Education and Science

Vol 40 (2015) No 179 11-24

Determining the Middle School 7th Grade Students' Levels of Understanding the Concept of Ecosystem via Worksheets *

Elif Özata Yücel [1], Muhlis Özkan [2]

Abstract

This study aims to determine students' levels of understanding the concept of ecosystem and its elements. Data were collected from 47 seventh grade students attending 3 different middle schools via the worksheets entitled "Let's Create Our Own Ecosystem", which was developed by the researchers. The collected data were analyzed through the rubric developed by the researchers. The research results indicate that students understand the concept of ecosystem partially, and that although they are aware of the elements of ecosystem individually, they have limited cognition of and some misconceptions regarding the functions of these elements as well as their interactions with one another. To get rid of these problems, students should be made to comprehend that the ecosystem is a dynamic system, and that any change in one of its elements affects the entire system. Relationships between these elements should be presented to students on the basis of cause and effect relationships by providing concrete examples from the daily life.

Keywords

Ecosystem
Sciences
Worksheet
Drawings
Conceptual Understanding

Article Info

Received: 01.06.2015
Accepted: 04.29.2015
Online Published: 05.20.2015

DOI: 10.15390/EB.2015.4326

Introduction

To ensure the protection of environment, value judgments should be developed for human-environment and human-nature relations in regard to natural beings, their habitats, and the continuity of their life styles (Özkan, 2008). Teaching of ecological issues plays an important part in developing these value judgments for human-nature relations and displaying responsible behaviors (Pfundt & Duit, 2002; Özkan, Tekkaya & Geban, 2004).

The most important ecological concept is ecosystem which refers to an ordered integrity of species existing in a particular area and abiotic environment. The ecosystem is also a system where energy and matter cycle takes place (Odum & Barrett, 2008). The continuity of flow of energy and cycle of matter in the ecosystem points to habitable environment (Dinç & Özkaya, 2007). However, it is difficult to learn the concept of ecosystem (Jordan, Gray, Demeter, Liu & Hmelo-Silver, 2009; Gallegos, Jerezano & Flores, 1994; Grotzer, 2009). This is mainly because the ecosystem is a complicated system (Eilam, 2012; Hmelo-Silver, Marathe & Liu, 2007; Jordan et al., 2009). However, effective teaching of this comprehensive concept may allow students to know living and non-living worlds that surround them, interpret the relations between them, comprehend the elements of this

* This study was presented as oral paper at the XI. National Congress on Science and Mathematics Education

[1] Kocaeli University, Faculty of Education, Department of Primary Education, Turkey, elif.ozata@kocaeli.edu.tr
[2] Uludağ University, Faculty of Education, Department of Primary Education, Turkey, muozkan@uludag.edu.tr

system, and become aware that it must be protected. Therefore, it is important to determine how students construct the ecosystem in their minds and identify the misconceptions that hinder learning.

The literature review shows that students have some misconceptions about the functions of some organisms in the ecosystem (Arkwringht, 2014; Özkan et al., 2004; Palmer, 1999; Yörek, Uğurlu, Şahin & Doğan, 2010) besides the following misconceptions: the ecosystem consists of only living beings; living beings are more important than non-living beings (Brehm, Anderson & DuBay, 1986; Prokop, Tuncer & Kvasnicak, 2007; Yörek, et al., 2010); and the ecosystem has the same meaning as population, habitat, and community and refers to the relations between the living beings in the ecosystem (Adeneyi, 1985; Özkan, et al. 2004; Sander, Jelemenska & Kattmann, 2006). Some studies indicate that students cannot understand that different species have unique needs and different effects on the ecosystem (Munson, 1994). Previous studies also demonstrate that many students fail to comprehend the complicated relations in the ecosystem. For example, many students think that there is no interaction between living and non-living beings in the ecosystem (Adeneyi, 1985) or they think that there is a one-way relationship between the biotic and the abiotic elements of the ecosystem (Eilam, 2012; Sander et al., 2006). Hogan (2000) found out that the responses of 11-year-old students about irregularities in the food web included one-way and linear relationships rather than complex, two-way, and cyclical relationships. Also, some studies put forward that students are not aware of the flow of energy among the living beings in the ecosystem and fail to understand the true flow of energy in the food chain (Arkwringht, 2014; Griffiths & Grant, 1985; Hogan, 2000; Özkan et al., 2004; Yörek et al., 2010) and for example, according to Yörek et al. (2010), 9th grade students fail to understand feeding relationships in the ecosystem and just establish a linear cause and effect relationship between living beings (e.g. "the strong eats the weak"). According to some students who are in the 16 to 17 age group, there is always a biological balance in the nature. Balance is established again following a state of imbalance (Sander et al., 2006). Similarly, some students cannot understand that any change in the elements of the ecosystem may affect the entire system and just believe that the living beings in the ecosystem can be affected by such change only if there is a food chain relationship with the element undergoing change (Arkwringht, 2014; Gotwals & Songer, 2010; Grotzer, 2009; Munson, 1994). Gotwals and Songer (2010) determined that some of the 6th grade students have difficulties in explaining what might be impacts of deterioration on the ecosystem might be. According to Hogan (2000) the students thought that pollutants in the ecosystem are influential on an organism only when they are in direct with it, but they ignored their indirect influences. These misconceptions indicate that students cannot construct the concept of ecosystem in their cognitive structure truly and cannot comprehend this concept properly. ..

Although the literature contains many studies which show the misconceptions about ecology (Adeneyi, 1985; Brehm et al., 1986; Griffiths & Grant, 1985, Munson, 1994; Özkan et al., 2004; Ürey, Şahin & Şahin, 2011; Palmer, 1999; Prokop et al., 2007, etc.), and which show the understanding of only one relation in the ecosystem (Arkwringht, 2014; Eilam, 2012; Gotwals & Songer, 2010), there are only a limited number of studies dealing with students' levels of understanding the concept of ecosystem (Sander et al., 2006; Hogan, 2000; Yörek et. al., 2010). While two of them focused on high-school students in the 15 to 17 age group (Sander et al., 2006; Yörek et al., 2010), only one of them (Hogan, 2000) was conducted on middle school students at the age of 11. In this regard, the present study may fill a gap in the literature.

Studies dealing with the conceptual understanding and perception of ecology frequently employed the worksheets prepared based on the draw and explain protocol of White and Gunstone (1992). In the primary school level, drawings are tools that frequently used to illustrate the stories that have been heard, read or written by the students in order to explain where they had visited, and the activities they had performed. Also, it is possible to determine the students' conceptual understanding related with the scientific subjects by the help of drawings (Rennie & Jarvis, 1995). Students enjoy mostly drawings. Thus, drawings are powerful tools reduce the stress more than classical exams in order to evaluate students' success (Barraza, 1999). Drawings also enable to students that have

linguistic barriers for a better explanations of what they know (Chambers, 1983). Even it is easy to collect and analyze data, it is obviously difficult to understand main ideas beneath the drawings (Rennie & Jarvis, 1995). Furthermore, students who have different learning style may not reflect the understandings through drawings (Prokop & Francovicava, 2006). In order to overcome these limitations, drawings should be explained by the students (Rennie & Jarvis, 1995).

In the literature, there are some studies which bring out the conceptual understanding and perception of ecology through drawings. Some studies using such worksheets are Barraza (1999) that concentrated on the environmental perceptions of students in the 7 to 9 age group, Moseley, Desjean-Perrottaa and Utley (2010) that focused on the environmental perceptions and comprehension of pre-service teachers; Alerby (2000) that addressed the environmental thoughts of students in the 7 to 16 age group, Judson (2011) that investigated the mental models of the seventh grade students about the surroundings of deserts, Shepardson, Wee, Priddy, and Harbor (2007) that examined the mental models of the 4th to 12th grade students concerning environment, Sheparson, Choi, Niyogi, and Charusombat (2011) and Sheparson, Niyogi, Choi, and Charusombat (2009) that searched the comprehension of the seventh grade students regarding greenhouse effect, global warming, and climate change, and Duan and Fortner (2005) that ascertained the perceptions of university students regarding local and global environmental problems. The present study has two differences from the above-mentioned studies in terms of the methodology employed. Firstly, the present study enabled students to express their responses through not only drawings but also poems and compositions. Secondly, this study, contrary to other studies, did not request students to explain their drawings. Instead, it included questions about the elements of the ecosystem. In this way, it was aimed to overcome limitations of the analyzing of the data collected through drawings. Almost all studies in the literature make a qualitative evaluation of the data obtained through drawings. The present study, on the other hand, employed the rubric developed by the researchers in order to evaluate the collected data, as in the study carried out by Moseley et al. (2010).

In Turkey, the ecosystem is taught within the scope of various topics in science courses, but it is particularly handled in the 7th grade unit "Human-Environment Relations" (MEB, 2013). This study aims to determine the middle school 7th grade students' (12 to 13 years old) levels of understanding the concept of ecosystem.

Method

In this study, case study design, which is one of the qualitative research design, was used and aimed to analyse single or multiple case in their own limitation holistically (Yıldırım & Şimşek, 2008). Since there have been single case and single unit of analysis, this study is an holistic single-case design (Yin, 1994).

Study group

The study group consisted of 47 seventh grade students attending 3 different public middle schools. 31(66%) of these students were female (%66), and 16 (34%) were male.

Data collection tool, and data collection process

The data were collected through the worksheets entitled "Let's Create Our Own Ecosystem" developed by the researchers. On the first page of the worksheet, the students were requested to draw the ecosystem or express it in a poem or a composition in the blank given. The second page of the worksheet contained the following 5 questions:

1. What are the environmental and climatic features of your ecosystem?
2. What are the producers in your ecosystem?
3. What are the consumers in your ecosystem?
4. What are the decomposers in your ecosystem?
5. How is the flow of energy between the elements of your ecosystem?

With these questions, an attempt was made to ensure that the evaluation would not miss the points which the students were aware of although they failed to express them in their pictures, poems, or compositions. The worksheets were administered to the students after the unit "Human-Environment Relations" including the topic of ecosystem was taught. Worksheets were given to students as home study and they were collected back previous day.

The development of the rubric

In developing the rubric, the elements that are supposed to exist in the ecosystem were determined in the first place. Then the success criteria of the rubric were defined based on the acquisitions in the science curriculum. The success criteria were determined to be as follows: the living elements of the ecosystem; the non-living elements of the ecosystem; population and communities; relations in the ecosystem; and flow of energy in the ecosystem. Since matter cycle was not included in the acquisitions of the unit "Human-Environment Relations" taught in the middle school 7th grade, it was not included in the success criteria. Lastly, the levels of achievement were determined. The first 25 papers were subjected to preliminary evaluation in the above-mentioned version of the rubric. The statements causing trouble in evaluation were identified and corrected. In this way, the draft rubric was made ready for use.

Validity and reliability

The draft scale was submitted to one biology faculty member and two science education experts to receive their opinions. Expert opinions were received though an expert feedback from composed of closed-ended questions. The statements in this form were as follows:

It covers all the criteria regarding ecosystem.
The content of each criterion is limited to its own purpose. It does not overlap with other criteria.
Each criterion is clear and understandable.
The levels of achievement are capable of reflecting the achievement differences between students.

The expert opinions showed that the success criteria of "living beings" and "flow of energy" overlapped. Thus, "living beings" was removed from the rubric. The corrected version of the scale was checked by the experts again. In this way, the rubric was finalized.

16 of the worksheets collected from the students were evaluated by a different expert. By this means, an attempt was made to determine whether or not the rubric was perceived by different graders in the same way. To this end, the Pearson's coefficient of correlation between the results of scoring carried out by two different experts was calculated. Correlation values were found to be high ($r>0.70$) (Table 1). In addition, the first grader reevaluated the data 2 months later following the first evaluation. It was seen that correlation value was found to be high for the correlation between the two results of scoring conducted by the same grader ($r>0.70$) (Table 1). These values indicated that the rubric was reliable enough.

Table 1. Reliability Values Regarding Two Different Graders and Those Regarding Two Different Periods

Score obtained from the worksheet	**Correlation between the evaluations made by two different graders**	**Correlation between the evaluations made in two different periods**
The non-living elements of the ecosystem	0.94	0.92
Population and communities	0.85	0.90
Relations in the ecosystem	0.74	0.89
Flow of energy in the ecosystem	0.85	0.98
Total	0.94	0.97

Data analysis

Data analysis was carried out both quantitative and qualitative. Rubric was used in the quantitative analysis. The final version of the developed rubric included 4 success criteria ("the non-living elements of the ecosystem", "population and communities", "relations in the eco-system", and "flow of energy in the ecosystem" and three levels of achievement (0 point, 15 points, and 25 points). The minimum score to be obtained by a student from a success criterion was 0, and the maximum to be obtained by him/her was 25. The minimum total score to be obtained was 0, and the maximum total score to be obtained was 100. Investigation of general distribution by means of the quantification of qualitative data, enables to see the general drift of the date more easily, quickly and unprejudiced (Miles & Huberman, 1994). Also, it allows making comparison between themes (Yılmaz & Şimşek 2008). After the quantitative evaluation was made, the worksheet of each student was qualitatively evaluated in terms of the themes of the non-living beings of the ecosystem, population and communities in the ecosystem, relations in the ecosystem, and flow of energy in the ecosystem.

Results

38 students (80.9%) expressed the ecosystem in picture, 8 (17%) in poem or composition, and 1 (2.1%) in both poem and picture. The lowest score achieved by the students was 15, and the highest score achieved by them was 100. The average score achieved by the students was 70.43. The evaluation of the results in terms of the success criteria indicated that the students obtained the highest score from "population and communities" ($\overline{X}$=21.28) and obtained the lowest score from "flow of energy in the ecosystem" ($\overline{X}$=12.23) (Table 2).

Table 2. Descriptive Measurements Obtained by the Students from the Success Criteria

Success criteria	N	Xmin	Xmax	$\overline{X}$	SD
The Non-Living Elements of the Ecosystem	47	0	25	17.77	8.328
Population and Communities	47	0	25	21.28	6.952
Relations in the Ecosystem	47	0	25	19.15	7.019
Flow of Energy in the Ecosystem	47	0	25	12.23	8.835
Total*	47	15	100	70.43	21.72

*Descriptive measurements obtained by the students from the rubric

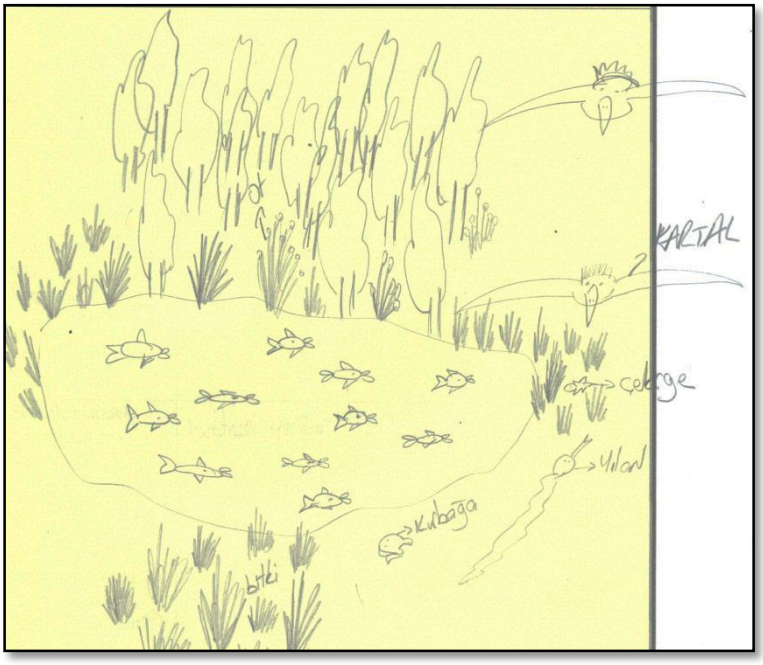


Figure 1. The Ecosystem Drawing of the Student Numbered 13

The examination of the worksheets of the students showed that they depicted natural environments free from human impact rather than cities, fields, etc. created by human beings (Figure 1). The worksheets including human life also gave coverage to natural environments (Figure 2). Few worksheets only highlighted city life (Figure 3).

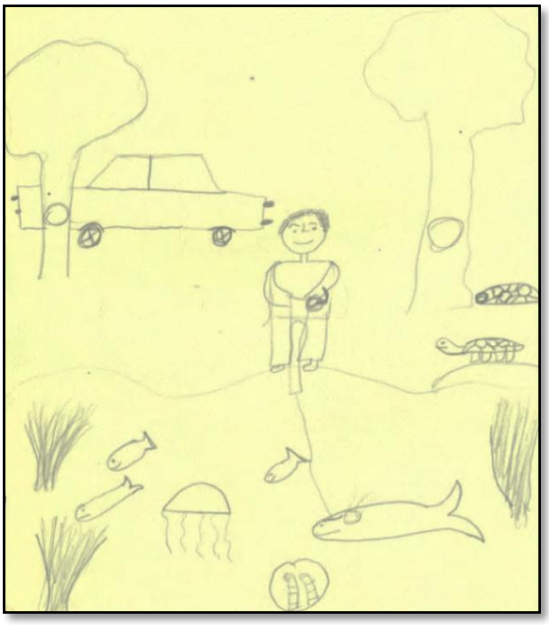
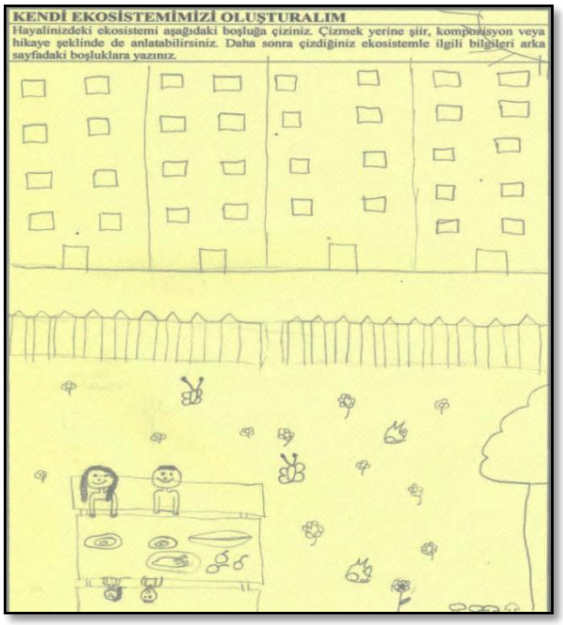


Figure 2. The Ecosystem Drawing of the Student Numbered 16



Şekil 3. The Ecosystem Drawing of the Student Numbered 6

The non-living elements of the ecosystem

The first success criterion was the non-living elements of the ecosystem. The average score achieved by the students from this success criterion was 17.77 (Table 2). 22 students (46.8%) highlighted both climatic elements (e.g. temperature, light, radiation) and non-climatic elements (e.g. soil, water, minerals) among the non-living elements of the ecosystem. 19 students (40.4%) highlighted either climatic elements or non-climatic elements. 6 students (12.8%) did not express any non-living element (Table 3).

Table 3. The Non-Living Elements of the Ecosystem

Success criteria	**f**	**%**
No non-living element was included (0 point).	6	12.8
Only one non-living element (climatic or non-climatic) was given as an example (15 points).	19	40.4
An example was given for both climatic elements (e.g. temperature, light, radiation) and non-climatic elements (e.g. soil, water, minerals) (25 points).	22	46.8
Total	47	100

Table 4. The Non-Living Elements of Ecosystem Indicated by the Students in the Worksheets

Climatic elements	f	Non-climatic elements	f
Sun	15	Soil	37
Temperature (e.g. arid climate, temperate climate)	15	Water (e.g. lake, river.)	33
Precipitation	6	House/apartment	10
Humidity	6	Mountain	6
Heat	2	Mineral	3
Light	1	Fence	3
Radiation	1	Bridge	3
		Road	2
		Bank	2
		Car	2
		Log	2
		Rock	1

A great majority of the students gave coverage to the non-living elements of ecosystem in their worksheets, but there were just a limited number of elements provided (Table 4). While the climatic elements included most were sun and temperature (Figure 3), the non-climatic elements included most were soil and water (e.g. lake, river) (Figure 1 and 2).

Population and communities

The second success criterion was population and communities. A great majority of the students (72.3%) included examples about population and communities in their worksheets (Table 5, Figure 1, Figure 2, and Figure 3). 10 students (21.3%) gave examples for either population or Communities. 3 (6.4%) students gave no example (Table 5).

Table 5. Population and Communities

Success criteria	f	%
No example was given for population and communities (0 point).	3	6.4
An example was given for either population or communities (15 points).	10	21.3
An example was given for both population and communities (25 points).	34	72.3
Total	47	100

Relations in the ecosystem

The third success criterion was "relations in the ecosystem". 24 students (51.1%) highlighted both the relations of living beings with living beings and their relations with non-living beings. 20 students (42.6%) highlighted either their relations with living beings or their relations with non-living beings. 3 students (6.4%), on the other hand, gave no example for the relations in the ecosystem (Table 6).

Table 6. Relations in the Ecosystem

Success criteria	f	%
Living beings were not associated with other living beings and non-living beings (0 point).	3	6.4
An example was given for either living beings' relations with other living beings or their relations with non-living beings (15 points).	20	42.6
An example was given for both living beings' relations with other living beings and their relations with non-living beings (25 points).	24	51.1
Total	47	100

Most of the students focused on feeding relationships within the scope of living beings' relations with living beings. This relationship was mostly described as fishing and grassing as seen in

Figure 2 and Figure 4. They mostly expressed living beings' relations with non-living beings by depicting people's shaping the natural environments. For example, fish were drawn in the lake environment. A worm was drawn on soil in Figure 5. Figure 4 described a nest built by a bird on a tree. Figure 3 and Figure 4 depict people shaping the environment (e.g. fence, bank, bridge).

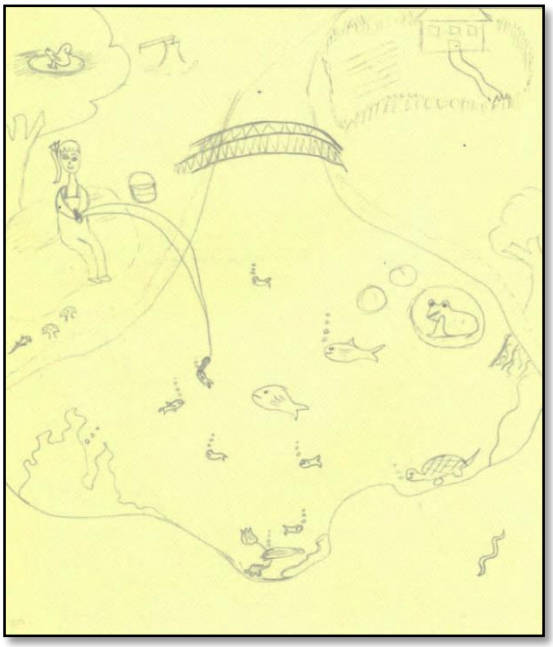


Figure 4. The Ecosystem Drawing of the Student Numbered 9

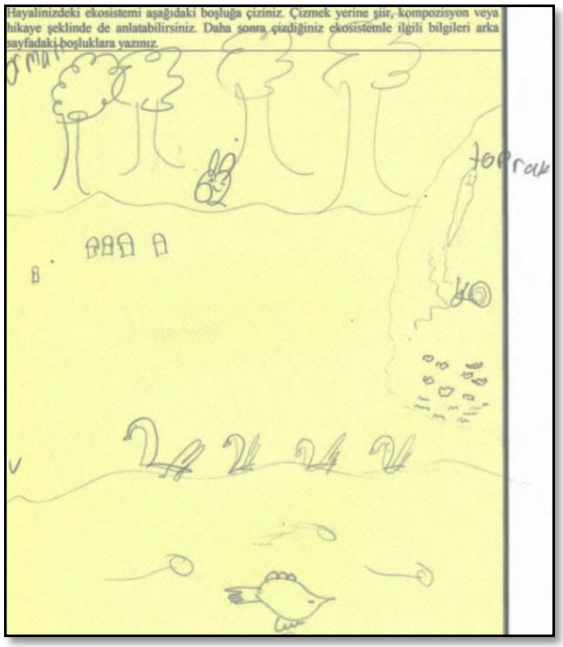


Figure 5. The Ecosystem Drawing of the Student Numbered 36

Flow of energy

The last evaluation criterion was flow of energy in the ecosystem. As is seen in Figure 6, only 8 students (17%) were able to give examples of food chain or food web including all living elements of the ecosystem. 53.2% of the students (25 students) left one of the living elements of the ecosystem out of the food chain or food web examples they gave. This element was mostly decomposers, as is seen in Figure 7. 14 students (29.8%) did not put any emphasis on flow of energy in their worksheets (Table 7).

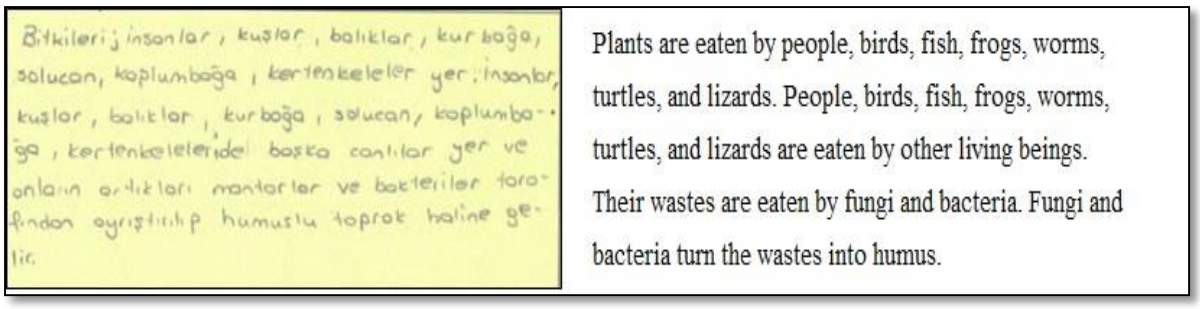


Figure 6. The Explanation of the Student Numbered 9 about the Flow of Energy in the Ecosystem

Figure 7. The Explanation of the Student Numbered 21 about the Flow of Energy in the Ecosystem

Table 7. Flow of Energy in the Ecosystem

Success criteria	**f**	**%**
No patterning was provided in regard to food chain and food web (0 point).	14	29.8
A food chain or food web example including one or two living element(s) of the ecosystem was given (15 points).	25	53.2
A food chain or food web example including all living elements of the ecosystem (producers, consumers, decomposers) was given (25 points).	8	17.0
Total	47	100

The examination of the living elements expressed by the students in their worksheets showed that plants, animals, and fungi were the living beings stated most for producers, consumers, and decomposers respectively (Table 8). In addition, the students had some misconceptions. For instance, soil, human beings, and animals were given as examples of producers; water and plants were given as examples of consumers; and minerals, plankton, and plants were given as examples of decomposers (Table 8).

Table 8. The Living Beings Stated in the Worksheets

Producer	**f**	**Consumer**	**f**	**Decomposer**	**f**
Plants	18	Human being	15	Fungus	23
Tree	16	Fish	12	Bacteria	6
Grass/herb	9	Animal	10	Alga**	2
Flower	6	Snake	10	Minerals**	2
Phytoplankton	3	Bird	8	Plankton**	2
Moss	2	Rabbit	7	Soil**	1
Reeds	1	Frog	6	Microbes**	1
Alga	1	Eagle	5	Insect**	1
Animal**	3	Squirrel	4	Birds**	2
Human being**	2	Insect	4	Plants**	2
Soil**	3	Lion	3		
Cow**	1	Grasshopper	3		
Light**	1	Zooplankton	2		
Mouse**	1	Other animals* ($f \leq 2$)	31		
Fly**	1	Water**	1		
Zebra**	1	Plants**	1		

* Duck, fly, turtle, worm, gazelle, whale, bear, cow, lamb, butterfly, donkey, lizard, deer, scorpion, sheep, jellyfish, mole, mouse, cat

** Misconception

Discussion and Conclusion

This study, which was conducted to determine the middle school students' levels of understanding, explaining, and expressing the concept of ecosystem, the elements of the ecosystem, and the relationships between these elements, shows that a great majority of the students construct the concept of ecosystem as a natural environment that has not been disrupted by negative human impact. Shepardson (2005), Lougland, Reid and Petocz (2002), Shepardson et al. (2007), Yavetz, Goldman and Pe'er (2014), and Barraza (1999) conducted studies on various age groups and determined that students regard natural areas as environment, but do not consider the areas created or changed by people as environment.

Brehm et al. (1986) stated that students think that the ecosystem includes only living beings. However, in the present study, as in Jordan et al. (2009), the students were found to be aware of that the ecosystem includes both living and non-living beings, and there is an interaction between them. However, they have limited cognition of them. For example, while the students put a big emphasis on sun and temperature, which are two climatic elements of the ecosystem, in their worksheets, they laid just a small emphasis on precipitation and humidity. They did not make any mention of heat, light, and radiation. Soil and water, which are two non-climatic non-living beings, were featured by the students as part of the ecosystem. This outcome shows parallelism with the studies of Ürey et al. (2011). Prokop et al. (2007) concluded that some students in the 11 to 12 age group regard living beings as the main elements of the ecosystem and think that non-living elements are less important than living beings.

The present study also revealed that the students had some misconceptions. For instance, some students thought that soil, human beings, and animals are producers in the food chain. These misconceptions may result from the daily life experiences of students such as people making agricultural production, plants reproducing on soil, and people obtaining products including milk from animals like cows or the daily life expressions such as "milk production" and "wheat production". There were also misconceptions that plants are consumers, and minerals, plankton, soil, etc. are decomposers. In parallel with this finding, Yörek et al. (2010) report that students attribute the function of decomposers to soil. Some studies reveal that there are misconceptions regarding the functions of the living beings in the ecosystem (Arkwringht, 2014; Munson, 1994; Palmer, 1999; Özkan et al., 2004).

Most of the students stated producers, consumers, and decomposers as the living elements of the ecosystem. However, there were only few participants who were able to give a food chain example including producers, consumers, and decomposers. Although some students gave bacteria and fungi as examples of decomposers, they just left them out of the food chains or the food webs they created. Accordingly, it can be said that, as found in Argwringht (2014), Griffiths & Grant (1985), Hogan (2000), Özkan et al., (2004), and Yörek et al. (2010), some students do not have a complete understanding of the flow of energy in the ecosystem, and some others do not have a perfect comprehension of the function of decomposers in the ecosystem.

The research results indicate that the students are aware of the fact that different communities live together in the ecosystem. The students mostly emphasized feeding relationships for living beings' relations with living beings. They mostly touched upon the habitats of non-living beings for living beings' relations with non-living beings. However, the students may have failed to describe in picture that non-living elements affect living-beings. Adeneyi (1985) stated that students are not aware of the relations between the living and the non-living elements of the ecosystem and have a misconception that there are relations only between living-beings. Jordan et al. (2009) determined that most of the students participating in their study were able to express in picture only one of the relations in the ecosystem. Ürey et al. (2011), put forward that some preservice teachers have difficulty in establishing the relationship between ecological events and facts. Additionally, the worksheets

contained some human activities that change natural ecosystems such as creating parks and gardens and logging.

These results reveal that although the students are aware of the elements of the ecosystem individually, they have just limited cognition of the functions of the elements in the ecosystem and their interactions with one another. Ecosystems are complex systems and that makes it difficult for students to understand this concept deeply (Eilam, 2012; Grotzer, 2009; Hmelo-Silver, Marathe & Liu, 2007; Jordan et al., 2009). In order to a deep understanding of concept of ecosystem, it is important for students to realize the close relation and look holistically to the ecosystems.

Implications

The fact that the students regard the ecosystem as natural environment not disrupted by negative human impact and consider only natural areas as environment is an important indicator of that students have cognition of that people have negative impacts on nature. That means an opportunity to deep the students' cognition of ecology. However, in doing so, not only the relationship between the conservation and the use of natural resources but also negative perception of the ecotechnological application should be taken into consideration during the teaching. Otherwise, each human activity about nature may be cognitively constructed by students as an activity disrupting the natural order.

Teachers should be aware of students' imperfect knowledge and misconceptions and deal with them precisely so that the ecological cognition of students is deepened meaningfully. Learning environments allowing students to perceive the ecosystem as a whole should be created. In addition, students should be made to comprehend that the ecosystem is a dynamic system, and any change in one of its elements affects the entire system. Relationships between these elements should be presented to students on the basis of cause and effects relationships by providing concrete examples from the daily life in a way clear to them. Real life-based activities such as documentaries and observations may be helpful in the teaching of food chain and food web, flow of energy, and relations in the ecosystem, which students are seen to have difficulty in understanding completely.

More detailed research may help to explain the relationship between students' cognitive levels and their perceptions regarding the ecosystem, its elements, their functions, and their positions in this integrated order.

Limitations

When the evaluation held away from the classic exam feelings, drawings are more useful evaluation tools that simply to carry out for the students. However, they have some limitations. For example, because of the limited space for drawings, students may not illustrate the some of the details (Prokop & Francovicava, 2006). It will be difficult to explain some of the component and some relations of the ecosystem by drawings. For instance, humidity which is one of the climatic component or effects of temperature on organisms. Also, some students may not be keen on drawings. To reduce these limitations, we also asked questions related with their drawings in the worksheets. Furthermore, students who did not want to draw were allowed to explain his or her opinion by the help of a poetry or an essay. Interviewing with students may be one of the effective steps to reduce limitations for further research Even it was not held in this study.

References

Adeniyi, E. O. (1985). Misconceptions of selected ecological concepts held by some Nigerian students. *Journal of Biological Education, 19*(4), 311-316. doi:10.1080/00219266.1985.9654758E

Arkwright, A. B. (2014). *2014 Fourth and eighth grade students' conceptions of energy flow through ecosystems.* Unpublished Doctoral Dissertation. University of Kentucky, USA. Retrived 9 February 2015 from http://uknowledge.uky.edu/cgi/viewcontent.cgi?article=1002&context=edsc_etds

Alerby, E. (2000). A way of visualising children's and young people's thoughts about the environment: A study of drawings. *Environmental Education Research*, *6*(3), 205-222. doi:10.1080/13504620050076713

Barraza, L. (1999). Children's drawings about the environment. *Environmental Education Research*, *5*(1), 49-66. doi:10.1080/1350462990050103

Brehm, S., Anderson, C. W., & DuBay, J. (1986, June). *Ecology: A teaching module (Occasional Paper no. 94).* Retrieved 27 May, 2011 from http://www.eric.ed.gov/PDFS/ED273445.pdf

Chambers, D. W. (1983). Stereotypic images of the scientist: the draw-a-scientist test. *Science Education*, *67*(2), 255-265. doi:10.1002/sce.3730670213

Dinç, M., & Özkaya, A. (2007). Ekosistem. Aydoğdu, M. ,Gezer, K. (Edi.). In *Çevre Bilimi* (pp. 35-70). Ankara: Anı Yayıncılık.

Duan, H., & Fortner, R. W (2005). Chinese College Students' Perceptions About Global Versus Local Environmental Issues. *The Journal of Environmental Education*, *36*(4), 23-58. doi:10.3200/JOEE.36.4.23-58

Eilam, B. (2012). System thinking and feeding relations: Learning with a live ecosystem model. *Instructional Science*, *40*(2), 213-239. doi:10.1007/s11251-011-9175-4

Gallegos, L., Jerezano, M., & Flores, F. (1994). Preconceptions and relations used by children in the construction of food chains. *Journal of Research in Science Teaching*, *31*(3), 259-272. doi:10.1002/tea.3660310306

Griffiths, A. K., & Grant, B.A.C. (1985). High school students' understanding of food webs: Identification of a learning hierarchy and related misconceptions. *Journal of Research in Science Teaching*, *22*(5), 421-436. doi:10.1002/tea.3660220505

Grotzer, T. A. (2009). Addressing the challenges in understanding ecosystems: Classroom studies. *National Association of Research in Science Teaching (NARST) Conference, Orange Grove, CA, April 18, 2009*. Retrieved 9 February, 2015 from http://ecomuve.gse.harvard.edu/publications/GrotzeretalNarst.pdf

Gotwals, A. W., & Songer, N. B. (2010). Reasoning up and down a food chain: Using an assessment framework to investigate students' middle knowledge. Science Education, *94*(2), 259-281. doi:10.1002/sce.20368

Hmelo-Silver, C. E., Marathe, S., & Liu, L. (2007). Fish swim, rocks sit, and lungs breathe: Expert-novice Understanding of complex systems. *Journal of the Learning Sciences*, *16*(3), 307-331. doi:10.1080/10508400701413401

Hogan, K. (2000). Assessing students' systems reasoning in ecology. *Journal of Biological Education, 35*(1), 22-28. doi:10.1080/00219266.2000.9655731

Jordan, R., Gray, S., Demeter, M., Lui, L., & Hmelo-Silver, C.E. (2009) An assessment of students' understanding of ecosystem concepts: conflating ecological systems and cycles. *Applied Environmental Education & Communication*, *8*(1), 40-48. doi:10.1080/15330150902953472

Judson, E. (2011). The impact of field trips and family involvement on mental models of the desert environment. *International Journal of Science Education*, *33*(11), 1455-1472. doi:10.1080/09500693.2010.495758

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

Milli Eğitim Bakanlığı (2013). *İlköğretim kurumları (ilkokullar ve ortaokullar) fen bilimleri dersi öğretim programı (3, 4, 5, 6,7 ve 8. sınıflar)*. Ankara.

Moseley, C., Desjean-Perrotta, B., & Utley, J (2010). The Draw-An-Environment Test Rubric (DAET-R): exploring pre-service teachers' mental models of the environment. *Environmental Education Research*, *16*(2), 189-208. doi:10.1080/13504620903548674

Munson, H. B. (1994). Ecological misconceptions. *Journal of Environmental Education 25*(4), 30-34. doi:10.1080/00958964.1994.9941962

Loughland, T., Reid, A., & Petocz, P. (2002). Young people's conceptions of environment: A phenomenographic analysis. *Environmental Education Research*, *8*(2), 187-197, doi:10.1080/13504620220128248

Odum, E., & Barrett, G. W. (2008). *Ekolojinin temel ilkeleri* (Işık, K., Çeviri Editörü). Ankara: Palme Yayıncılık.

Özkan, M. (2008). Biyolojik, ekolojik, genetik çeşitlilik ve doğa eğitimi. *Uludağ Milli Parkı, Bursa ve Çevresinde Ekoloji Temelli Doğa Eğitimi-III Sonuç Raporu.* Proje No: 108B027, s.4-29. Bursa.

Özkan, Ö., Tekkaya, C., & Geban, Ö. (2004). Facilitating conceptual change in students' understanding of ecological concepts. *Journal of Science Education and Technology 13*(1), 95-105. doi:1059-0145/04/0400-0095/0

Palmer, D. H. (1999). Exploring the link between students' scientific and nonscientific conceptions, Science Education, *83*(6), 639-653. doi:10.1002/(SICI)1098-237X(199911)83:6<639::AID-SCE1>3.0.CO;2-O

Pfundt, H., & Duit, R. (2002) *Bibliography: Student's alternative frameworks and science education.* Kiel, Germany. Leibniz-Institute for Science Education (distributed electronically). In Sander, E., Jelemenská, P., & Kattmann, U. (2006). Towards a better understanding of ecology, *Journal of Biological Education*, *40*(3), 119-123. doi:10.1080/00219266.2006.9656028

Prokop, P., & Fancovicova, J. (2006). Students' ideas about the human body: Do they really draw what they know? *Journal of Baltic Science, 2*(10), 86-95. Retrieved 12 February, 2015 from http://www.jbse.webinfo.lt/journal.htm

Prokop,P., Tuncer,G., & Kvasnicak, R. (2007). Short-term effects of field programme on students' knowledge and attitude toward Biology: a Slovak experience. *Journal of Science Education and Technology*, *16*(3), 247-255. doi:10.1007/s10956-007-9044-8

Rennie, L. J., & Jarvis, T. (1995). Children's choice of drawings to communicate their ideas about technology. *Research in Science Education, 25*(3), 239-252. doi:10.1007/BF02357399

Sander, E., Jelemenská, P., & Kattmann, U. (2006). Towards a better understanding of ecology. *Journal of Biological Education*, *40*(3), 119-123. doi:10.1080/00219266.2006.9656028

Shepardson, D. P. (2005) Student ideas: What is an environment?. *The Journal of Environmental Education*, *36*(4) 49-58.

Shepardson, D.P, Wee, B., Priddy, M., & Harbor, J. (2007). Students' mental models of the environment. *Journal of Research in Science Teaching*, *44*(2), 327-348. doi:10.1002/tea.20161

Shepardson, D. P., Niyogi, D., Choi, S., & Charusombat, U. (2009). Seventh grade students' conceptions of global warming and climate change. *Environmental Education Research*, *15*(5), 549-570. doi:10.1080/13504620903114592

Shepardson, D. P., Choi, S., Niyogi, D., & Charusombat, U. (2011). Seventh grade students' mental models of the greenhouse effect. *Environmental Education Research*, *17*(1), 1-17. doi:10.1080/13504620903564549

White, R., & Gunstone, R. 1992. *Probing understanding*. London: The Falmer Press.

Ürey, M., Şahin, B., & Şahin, N. F. (2011). Öğretmen adaylarının temel ekoloji kavramları ve çevre sorunları konusundaki kavram yanılgıları. *Ege Eğitim Dergisi*, *12*(1), 22-51. Retrieved 6 February, 2015 from http://dergipark.ulakbim.gov.tr/egeefd/article/viewFile/5000003966/5000004482

Yavetz, B., Goldman, D., & Pe'er, S. (2014). How do preservice teachers perceive 'environment' and its relevance to their area of teaching? *Environmental Education Research*, *20*(3), 354-371. doi:10.1080/13504622.2013.803038

Yıldırım, A., & Şimşek, H. (2008). *Sosyal bilimlerde nitel araştırma yöntemleri* (6. Baskı). Ankara: Seçkin Yayıncılık.

Yin, R. K. (1994). *Case study research design and methods*. USA: Sage Publications.

Yörek, N., Uğurlu, İ., Şahin, M., & Doğan, A. (2010). Qualitative investigation of Students' understanding about ecosystem and its components. *Natura Montenegrina*, *9*(3), 973-981.