosystems affect each other, humans affect their environment and the environment affects humans. They become aware of both

ecological health and their own health; grasp the impact of environment on themselves and their own impact on the environment.

Dealing with ecological problems also requires ecological awareness (Schleicher, 1989). Therefore, not only should we teach ecological principles in theory in schools, but also we should ensure that children experience such principles in diverse ecosystems such as school garden, a beach or riverbed (Capra, 2007), and individuals should recognize nature, acquire life skills and attitudes in harmony with nature, and become involved in the solution of environmental problems. Thus, the Intergovernmental Conference on Environmental Education in Tbilisi in 1977 emphasized that successful environmental education *'should make individuals aware of the environment they live in, have more responsibility and be more informed, experienced, skilful and involved'* (as cited in Aydın, Dündar and Korkut, 2016). To that end, school gardens should be considered and designed as an open and dynamic classroom in which students can understand ecological cycles, experience them on site, gain awareness about the food web and have ecological literacy (Capra, 2005).

In their study suggesting that ecology education should start in early childhood period, Phenice and Grifforce (2003) stress the importance of education based on out-of-class and concrete experiences. The researchers claim that a teacher can help children understand ecological relationships when eating an apple in the school garden during lunch or snack time by explaining that *'The apple comes from a tree that took in the sun, soil, rain, and air. Now, we are taking this apple which is a part of nature into our body. After we digest the apple, our bodies use the nutrients. A part of the waste becomes foods of microbes. The apple core we compost also becomes part of soil and contributes to plant growth. When we breathe, we take in oxygen that plants have produced. When we breathe out carbon dioxide, plants use them to grow.'* This good example given by the researchers is important for covering many elements such as the food chain, energy, cycle of matter, and abiotic and biotic factors in ecosystems, and should be taken as example in applied studies. This study demonstrates the significance and benefit of exemplification and concretization. It also underlines the need to plan for child-focused and age-appropriate target skills.

Adult phenomena begin to be shaped during early childhood period, because neural webs in the brain start to develop with external stimuli in early childhood, and it also continues in adulthood stage. Due to this long process, ecological literacy and ecological awareness by extension can only be introduced through preschool, primary school, secondary school and adult education. Puk (2012) asserts that the reason for the scarcity of people with ecological consciousness and going back to ecological lifestyle is that *ecological literacy is accepted as a distinct component of schooling.* As ecological literacy is not integrated into 12 year compulsory education, adults unfortunately are not ecologically literate. Therefore, there is a huge gap between what is done and what is required, which can only be filled with educational activities at schools. Orr (2005) stresses that education is necessary to understand interdependence between human lifestyle and natural processes, and ecological understanding must be top priority pedagogically in all disciplines. According to Morris (2002), schools unfortunately do not pay attention to the voice of our dying planet.

1.1. Purpose of the Study

We can find the concept of ecological awareness in many studies such as in Schleicher (1989), Cohen (1992), Cohen and Horm-Wingerd (1993), Kottak and Costa (1993), Fu-liang and Pei-xu (2005), Wanninayake and Randiwela (2008), Deprez, Ramdoyal and Ponsard (2012), Edwards (2012), and Collado, Corraliza, Staats and Ruiz (2015). In Turkey, the concept is used by Sınmaz (2013) in relation to urbanisation; Kalaycı and Birişci (2013) with urban parks; Tosunoğlu (2014) concerning ecological footprint; Saygı (2016) regarding the perception of nature in art; and Ünsal and Görgün (2016) concerning furniture design. However, we see that the concept of ecological awareness is not used in education, where it should be in the first place, and is not the subject of academic studies. It is a deficiency in our domestic literature. We believe that this study will contribute to filling this gap in literature. As is understood from the abovementioned sources, achieving ecological awareness is only possible through relational thinking skill. That is because you observe relational webs everywhere you see a trace of life (Capra 1994). Thus, this study aims at assessing through metaphors how much the participants are aware of the relationships between living groups (first and second questions), relationships between living and non-living organisms (third question), relational impacts of an ecological event (fourth question) and what they understand about ecological relationships (fifth question). We also believe that the study will shed light on the development of the discipline in revealing the existing gap between theory and practise.

2. Method

2.1. Research Design

The study employed case study design, a qualitative research design, in determining participants' ecological awareness that requires an understanding of cause and effect relationships in ecological events. A case study uses one or more than one incident or person to understand a subject, phenomenon or problem (Güler, Halıcıoğlu and Taşğın, 2013:301). It is a research design that is based on the questions of 'how' and 'why', allowing in-depth exploration of a phenomenon or event that is not controlled by the researcher (Yıldırım and Şimşek, 2013:313). This study attempted to determine teacher candidates' ecological awareness by examining how they interpret ecological relationships. In addition, the study used phenomenological design in identifying the participants' perceptions of the concept of ecological diversity and the meanings they attached to this concept. In phenomenological approach, the researcher deals with participants' personal experiences and studies people's perceptions and meanings they attach to events (Baş and Akturan, 2013:84).

2.2. Study Group

The study was conducted on 127 participants who were students in the Department of Science Teaching in the Faculty of Education, Kafkas University on a voluntary basis. Candidates in 1st grade were not included in the study as they did not take any course

on ecology during their college education, and thus, criterion sampling method was employed in the selection of sample. Sex and other demographic factors were not taken into consideration in the assessment.

2.3. Data Collection Tool and Data Collection

As data collection tool, the study used a survey form comprising open-ended questions. To this end, a comprehensive literature review was performed to develop a conceptual framework and prepare questions of the assessment tool. Starting from the fact that ecological awareness is an understanding of ecological relationships (Goldstein, 1976; Capra, 1996; Maxwell, 2003; Orr, 2005; Sterling, 2009), and based on the ecological principles suggested by Pitmann and Daniels (2016), a pool of questions was created.

According to Pitmann and Daniels (2016), there are 7 key ecological principles:

1. relationships between ecological components;
2. abiotic and biotic components and food webs;
3. threatening processes and extinction;
4. adaptation and change;
5. energy, water and climate systems;
6. human interaction with environment;
7. biological diversity.

To have open and clear questions, the questions in the survey form were read to four students in different grades. Later, they were presented to two educators in the field for their opinion, and in accordance with their recommendations, adjustments were made to finalize the form. The first four questions are open-ended. The final question asks teacher candidates to generate metaphors concerning 'ecological relationships'. With the ecological awareness assessment tool, the following questions were addressed to the teacher candidates:

- Do you think there is a relationship between the cull of chickens and the increase in the Crimean-Congo Hemorrhagic Fever (CCHF) cases in an area? If your answer is yes, how?
- Do you think there is a relationship between the decline in snake numbers and increase in plague cases in an area? If your answer is yes, how?
- Do you think heavy metals in the soils of an area in a continent affect humans living in another continent? If your answer is yes, how?
- What do you think happens with only a few degrees of increase in global temperature?
- Ecological relationships are like……., because…….

2.4. Data Analysis

To analyse the data, content analysis method was employed based on the concepts derived from the data and information coding process. The content of the first four questions was assessed using the same method. First, the data was analysed, and words and sentences in the answers were conceptualized for coding. Then, they were categorized; frequency and percentage values of the answers given by the participants

were calculated and given in tables. To present findings, each student was given a code (S1, S2, S3,…S27).

In the fifth question, metaphors developed by the teacher candidates were evaluated according to Saban (2009). The data was analysed and interpreted in five stages –coding, classification, creation of categories, testing validity and reliability, and computerizing the data. During coding, the metaphors were put in alphabetical order in Turkish and the metaphor proposed by each candidate was coded. In classification stage, the metaphors were examined according to their subject, source and suitability in terms of attributes that can contribute to the subject of the metaphor. In creating categories, the metaphors were examined considering how they were conceptualized, related metaphors were gathered in a single category, and a total of 11 conceptual categories were created. In testing validity and reliability, the opinions of two field experts and an educational scientist were asked to determine whether the metaphors represent the relevant conceptual category, and the reliability of the study was tested using the formula developed by Miles and Huberman (1994) (Reliability = consensus / consensus+ dissidence). 80% consensus was achieved in the categories and the classification of codes obtained from the students' answers. In the final phase, all the metaphors were computerized, and the number (f) and percentage of each metaphor were calculated.

In the findings section, analysis method for each question is explained in detail and exact quotations from the answers were given.

3. Findings

The data gathered from the study was evaluated on question basis and is given below.

3.1 The teacher candidates' answers to the question of **'Do you think there is a relationship between the cull of chickens and the increase in the Crimean-Congo Hemorrhagic Fever (CCHF) cases in an area? If your answer is yes, how?'**

Crimean-Congo Hemorrhagic Fever (CCHF) is a disease caused by tick-borne viruses (Tezer et al., 2008; Kaya et al., 2009; Kömürlüoğlu et al., 2017). Based on the fact that the disease is transmitted through ticks in the food chain, 'tick' was accepted as key word in this sub-problem.

According to this reference information, the answers provided by the science teacher candidates for the question of 'Do you think there is a relationship between the cull of chickens and the increase in the Crimean-Congo Hemorrhagic Fever (CCHF) cases in an area? If your answer is yes, how?' were classified and analysed under 3 groups, and findings were given in Table 1. In light of the abovementioned reference information;

- Those who provided accurate/adequate explanation by predicating the CCHF on the food chain in the ecosystem by using the concept of 'tick' were accepted in the 1st group;

- Those who tried to explain the CCHF by only referring to 'food chain', 'insect' and 'certain tiny animals' without using the concept of 'tick' were accepted in the 2nd group;
- Those who made unscientific statements without using concepts such as tick or food chain, and those who made no explanation at all were accepted in the 3rd group.

Table 1: Frequency and percentage values of the groups created according to the answers to the question of *'Do you think there is a relationship between the cull of chickens and the increase in the Crimean-Congo Hemorrhagic Fever (CCHF) cases in an area? If your answer is yes, how?'*

		f	**%**
1.	Group 1	54	42.6
2.	Group 2	12	9.4
3.	Group 3	61	48
Total		**127**	**100**

An analysis of Table 1 indicates that 54 science teacher candidates (42.6%) referred to the food chain by using the key word 'tick' and answered the question correctly by establishing a sufficient relationship between *the cull of chickens and the increase in the Crimean-Congo Hemorrhagic Fever (CCHF).* Some of the views of the teacher candidates in the first group are given below:

> S66: '*Of course, there is. The Crimean-Congo Hemorrhagic Fever is caused by ticks which are natural prey for chickens. If chickens are destroyed in an area, the number of tick increases, and thus, the CCHF cases are seen frequently.*
> S40: *'Animals such as chicken, duck, bird, etc. feed on insects like ticks. The destruction of chickens causes an increase in the tick population that transmits the disease.'*
> S113: *'If chickens diminish in number, ticks increase. If humans are bitten by ticks, the CCHF is seen (in humans).'*

However, 12 science teacher candidates (9.4%) did not use the key concept of 'tick', but emphasized the food web with concepts such as 'food chain' or 'insect'. Teacher candidates in this group provided partly correct answers. Some of the views of the teacher candidates in the second group are as follows:

> S4: '*… there is a relationship. It is about the food chain. The decrease of one of them means an increase in the other population.'*
> S22: *'There might be an increase in the number of living organisms causing the CCHF with the cull of chickens. As a result, the cases of the disease might increase.'*
> S53: *'Since chickens feed on the living organisms causing this disease, such a relationship exists.'*

61 science teacher candidates (48%) either gave irrelevant answers or replied as 'I do not know' or left the answer blank. Some of the answers provided by the teacher candidates in the third group are given below:

S10: *'I think there is (a relationship). That is because chickens are killed so that they do not transmit the disease to humans.'*
S57: *'A certain type of virus can spread in an area due to the death of chickens. Such viruses cause an increase in the CCHF cases.'*
S103: *'There is (a relationship), because this disease is transmitted to humans by poultry.'*

3.2. The answers of the teacher candidates to the question of **'Do you think there is a relationship between the decline in snake numbers and increase in plague cases in an area? If your answer is yes, how?'**

Snakes are carnivorous animals and mice have an important place in their diet (Demirsoy, 1995; Bozkurt, 2010). Mice also play a huge role in the spread of plague, because plague occurs when humans are bitten by fleas in mice (Özden and Özmat, 2014; Yiğit and Gümüşçü, 2016). Based on the fact that plague is transmitted with mice in the food chain, the key word in this sub-problem was accepted as 'mice'.

According to this reference information, the answers of the science teacher candidates to the question of 'Do you think there is a relationship between the decline in snake numbers and increase in plague cases in an area? If your answer is yes, how?' were classified and analysed in three groups, and findings were presented in Table 2. In light of this information;

- Those who provided an accurate/adequate explanation predicating the disease on the food chain in the ecosystem by using the concept of 'mice' were accepted in the first group;
- Those who tried to explain plague by only referring to 'food chain' and 'some animals' without using the concept of 'mice' were accepted in the second group;
- Those who made unscientific statements without using concepts such as mice or food chain, and those who made no explanation were accepted in the third group.

Table 2: Frequency and percentage values of the groups created according to the answers to the question of *'Do you think there is a relationship between the decline in snake numbers and increase in plague cases in an area? If your answer is yes, how?'*

		f	**%**
1.	Group 1	63	49.6
2.	Group 2	21	16.5
3.	Group 3	43	33.9
Total		**127**	**100**

An analysis of Table 2 indicates that 63 science teacher candidates (49.6%) referred to the food chain using the key word 'mice and gave the correct answer to the question by establishing a sufficient relationship between *the decline in snake populations and increase of plague incidents in an area.* Some of the statements made by the teacher candidates in the first group are given below:

S18: *'Mice and flea populations grow with the decline in snake numbers, and thus, plague cases also increase.'*
S58: *'Plague is spread through mice. If snakes diminish in number, mice population grows, which causes an increase in the spread of the disease.'*
S65: *'Plague is transmitted with mice. If snakes decrease in number, then mice population has grown and spread the disease.'*

21 science teacher candidates (16.5%) did not use the key concept 'mice', but referred to the food chain with concepts such as 'food chain' or 'some animals'. The teacher candidates in this group gave partly correct answers. The views of some teacher candidates in the second group are as follows:

S118: *'I think there is (a relationship), because snakes prey on animals that cause plague.'*
S68: *'I think there is (a relationship). Decline in snake population causes imbalances in the food chain.'*
S14: *'I think there is (a relationship), because there is a food chain in nature.'*

43 science teacher candidates (33.9%) either gave irrelevant answers to the question, or answered 'I do not know' or left the answer blank. The views of some teacher candidates in the third group are given below:

S92: *'I do not think there is (a relationship).'*
S11: *'Snakes decline in number due to the increase in the disease.'*
S57: *'Plague is caused by dark blood. It cannot be related to the decrease of snakes.'*

3.3. The answers of the teacher candidates to the question of **'Do you think heavy metals in the soils of an area in a continent affect humans living in another continent? If your answer is yes, how?'**

Metal pollution in a certain area can be carried to other places with wind, currents, turbulence, agricultural products, export, import, natural substance/water cycle and the food chain. As humans are at the top of the food pyramid, they become exposed to heavy metals in diverse ways. With the consumption of vegetables and fruits produced using agricultural pesticides containing heavy metals, these substances are transmitted to humans, and this pollution can be carried between continents through export and import (Akbostancı, Tunç and Türüt-Aşık, 2005; Büyükgüngör, 2006; Taylan, Böke and Özkoç, 2007; Süer,2013).

According to this reference information, the answers of the teacher candidates to the question of 'Do you think heavy metals in the soils of an area in a continent affect humans living in another continent? If your answer is yes, how?' were classified and analysed in three groups, and the findings were given in Table 3.

In light of the abovementioned reference information;

- Those who gave correct/sufficient answers by saying 'Yes, it does affect' were accepted in the first group;
- Those who did/could not provide a correct/sufficient explanation despite answering that 'Yes, it does affect' were accepted in the second group;
- Those who said 'No, it does not affect', made unscientific statements or did not say anything were accepted in the third group.

Table 3: Frequency and percentage values of the groups created according to the answers to the question of *'Do you think heavy metals in the soils of an area in a continent affect humans living in another continent? If your answer is yes, how?'*

		f	**%**
4.	Group 1	86	67.8
5.	Group 2	29	22.8
6.	Group 3	12	9.4
Total		**127**	**100**

When Table 3 was analysed, it was seen that 86 science teacher candidates (67.8%) replied that 'Yes, it does affect', made correct/sufficient explanations and established a correct relationship between *heavy metals in the soils of an area in a continent and their impact on people living in another continent*. Some teacher candidates in the first group stated the following views:

> S50: *'Of course, it does. Heavy metals leaching into water with erosion are taken by marine species. In time, they are transferred to people in other continents who catch them.'*
> S14: *'I think it does. Products grown in soils containing heavy metals come to our country in any case, and when we consume such products, they pass into our body.'*
> S53: *'It does. They are carried when food produced in that continent is exported.'*

Although 29 teacher candidates (22.8%) replied that 'Yes, it does', they failed in making an accurate/sufficient statement and provided partly correct answers. Some of these answers in the second group are given below:

> S110: *'It does, they (metals) are carried with rain.'*
> S15: *'It affects, because plants in this continent will be unfruitful and people will meet their needs from other continents.'*
> S66: *'It does, because the world is a whole.'*

On the other hand, 12 science teacher candidates (9.4%) replied either 'I do not know' or 'It does not affect', or gave irrelevant answers to the question or left the answer blank. The views of some teacher candidates in the third group are as follows:

S11: *'It does not affect.'*
S108: *'I do not think it does, because we do not share the same soils.'*
S19: *'People emigrate and the balance is disrupted.'*

3.4. The answers given by the teacher candidates to the question of **'What do you think happens with only a few degrees of increase in global temperature?'**
Global warming is caused by the emission of greenhouse gases (CO_2, CH_4, N_2O, CFC, O_3, CO). These gases intercept some of the heat coming from the sun and causes the warming of the Earth's surface (Aksay, Ketenoğlu and Kurt, 2005; Sağlam, Düzgüneş and Balık, 2008; Akın, 2017). Potential impacts of just a few degrees of increase in global temperature were determined according to these reference sources, and the impacts were classified by the researcher in 11 categories: temperature, living organisms, water, air, balance, natural disasters, economy, human health, habitats, soil and forest. Answers provided by the science teacher candidates are given in Table 4 according to this classification.

Table 4. Categories And Frequency Values Of Answers To The Question Of 'What Do You Think Happens With Only A Few Degrees Of Increase In Global Temperature?'

Category	F	%	Impact	F	%
Temperature	110	29.8	Glaciers melt	55	14.90
			Droughts increase	34	9.21
			Climate change occurs	16	4.34
			Desertification increases	5	1.35
Living Organisms	75	20.3	Many living organisms die	14	3.79
			Polar species get harmed	12	3.25
			Plants get harmed	12	3.25
			Some living organisms become extinct	9	2.43
			All living creatures get harmed	9	2.43
			Animal species decrease	6	2.43
			Animals and plants get harmed	5	1.35
			The nature of the living beings is disrupted	3	0.81
			The living who cannot adjust their body temperature die	2	0.54
			Some hibernating species wake up	1	0.27
			Certain living organisms increase in number	1	0.27
			The bacteria increase in number	1	0.27
Water	47	12.7	Water shortage occurs	12	3.25
			Sea level rises	8	2.16
			Evaporation increases	4	1.08
			Precipitation decreases	4	1.08
			Lakes dry up	3	0.81
			Water level in seas, rivers and lakes decreases	3	0.81
			The amount of fresh water decreases	2	0.54
			Water shortage occurs in dams	2	0.54
			Drinking water diminishes	2	0.54
			Water balance is disrupted	2	0.54
			Sea level falls	2	0.54
			Seas dry up	2	0.54
			Hot water streams may change course	1	0.27
Balance	40	10.8	Natural balance is disturbed	31	8.40
			Stable balance is disrupted	5	1.35
			The balance of ecosystem is disrupted	4	1.08

Category	F	%	Impact	F	%
Air	37	10	Seasons change	14	3,79
			Ozone layer is damaged	8	2.16
			Unstable weather conditions are observed	5	1.35
			Layers of the atmosphere become thinner	3	0.81
			Air pollution increases	3	0.81
			Acid rains increase	2	0.54
			Direction of winds change	2	0.54
Human Health	14	3,8	Diseases increase	4	1.08
			People get harmed	4	1.08
			Epidemics increase	3	0.81
			People get depressed	1	0.27
			Homeostasis is disrupted	1	0.27
			It causes brain haemorrhage	1	0.27
Natural Disasters	13	3,5	Famine and scarcity increase	5	1.35
			Disasters increase	3	0.81
			Earthquakes increase	2	0.54
			Floods increase	2	0.54
			Tsunamis occur	1	0.27
Economy	12	3,25	Agriculture is affected adversely	10	2.71
			It paves the way for economic crises	2	0.54
Habitats	10	2,7	Habitats of living organisms decline	5	1.35
			Many places submerge under water	1	0.27
			Countries submerge under water	1	0.27
			Cities submerge under water	1	0.27
			Habitats are degraded	1	0.27
			It causes environmental pollution	1	0.27
Soil	8	2,1	Soils become infertile	5	1.35
			It leads to erosion	3	0.81
Forest	3	0,8	Forest animals die	1	0.27
			Forest animals get harmed	1	0.27
			Forests disappear	1	0.27

When Table 4 was analysed, it was found that the science teacher candidates offered a total of 369 answers, 63 of which were different, in 11 categories. Some teacher candidates mentioned several impacts of global temperature in diverse categories, namely gave multiple answers. Each of these answers was assessed separately and added to frequency in each category.

In the temperature category (f=110), the teacher candidates replied that glaciers melt (f=55), droughts increase (f=34), climate change occurs (f=16) and desertification increases (f=5). In their answers, they underlined the impacts of only a few degrees of increase in global temperature on the Earth's temperature. Some of the answers given by the participants are as follows:

S9: *'A few degrees seem insignificant, but in this case, drought increases and glaciers melt.'*
S41: *'It causes melting at the Poles.'*
S68: *'It gradually leads to desertification and drought.'*

In the living organisms category (f=75), the teacher candidates answered that it causes the death of many living organisms (f=14), polar species get harmed (f=12), plants get harmed (f=12), some living organisms become extinct (f=9), all living creatures get harmed (f=9), animal species decrease (f=6), animals and plants get harmed (f=5), the nature of the living beings is disrupted (f=3), living organisms who cannot adjust their body die (f=2), some hibernating species wake up (f=1), certain living organisms increase in number (f=1) and the bacteria increase in number (f=1). In these answers, they stated the negative impacts of only a few degrees of increase in global temperature on living organisms in the world. Some of these answers are given below:

S48: *'Living organisms living at the Poles get harmed, the species diminish in number and some animals become extinct.'*
S19: *'Deaths increase.'*
S86: *'It causes plants blooming and growing old earlier.'*

In the water category (f=47), the teacher candidates replied that water shortage occurs (f=12), sea level rises (f=8), evaporation increases (f=4), precipitation decreases (f=4), lakes dry up (f=3), water level in seas, rivers and lakes decreases (f=3), the amount of fresh water decreases (f=2), water shortage occurs in dams (f=2), drinking water diminishes (f=2), water balance is disrupted (f=2), sea level falls (f=2), seas dry up (f=2) and hot water streams may change course (f=1). With these answers, they stated that only a few degrees of increase in global temperature will disrupt the general water balance on the Earth and cause problems for all fresh and salt water springs. Some of the answers in this category are as follows:

S87: *'Water resources decrease.'*

S119: *'Seas, lakes and rivers dry up. Water shortages occur.'*
S8: '*Sea level rises.'*

In the balance category (f=40), the teacher candidates told that natural balance is disturbed (f=31), stable balance is disrupted (f=5) and the balance of the ecosystem is disrupted (f=4). With these answers, they stated that only a few degrees of increase in global temperature will disrupt the natural/ecological balance on the Earth. Some of the answers given by the participants are as follows:

S11: *'Natural balance is disturbed.'*
S92: '*Earth's order is disrupted.'*
S105: '*It can disrupt ecological balance.'*

In the weather category (f=37), the teacher candidates replied that the seasons change (f=14), ozone layer is damaged (f=8), unstable weather conditions are observed (f=5), the layers of the atmosphere become thinner (3), air pollution increases (f=3), acid rains increase (f=2) and the direction of winds change (f=2). With these answers, they indicated how only a few degrees of increase in global temperature will affect weather conditions in our planet. Some of the answers in the weather category are as follows:

S70: '*Seasonal abnormalities are seen.'*
S3: '*Direction of winds change.'*
S5: '*Acid rains increase.'*

In the human health category (f=14), the teacher candidates answered that diseases increase (f=4), people get harmed (f=4), epidemics increase (f=3), people get depressed (f=1), homeostasis is disrupted (f=1) and it causes cerebral haemorrhages (f=1). With these answers, they mentioned potential impacts of only a few degrees of increase in global temperature on humans/human health. Some of the answers provided by the teacher candidates in this category are given below:

S62: '*Epidemics increase.'*
S15: *'It disturbs people's psychological and mental balance.'*
S99: '*It causes cerebral haemorrhages.'*

In the natural disasters category f=13), the teacher candidates replied that famine and scarcity increase (f=5), disasters increase (f=3), earthquakes increase (f=2), floods increase (f=2) and tsunamis occur (f=1). With these answers, they pointed out major disasters that will be caused by only a few degrees of increase in global temperature. Some of the answers in the natural disasters category are given below:

S24: '*It causes events such as erosion, earthquake and tsunami.'*

S74: '*It leads to many disasters.'*
S17: '*It causes floods.'*

In the economy category f=12), the teacher candidates replied that agriculture is affected adversely (f=10) and it paves the way for economic crises (f=2). With these answers, they mentioned economic problems that will result from only a few degrees of increase in global temperature. Some of their answers in the economy category are as follows:

S91: *'Agricultural production will be harmed.'*
S85: *'As agricultural productivity will not be sufficient, demand for import will increase.'*
S65: '*It paves the way for economic crises.'*

In the habitats category (f=10), the teacher candidates replied that the habitats of living organisms decline (f=5), many places submerge under water (f=1), countries submerge under water (f=1), cities submerge under water (f=1), habitats are degraded (f=1) and it causes environmental pollution (f=1). With these answers, they mentioned possible adverse effects of only a few degrees of increase in global temperature on the habitats of living organisms. Some of the answers provided by the teacher candidates in this category are as follows:

S14: 'M*any places submerge under water.'*
S61: '*Cities submerge under water.'*
S8: '*The habitats of living organisms decline or submerge.'*

In the soil category (f=8), the teacher candidates replied that soils become infertile (f=5) and it causes erosion (f=3). With these answers, they emphasized the negative impacts of only a few degrees of increase in global temperature on the soil which is vital for living beings. Some of the answers provided by the teacher candidates in the soil category are given below:

S20: '*It affects the soil and abiotic factors negatively.'*
S57: *'It causes soils transform into vertisols.'*
S69: *'Soils become infertile.'*

In the forest category (f=3), the participants answered that forest animals die (f=1), forest animals get harmed (f=1) and forests disappear (f=1). With these answers, they mentioned the impacts of only a few degrees of increase in global temperature on forests. Some of the answers given in this category are as follows:

S64: '*Forests disappear.'*

S63: 'F*orests get harmed, and it results in the deaths of animals living in forests.'*

3.5. Metaphors developed by the teacher candidates for the question of **'Ecological relationships are like ……., because ……..……'**

The metaphors created by the science teacher candidates on 'ecological relationships' were assessed and analysed, and their frequency and percentage values are given in Table 5.

Table 5: Metaphors concerning 'ecological relationships' (in alphabetical order), frequency and percentage values

Metaphor	Frequency (f)	Percentage (%)
A relationship based on interests	1	.85
A whole	6	5.13
Air	1	.85
Army	1	.85
Bodily systems	2	1.70
Breath	1	.85
Building foundation	1	.85
Building pillar	1	.85
Cables	1	.85
Chain	23	19.7
Cycle	4	3.42
Disciplinary board	1	.85
Domino	5	4.27
Engine	2	1.70
Environment	4	3.42
Equality	1	.85
Family	4	3.42
Freedom	1	.85
Friendship	1	.85
Human body	3	2.56
Jenga	3	2.56
Jigsaw	5	4.27
Key and lock	1	.85
Knot	1	.85
Life	8	6.84
Living and nonliving organisms	1	.85
Love	1	.85
Neighbourhood	1	.85
Noun phrase	1	.85
Organ	1	.85
Puzzle	4	3.42
Pyramid	1	.85
Regular relationships	1	.85
Relationship between a cat and dog	1	.85
Ring	3	2.56
Rope	1	.85

Rosary	1	.85
Scales	3	2.56
Season	1	.85
Seesaw	1	.85
Sequence	1	.85
Spouse	1	.85
Stair	1	.85
Station	1	.85
Students in a dorm	1	.85
Superior-subordinate relationship	1	.85
System	2	1.70
Tree	2	1.70
Water	1	.85
Web	1	.85
World	1	.85

The metaphors generated by the teacher candidates concerning 'ecological relationships' were shown in Table 5 in alphabetical order according to their Turkish equivalents. An analysis of Table 5 demonstrated that there are 117 metaphors in total, 51 of which were different metaphors.

Metaphors proposed by more than one participant are given in Table 6 according to their frequency rating.

Table 6: Most proposed metaphors on 'ecological relationship', frequency and percentage values

Metaphor	**Frequency (f)**	**Percentage (%)**
Chain	23	19.7
Life	8	6.84
A whole	6	5.13
Domino	5	4.27
Jigsaw	5	4.27
Puzzle	4	3.42
Cycle	4	3.42
Family	4	3.42
Environment	4	3.42
Ring	3	2.56
Human body	3	2.56
Jenga	3	2.56
Scales	3	2.56
Tree	2	1.70
Engine	2	1.70
System	2	1.70
Bodily systems	2	1.70

When Table 6 was analysed, it was seen that metaphors proposed by more than one participant and had a frequency value greater than 1 were 'chain' (f=23; 19.7%), 'life'

(f=8; 6.84%), 'a whole' (f=6; 5.13%), 'domino' (f=5; 4.27%), 'jigsaw' (f=5; 4.27%), 'puzzle' (f=4; 3.42%), 'cycle' (f=4; 3.42%), 'family' (f=4; 3.42%), 'environment' (f=4; 3.42%), 'ring' (f=3; 2.56%), 'human body' (f=3; 2.56%), 'jenga' (f=3; 2.56%), 'scales' (f=3; 2.56%), 'tree' (f=2; 1.70%), 'engine' (f=2; 1.70%), 'system' (f=2; 1.70%), and 'bodily systems' (f=2; 1.70%).

34 metaphors among the 51 different metaphors were proposed once. Having a frequency of 1 (f=1), these metaphors were *web, key-lock, love, superior-subordinate relationship, building foundation, building pillar, stair, living and non-living organisms, a relationship based on interests, friendship, disciplinary board, knot, world, regular relationships, equality, spouse, air, rope, noun phrase, station, neighbourhood, cables, relationship between a cat and dog, season, breath, organ, army, freedom, pyramid, water, sequence, seesaw, rosary* and *students in a dorm.*

The metaphors developed by the teacher candidates were categorized according to the relationship between them and their semantic closeness, and are given in Table 7.

Table 7: Conceptual categories of the metaphors on 'ecological relationships'

Category	Category frequency	Percentage (%)	Metaphors	Metaphor frequency
Successive	26	22,2	Chain	23
			Station	1
			Range	1
			Rosary	1
Game	17	14,6	Jigsaw	5
			Domino	5
			Puzzle	4
			Jenga	3
Integrity	17	14,6	A whole	6
			Human body	3
			Bodily systems	2
			Living and non-living organisms	1
			Organ	1
			Earth	1
			Rope	1
			Building foundation	1
			Building pillar	1
Life	17	14,6	Life	8
			Environment	4
			Tree	2
			Air	1
			Water	1
			Breath	1
Social	13	11,1	Family	4
			Neighbourhood	1
			Friendship	1
			Spouse	1
			Love	1

Relationships			Students in a dorm	1
			Equality	1
			Freedom	1
			Relationship between cat and dog	1
			A relationship based on interests interest	1
Circulation	8	6,8	Cycle	4
			Ring	3
			Season	1
Order	6	5,1	System	2
			Engine	2
			Disciplinary board	1
			Regular relationships	1
Hierarchy	4	3,4	Superior-subordinate relationship	1
			Army	1
			Pyramid	1
			Stair	1
Balance	4	3,4	Scales	3
			Seesaw	1
Complex	3	2,5	Web	1
			Cables	1
			Knot	1
Harmony	2	1,7	Key-lock	1
			Noun phrase	1

In Table 7, the metaphors generated for 'ecological relationships' were classified in 11 categories. When the categories were examined, it was found that the 'successive' category' (f=26) had the highest frequency. There were 4 metaphors in this category. An analysis of the frequency distribution of the metaphors indicated that chain (f=23), station (f=1), sequence (f=1) and rosary (f=1) were the most proposed metaphors in this category. The science teacher candidates stated that ecological components exist in nature in sequence and thus, they are related to each other by comparing them to chain, station, sequence and rosary. The views of some teacher candidates in this category are as follows:

S20: *'Ecological relationships are like a sequence, because each relationship affects others.'*
S84: *'Ecological relationships are like a rosary, because they are successive and in order.'*
S88: *'Ecological relationships are like stations, because there is a link between them.'*

The examination of Table 7 also exhibited that other categories with the highest number of metaphors were 'game', 'integrity' and 'life', and these categories had equal frequency (f=17).

Metaphors in the game category (f=17) were jigsaw (f=5), domino (f=5), puzzle (f=4) and jenga (f=3). In this category, the respondents compared 'ecological relationships' to games that consist of many parts and cannot be completed without any

of them. They stated that in jigsaw, domino, puzzle and jenga games, all the pieces are connected and even a single missing piece prevents completing the game. In a similar vein, ecological relations are also interconnected, interdependent and integrated. The views of some teacher candidates in this category are as follows:

> S83: *'Ecological relationships are like the pieces of a jigsaw, because it is a whole consisting of components.'*
> S98: *'Ecological relationships are like a jigsaw, because every piece complements each other.'*
> S113: '*Ecological relationships are like a puzzle, because all the pieces are related.'*

The integrity category (f=17) includes the metaphors a whole (f=6), human body (f=3), bodily systems f=2), living and non-living organisms (f=1), organ (f=1), world (f=1), rope (f=1), building foundation (f=1) and building pillar (f=1). In this category, the teacher candidates used these metaphors to compare 'ecological relationships' to structures that consist of several parts and constitute integrity between them. They particularly noted that the systems in the human body form the organism, the organs come together to create a living organism, the living and non-living form the integrity of the ecosystem, and ecological relationships are integral and vital just like the foundation and pillars are vital for a building. Some of the views presented through metaphors in this category are as follows:

> S114: *'Ecological relationships are like a whole, because they consist of successive processes.'*
> S106: *'Ecological relationships are like a whole, because there is a shared life.'*
> S117: *'Ecological relationships are like the human body, because everything is interconnected.'*

In the life category (f=17), there were life (f=8), environment (f=4), tree (f=2), air (f=1), water (f=1) and breath (f=1) metaphors. Using these metaphors, the teacher candidates remarked that ecological relationships constitute the life, create integrity like the environment and they are vital like the air, water and breathing. The views proposed by some teacher candidates through metaphors are as follows:

> S128: *'Ecological relationships are like the life, because they have an order.'*
> S11: *'Ecological relationships are like the life, because they are of vital importance.'*
> S12: *'Ecological relationships are like the life, because it also functions systematically.'*

In the social relationships category (f=13), 10 different metaphors were developed: family (f=4), neighbourhood (f=1), friendship (f=1), spouse (f=1), love (f=1), students in a dorm (f=1), equality (f=1), freedom (f=1), relationship between a cat and dog (f=1) and a relationship based on interests (f=1). In this category, the teacher

candidates compared ecological relationships to sociological relationships. Some of them expressed the following views through metaphors:

S39: *'Ecological relationships are like family, because they have integrity.'*
S42: *'Ecological relationships are like family, because they have coordination, balance and harmony as in the family.'*
S70: *'Ecological relationships are like neighbourhood, because each component interacts with others.'*

Metaphors in the circulation category (f=8) were cycle (4), ring (f=3) and season (f=1). In this category, the teacher candidates stated that ecological relationships are continuous and run in a common cycle. Some of them expressed the following views through metaphors:

S36: *'Ecological relationships are like a cycle, because otherwise it is derailed.'*
S17: *'Ecological relationships are like interconnected rings, because they are affected by each other.'*
S54: *'Ecological relationships are like the seasons, because they follow each other.'*

There were system (f=2), engine (f=2), disciplinary board (f=1) and regular relationships (f=1) metaphors in the order category (f=6). In this category, the participants remarked that ecological relationships form an order overall and function systematically. Their views in this category include the following:

S51: *'Ecological relationships are like a system, because it is hierarchical.'*
S32: *'Ecological relationships are like an engine, because it runs like a machine.'*
S33: *'Ecological relationships are like an engine, because it cannot function well if one part is missing.'*

Superior-subordinate relationship (f=1), army (f=1), pyramid (f=1) and stair (f=1) metaphors were gathered in the hierarchy category (f=4). In this category, the teacher candidates maintained that ecological relationships advance in a hierarchical order. The views expressed by some teacher candidates through metaphors are as follows:

S89: *'Ecological relationships are like superior-subordinate relationship, because they cannot work being unaware of each other, and even if they do, it goes wrong.'*
S93: *'Ecological relationships are like the army, because there is a military order.'*
S65: *'Ecological relationships are like a pyramid, because it expands from top to bottom.'*

In the balance category (f=4), scales (f=3) and seesaw (f=1) metaphors were used. In this category, the teacher candidates pointed out the balance in ecological relationships. Their views in this category are as follows:

S15: *'Ecological relationships are like a pair of scales, because they entail balance.'*
S16: *'Ecological relationships are like a pair of scales, because there is equilibrium.'*
S14: *'Ecological relationships are like a seesaw, because when there is a change in one side, the other side is also affected.'*

In the complex category (f=3), web (f=1), cables (f=1) and knot (f=1) metaphors were gathered. Using these metaphors, the teacher candidates emphasized the complexity of ecological relationships. Some of these views expressed through metaphors are as follows:

S1: *'Ecological relationships are like a web, because they are all interconnected and interrelated.'*
S2: *'Ecological relationships are like intertwined cables, because you understand what is what as you sort them out.'*

In the harmony category (f=2), there were key-lock (f=1) and noun phrase (f=1) metaphors. The teacher candidate who proposed the key-lock metaphor (S53) stated that *'Ecological relationships are like key and lock, because they always fit each other.'*, referring to the harmony in ecological relationships while the teacher candidate who developed the noun phrase metaphor said that *'Ecological relationships are like a noun phrase, because they make sense when they all come together.'*, emphasizing that components in ecological relationships constitute a meaningful whole together.

4. Conclusion

Ecological awareness entails an understanding of the cause and effect relationships between ecological events. When the data acquired from this study that was conducted to see to what extent science teacher candidates can establish a relationship between ecological components and events was assessed, the following results were obtained.

For the first question of the study which was *'Do you think there is a relationship between the cull of chickens and the increase in the Crimean-Congo Hemorrhagic Fever (CCHF) cases in an area? If your answer is yes, how?'*, 42.6% of the participants gave correct and sufficient answers, 9.4% provided partially correct answers, and 48% either gave irrelevant answers or wrote 'I do not know' or left the answer blank. This result indicated that nearly half of the teacher candidates who participated in the study (42.6%+9.4%+52%) gave correct or partially correct answers; in other words, they could establish a relational link between chicken and the Crimean-Congo Hemorrhagic Fever (CCHF) according to cause and effect. On the basis of this question, it can be claimed that the participants had moderate ecological awareness.

For the second question of the study which was *'Do you think there is a relationship between the decline in snake numbers and increase in plague cases in an area? If your answer is yes, how?'*, 49.6% of the teacher candidates provided correct and sufficient answers and

16.5% gave partially correct answers while 33.9% either gave irrelevant answers, or said 'I do not know' or left the answer blank. According to this result, it was seen that about two third of the respondents (49.6%+16.5%=66.1%) gave correct or partially correct answers; that is to say, they could establish an ecological relationship between snakes and the plague epidemic. On the basis of this question, it can be said that the participants had a good level of ecological awareness. The answers to the first two questions of the study overall demonstrated that the participants were able to establish cause-effect relationships of ecological interactions in the food chain.

With regard to the third question which was *'Do you think heavy metals in the soils of an area in a continent affect humans living in another continent? If your answer is yes, how?'*, 67.8% of the teacher candidates gave correct and sufficient answers while 22.8% gave partially correct answers. The remaining 9.4% responded to the question either saying 'I do not know' or 'It does not', or left the answer blank. This finding revealed that a great majority of the participants (67.8%+22.8%=90.6%) made accurate and sufficient statements, namely they remarked that heavy metals can affect people not only in their area but also people in other continents. Based on this question, it can be asserted that the participants had high ecological awareness.

When the answers to the fourth question that was *'What do you think happens with only a few degrees of increase in global temperature?'* were analysed, it was found that the candidates generated 65 different metaphors in 11 categories – a total of 369 metaphors. This result indicated that the participants mentioned 65 different impacts of only a few degrees of increase in global temperature. 29.8% of the candidates stressed other temperature impacts of global warming on the Earth; 20.3% impacts on living organisms; 12.7% impacts on water and water resources in our planet; 10.8% impacts on natural balances on the Earth; 10% impacts on weather events; 3.8% impacts on human health; 3.5% impacts on natural disasters; 3.25% economic impacts; 2.7% impacts on the habitats of living organisms; 2.1% impacts on soil; and 0.8% impacts on forests. With these answers, the science teacher candidates stated that with only a few degrees of increase in global temperature, temperature balances will change, which will affect glaciers and the Poles most; living organisms will get harmed to a great extent and many species will even become extinct; there will be droughts and ecological balances will be disturbed. The participants most frequently responded that glaciers melt (14.90%), droughts increase (9.21%), natural balance is disturbed (8.40%), climate changes occur (4.34%), the seasons change (3.79%), polar species get harmed (3.25%), many living organisms die (3.25%), plants get harmed (3.25%) and water shortages occur (3.25%). The least mentioned impacts in the answers were the impacts on the habitats of living organisms, soil and forests. When all the answers to this question were examined overall, it was seen that the candidates could establish detailed cause and effect relationships between global warming and its potential impacts. Based on this question, it can be claimed that the participants had very high ecological awareness because they addressed 65 different impacts of a single event and demonstrated a pretty good skill in relational thinking.

For the question of *'Ecological relationships are like ……., because ……..……'*, the teacher candidates generated 117 metaphors in total, 51 of which were different metaphors. When all the metaphors were analysed, it was found that the participants could develop appropriate metaphors for ecological relationships, made accurate analogies and thought relationally. Considering the common properties of these metaphors, the researcher created 11 conceptual categories which were successive (22.2%), game (14.6%), integrity (14.6%), life (14.6%), social relationships (11.1%), circulation (6.8%), order (5.1%), hierarchy (3.4%), balance (3.4%), complex (2.5%) and harmony (1.7%). It was identified that the metaphors most used by the participants were chain (19.7%), life (6.84%), a whole (5.13%), domino (4.27%) and jigsaw (4.2%7). Using these metaphors, they stated that ecological relationships are connected to each other like the rings of a chain, and affect the life directly, all ecological relationships are parts of a whole and affect each other like domino tiles, and even a single missing component causes defects in ecosystems as in the jigsaw game.

5. Discussion

Individuals who have ecological awareness can think relationally and establish cause and effect relationships between ecological events. This study indicated that the participating science teacher candidates could establish cause and effect relationships between the cull of chickens and the increase in the Crimean-Congo Hemorrhagic Fever (CCHF) cases by 52%; between the decline in snake populations and the spread of plague by about 66%; and on the intercontinental interaction of heavy metals by about 91%. In other words, they could demonstrate relational thinking skills concerning ecological events. The participants expressed 65 different views on the potential impacts of only a few degrees of increase in global temperature. This result showed that the teacher candidates could establish rather detailed effect relationships depending on the cause of a single ecological event. The candidates also demonstrated bright metaphorical perception by generating 51 different metaphors on 'ecological relationships'. All these results suggest that the science teacher candidates who participated in the study were aware that components in an ecosystem are not independent from each other, they could discern the integrity of the components, were conscious of the fact that universe is an integrated whole and could establish cause and effect relationships between these components. Based on this result, it can be asserted that the participants were well aware of their environment and ecosystems with living and non-living organisms, and had a certain level of ecological vision as to what ecological relationships and interactions can lead to.

A review of domestic literature revealed that there was no study conducted for assessing ecological awareness. Studies that were conducted to the present day mostly investigated environmental awareness (Tunç, Ömür and Düren, 2012; Okur-Berberoğlu and Uygun, 2012; Dinç and Üztemur, 2016; Aydın and Aykaç, 2016; Doğan and Purutçuoğlu, 2017; Gezer and Erdem, 2018). However, considering the difference

between 'environmental science' and 'ecology', it is seen that these two are rather different disciplines. In this context, some researchers attempted to increase environmental awareness by organizing ecopedagogy-based outdoor education activities. For instance, Okur-Berberoğlu (2015) conducted an ecopedagogy-based outdoor environmental education programme and maintained that the participants' environmental awareness increased after the programme. Oğurlu (2016) stated that his ecology-based educational activity with teacher and teacher candidates raised ecology-based awareness in the participants. Although such practical trainings do not emphasize cause and effect relationships directly, they will contribute to increased ecological awareness. In his study on the role of national parks in enhancing ecological awareness, Kocalar (2016) came to the conclusion that national parks certainly had positive impacts on raising ecological awareness. We found only one study by Ürey, Şahin and Şahin (2011) that shared similar properties with the present study. In their study on classroom teacher candidates, the researchers found that the participants performed below average in establishing relationships between ecological events and phenomena, and had misconceptions about the causes and effects of energy pyramid, biomass, food web, food chain and environmental problems such as greenhouse effect, acid rains and thinning of ozone layer. However, the teacher candidates in this study could establish links between ecological events very well and display relational thinking skill on the subject.

Metaphors are tools used to reveal people's perceptions through analogies (Deniz-Çeliker and Akar, 2015). Therefore, Gürbüzoğlu-Yalmancı and Aydın (2013) studied metaphorical perceptions about biology course; Doğan (2017) about environment; Kelleci (2014) about climate; İbret and Aydınözü (2011) about the world; Ateş and Karatepe (2013), Kaya (2013) and Arslan and Zengin (2016) about global warming; and Deniz-Çeliker and Akar (2015) about nature. However, we found no metaphor study on ecological relationships or at least on ecology in literature.

Based on the result of their study, Ateş and Karatepe (2013) stated that students had a good level of awareness and perception about global warming. Some of the teacher candidates (3.5%) in this study said that only a few degrees of increase in global temperature will lead to disasters such as famine-scarcity, earthquake, flood and tsunami. In a similar vein, Arslan and Zengin (2016) examined science teacher candidates' metaphorical perceptions about the concept of global warming and concluded that the participants interpreted global warming as a disaster (4.8%). While the participants in this study stated that an increase in global temperature will have negative impacts on human health (3.8%), participants in the study conducted by Arslan and Zengin (2016) explained global warming with the disease metaphor (5.5%). When the two studies were compared also based on other categories, it was seen that they shared similarities. Looking at the discussions and comparisons on the subject, it can be concluded that Turkish people have gained above-average awareness about global warming and its impacts.

In this study, the teacher candidates generated 'chain' (f=23; 19.7%), 'domino' (f=5; 4.27%), 'jigsaw' (f=5; 4.27%), 'puzzle' (f=4; 3.42%), 'family' (f=4; 3.42%), 'human body' (f=3; 2.56%), 'jenga' (f=3; 2.56%), 'scales' (f=3; 2.56%), 'system' (f=2; 1.70%), and 'bodily systems' (f=2; 1.70%) metaphors. Using these metaphors, they explained that ecological relationships are linked to each other like the rings of a chain, affect each other like domino tiles, they are interconnected and interdependent like jigsaw/puzzle/jenga/family members/organs in the human body/bodily systems/components of a system/scales of a balance. Likewise, Capra (1994) asserts that all the components in the ecosystem form a community and each member is connected to and dependent on others.

Ecological awareness has become a research subject in foreign literature since the 1940s. Cohen, Horm-Wingerd and Cohen (1993) examined ecological awareness in preschool children and their age-appropriate study on children concluded that children could accurately identify and define ecological problems according to the nature of the task and its level of difficulty. In their survey study on college students, Groves and Pugh (1999) found that the students had some misconceptions regarding greenhouse effect and global warming. Similarly, in his survey study on teacher candidates, Khalid (2001) stated that the students had misconceptions about global warming and usually supposed that ozone layer depletion caused global warming. The first two questions of our study were intended to predict ecological relationships based on the food chain. Indeed, as stated by Capra (1994), in the field of ecology, researchers study food chains first. That is because food chains affect other food chains and thus, complex food chains emerge.

Cuddington (2001) uses the metaphor 'balance of nature'. In the same vein, 4 participants in this study developed the metaphors scales (f=3) and seesaw (f=1). Since the participants referred to the balance in ecological relationships though these metaphors, the researchers gathered these metaphors under the 'balance' category.

Each metaphor obtained from this study points out a different reality in ecosystems even if they have low frequency. For example, the teacher candidates compared ecological relationships to social relationships. In the social relationships category (f=13) created accordingly, they generated metaphors such as family, neighborhood, friendship, spouse, love, students in a dorm, relationship between a cat and dog and a relation based on interests. This situation is consistent with Capra (1994), because he argues that ecological relationships do not consist of food chains only, and living organisms in ecosystems also provide shelter and support for each other. For instance, trees provide shelter for birds, dogs for fleas and some plant roots for certain bacteria. With the metaphors in this category, the participants referred to symbiotic relationships like mutualism and commensalism.

This study is unique as it measures ecological awareness, is the first of its kind in domestic literature and predicts relational thinking skill on ecological subjects.

6. Recommendations

1. This study revealed that science teacher candidates had a good level of skill in establishing links between ecological components. Similar studies should also be conducted on students at different educational levels to see their deficiencies concerning ecological awareness, and programmes should be prepared accordingly.
2. This study prompted teacher candidates to think relationally, ie. on the basis of causes and effects. Relational thinking skill is among significant characteristics that every individual must have regardless of their occupation. Thus, similar studies should be conducted to allow participants to improve it.
3. As this study indicated, ecological awareness has been hardly addressed in domestic literature until today. The examination of the subject by experts using diverse methods and techniques will be appropriate to underline the subdimensions as to what ecological awareness is.
4. Tackling with ecological problems entails developing ecological awareness throughout the country and at every level of education. In this context, foreign studies should be examined and taken as reference, and educational activities should be held accordingly.
5. This study is limited to science teacher candidates. The subject should be studied in detail by conducting research on other populations and samples.
6. This is a qualitative study. Research should be extended by also developing quantitative assessment tools.
7. This study did not take demographic factors into consideration. Future studies can involve diverse dimensions with the addition of factors such as grade, sex, age and academic achievement.

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