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RESEARCH ARTICLE

Environmental Mental Models of Primary School Students: Are They Related to Gender and Grade Level?*

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Abstract

The purpose of this study is to determine the mental models of primary school students about the concept of environment. The research group consisted of 400 students, 219 girls and 181 boys, enrolling to the 3rd and 4th grade in a primary school located in İstanbul. The students were asked to draw the environment and explain the items they draw. Students' drawings were converted into quantitative data and scored with Draw an Environment Test-Rubric. When the drawings were examined, it was found that there are 110 different items related to the concept of environment. These items include biotic elements such as humans, different kinds of animals and plants, as well as abiotic elements such as sun, cloud, rain and sea. It was seen that there are also elements of artificial environment such as houses, cars, schools, factories and roads. Mann-Whitney U Test was used in statistical comparisons to determine the difference between the total scores obtained from the drawings according to grade level and gender. While there was a significant difference between the scores of the 3rd and 4th grade students ($MD_{3rd\ grade}$=189,46 n=200, $MD_{4th\ grade}$ =211,54 n=200, U=17792, p=.04), no significant difference was found in the comparisons made according to the gender (MD_{girls}=205,92 n=219, MD_{boys}=193,94 n=181, U=18632,50, p=.29). The drawings showed that the majority of the students do not see humans as a part of the environment and they have unscientific and missing mental models about the environment.
Keywords: Environment, Mental Models, Environmental Education

Introduction

In the environment, living things systematically interact with non-living things throughout their lives and carry out all their vital activities (Sadava et al., 2006). It is not possible to think of the environment and living things separately. They affect and are also affected by the environment. Among all living things, the human being is the one that affects the environment the most. Mankind, who lived by gathering, herding and hunting in ancient times, started to cultivate, grow crops and create pastures for animals in later periods (Ponting, 2010). With the adoption of agriculture, the population of human being, who settled down, increased rapidly, and this situation started to create a negative effect on the environment. The artificial environment that people created in order to be able to grow the food and to feed the animals has started to harm natural ecosystems. The agricultural process, which emerged with cultivation and domestication of animals, dating back about 10.000 to 12.000 years, was competed a few thousand years ago and the first cities were established with the discovery of different uses of tools (Türkman, 2000). Until the 16th century, developments in food production and disease control were limited, and in parallel, population growth remained at a certain level. The world population, which was 536 million in the 1650s, increased to over 1.5 billion in the 1900s with industrial revolution

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as well as the developments in the 18th and 19th centuries. This rapid increase in population has brought about an increase in environmental problems.

With the development of the industry and the increase in the need for raw materials, the unconscious consumption of natural resources in nature and the wastes generated due to production cause environmental problems. Especially after the Second World War, industrialization and urbanization in Europe accelerated to a great extent. Unfortunately, as a result of these developments, intense environmental pollution has been encountered. Factors such as rapid armament, use of nuclear weapons, radioactive pollution, industrialization and the need for raw materials, increasing population, increasing need for nutrients, use of fertile lands for either agriculture or urbanization have caused the depletion of natural resources before they find time to renew themselves (Joiremann, Truelove & Duell, 2010). While the value of the natural environment in life is increasing day by day, unfortunately the rate of pollution is also increasing. When considered in this context, solutions to environmental problems should be found before these problems threaten all living things.

The sensitivity of the society towards environmental problems in recent years is not without reason. Environmental problems are the problems that all humanity has to deal with and that shake the whole world in terms of impact. In the last 50 years, scientific and technological developments have reached significant dimensions. The economies of the countries have developed and the living standards of people have increased. In this period, environmental issues started to form the agenda of oral and written media. An increase has been observed in the number of newspapers and magazines dealing with the environmental issues. Various environmental protection laws have come to the fore in Western countries where industrialization has developed since the late 1960s and the early 1970s, when environmental problems began to be noticed.

Human beings, harming the environment; conducted international conferences to solve this problem. The first, Stockholm Conference (1972) was held for the solution of environmental problems. In this meeting, the delegates from the countries of the world discussed environmental problems and tried to determine short and long term measures. The declaration of the conference, which constitutes the first of the main resources on the environment in the world, is an example for subsequent national and international studies and is also important because it guides the actions to be taken in this field. The agenda items of the United Nations Conference on the Human Environment (UNCHE, 1972) are the resolutions published in the Stockholm Declaration (1972). In Stockholm Decleration it is stated that individuals, societies and states are responsible for the fulfillment of the obligations to protect the environment. During the preparation phase of the conference, many leaders approached this idea in moderation, due to factors such as the perspective and legal dimensions of the declaration in question. They did not support the idea of environmental protection, which imposes obligations on their citizens and the state. They stated that the declaration should not have binding judgments on the relations between the state-individual and the individual-individual (Pallemaerts, 1997). The Stockholm Declaration was reluctant to be adopted in the implementation process due to its binding decisions against states. Despite their political and moral commitment to a better environment, states have not prepared a document with binding provisions. The obligations and rights of the state, society and individuals have remained suspended. Although the states agreed on environmental problems, they could not take great steps in the implementation phase. Nevertheless, although it is not a binding document, the Stockholm Declaration is recognized as the foundation of contemporary international environmental law that fosters thought and innovation. Despite some obscurities, the Stockholm Declaration is not just a political and moral text; at the same time, some of its principles have been evaluated in international law today; some of these principles have made states binding. The Stockholm Declaration did not fully meet the demands.

However, due to the fact that it talked about the environment in the international arena, it enabled the establishment of the United Nations Environment Program (UNEP) within the United Nations. At the United Nations Conference on Environment and Development (1982), decisions were taken to protect the environment.

Another important act on environmental issues Our Common Future Report, or Brundtland Report, was prepared in 1987. The World Commission on Environment and Development (WCED) took part in the preparation of this report. This commission consisted of participants from twenty different countries (Bozlağan, 2005). The term sustainable development was mentioned for the first time in this study. In this report sustainable development is defined as “meeting the needs of the present generation without compromising the needs of future generations". Again, this report has applied a method that combines the development policies of the 1960s and the environmental policies of the 1970s. In Brundtland Report, in the face of growing environmental problems, establishing a vital bridge between environmental development and economic development and ensuring that development is “sustainable” has been accepted as the way out for humanity (Brundtland, 1987).

The United Nations Conference on Environment and Development (UNCED) was held in 1992. This conference was named as the ‘Earth Summit’. The most important feature that distinguishes this meeting from the others is that it was attended by the highest number of heads of states among the meetings held so far. Thanks to this meeting, heads of states came together around a common idea. The declaration of the Earth Summit Conference has been a document stating the extent of the damage done to the environment. This conference brought new dimensions to the movements for environmental protection.

The Rio+5 Conference was held in 1997 and Rio Summit was evaluated in this conference. Another movement that took place in the same time frame is the Millennium Goals. The Millennium Goals are in line with the sustainable development goals. It is a statement in which the principles of combating the obstacles in front of sustainable development are stated.

Along with the environmental development plans made in the international area, studies have been carried out in Turkey. The Third Five-Year Development Plan was developed in line with the Stockholm Conference (Kaya, Çobanoğlu & Artvinli, 2011). The Fifth Five-Year Development Plan, on the other hand, aimed to reduce environmental pollution. Sustainable development, which was revealed by the Rio Conference was adopted in the 6th Five-Year Development Plan (Sürdürülebilir Kalkınma Ulusal Rapor, 2002). The most important step in this area is the Right to Healthy Environment and Environmental Education, which are included in the 1982 Constitution. Article 56 of the Constitution states that all individuals have the right to live in a healthy environment. Environmental education is discussed in the 7th Development Plan Environment Specialization Commission Report (Akçay, 2006). Sustainable development and education for sustainable development have become the agenda items of the country in the 8th and 9th Development Plans (Özsoy, 2012)

Despite many meetings held on the subject of the environment and many precautions taken for environmental problems, it is seen that environmental problems are increasing day by day. Today, when the COVID-19 pandemic is experienced, how the human beings affect and are affected by the environment are the questions that need to be answered once again. It is obvious that holding meetings and making decisions in these meetings is not a solution to environmental problems. Environmental education has emerged as a solution for the destruction caused by humans to nature (Karataş, 2011). Individuals need to change their behavior in order to solve existing or potential problems. Behavior change is possible with environmental education that will

enable the change of knowledge, attitudes and values. For this to happen, individuals should have an improved understanding and should develop scientific mental models about the environment.

Mental models are the cognitive structures that reflect objects, symbols or relationships formed by many interrelated schema in the human mind (Gilbert et al., 2000). Mental models are dynamic constructs. They have a functioning that constantly evolves and changes through experiences (Greca & Moreira, 2000). Vosniadou and Brewer (1994) argue that mental models are effective tools in determining how concepts with a complex structure are interpreted in the human mind. According to Harrison and Treagust (2000), mental models reflect our mind. When we think of mental models as the reflection of the reality in the minds of individuals, all kinds of visual data about a subject, concept and phenomenon can be used as a good measurement tool (Moseley, Desjean-Perrotta, & Utley, 2010). For this reason using drawings, especially in early childhood, contributes to the understanding of the cognitive structures of the child (Cronin-Jones, 2005).

When the studies in the literature are examined; drawing a picture during a scientific study shows that it is both easy and instructive for children to express their feelings and thoughts, and that children communicate easily with the researcher without feeling any negative effects (Barraza, 1999; Dove, Everett, & Preece, 1999). Before children begin to speak or write, they learn to draw, which is the best and natural way to express themselves (Barraza, 1999). Drawings are like mirrors reflecting the inner worlds of children. Pictures are a kind of window to the minds of children. Besides, if children are prevented from carrying some artistic and aesthetic concerns, drawing a picture will motivate them more, the act of creation will progress, and they can do their mental activities. Drawings are powerful tools used in research of mental models. No matter how complex the concept may seem when the pictures are analyzed correctly, the pictures drawn reveal the mental model of the individual; reflect the relationship status of the schema in his/her mind (Schafer, 2012).

The first studies on environment (Payne, 1998; Rickinson, 2001) generally focused on the perception of the concept of environment and attitudes towards the environment. The following research studies focused on the impact of culture on the environmental perspective (Boeve-de Pauw &. Van Petegem, 2012; Liu & Lin, 2014), the perception of the future environment (Fleer, 2002; Özsoy & Ahi, 2014) and the factors affecting the perception of the environment (Loughland, Reid, Walker and Petocs, 2003). Studies investigating the concept of environment in cognitive dimensions and as a mental model (Ahi, Balcı & Alisinanoğlu, 2017; Liu & Lin, 2014; Moseley, Desjean-Perrotta, & Utley, 2010; Shepardson, Wee, Priddy, & Harbor, 2007) are relatively limited. For this reason, it is important to determine the mental models of children, who are our future, about the environment, with the drawing technique. In this context, in this study, it is aimed to examine the mental models of the third and fourth grade primary school students about the concept of environment.

Methodology

This study is a qualitative research conducted to determine the mental models of primary school students about the concept of environment. The most important feature of qualitative research is that it allows to examine the facts, norms and values from participants' perspectives (Ekiz, 2009). The phenomenology design, one of the qualitative research designs, was used as the research design. They are the studies carried out to explain the situations that we are aware of and that we do not fully understand and do not have in-depth knowledge (Yıldırım & Şimşek, 2008).

Working Group

The study group of this research consisted of 400 students who were enrolled in a primary school located in Esenyurt district of Istanbul province. The study group consisted of the 3rd and 4th grade students of this primary school. In this study, convenience sampling, which provides speed and practicality to the researcher, was used (Yıldırım & Şimşek, 2008). Students at the 3rd and 4th grades take science course, and in this course they encounter concepts related to the environment quite intensely. These grade levels are considered as the ages when students shape their mental models about the environment and related concepts. Therefore, in this study, it was studied with the 3rd and 4th grade primary school students. The distribution of participants with respect to their gender and grade level is shown in Table 1.

Table 1.

The Frequencies and Percentages of Participants

			Grade Level		
			3rd Grade	**4th Grade**	**Total**
Gender	**Female**	*f*	102	117	219
		%	46,6	53,4	100
	Male	*f*	98	83	181
		%	54,1	45,9	100
Total		*f*	200	200	400
		%	50,0	50,0	100

Data Collection Tools

In the study, drawings of children about the concept of environment were used as a data collection tool. Students were given a blank page to make their drawings, and an area was left at the bottom of the page where they could explain their drawings. In order for the evaluation of the drawings, Draw an Environment Test-Rubric, prepared by Moseley, Desjan-Perotta, and Utley (2010) and adapted into Turkish by Ahi (2015), was used. Four factors are used in the design of the DAET-R. These are: (a) humans, (b) biotic, (c) abiotic and (D) artificial environment. Each factor of the DAET-R is scored between 0-3 according to the features in the drawing. By scoring four factors, the total score from the DAET-R is calculated. A score between 0-12 can be obtained from the rubric. As the score obtained from the rubric increases, it is decided that the power of the drawing to reflect the environment increases. Scoring of DAET-R according to the factors is given below (See Table 2).

Table 2.

Draw an Environment Test Rubric

Factors	Scores			
	0	1	2	3
Human Factor	There is no human figure in the drawing.	The human figure is drawn without obvious interaction with other factors.	The human figure is drawn in interacting with another person or factor(s) (fishing, walking on a bridge etc.) But specific interaction with her/ his environment is not clearly depicted.	Clearly, the human figure is drawn in a system interacting with one or more factors. The student indicated this with arrows or labels.
Biotic Factor	The drawing does not contain a biotic factor.	A biotic factor (plant or animal) drawn without interacting with its environment.	A biotic factor is drawn in interaction with other biotic/ abiotic factor(s) but specific interaction with the environment is not clearly depicted.	A biotic factor is clearly drawn within a system in interaction with one or more factors. Arrows or labels are used to demonstrate interaction.
Abiotic Factors	The drawing does not contain an abiotic factor.	An abiotic factor is drawn without interacting with its environment.	An abiotic factor is drawn as an interaction with other biotic/abiotic factor(s) but specific interaction with the environment is not clearly depicted.	An abiotic factor is clearly drawn within a system in interaction with one or more factors. This interaction is indicated by arrows or labels.
Artificial Environment	The drawing does not contain any man-made elements.	Constructions (buildings, cars, bridges etc.) are drawn without interacting with their surroundings.	Constructions are drawn as interacting with other biotic/ abiotic factor(s) (e.f. smoke from chimney, exhaust etc.) but specific interaction with the environment is not clearly depicted.	Constructions are clearly drawn within a system in interaction with one or more factors. This interaction is indicated by arrows or labels.

Data Collection

The study was carried out in the spring semester of the 2017-2018 academic year. Before starting the data collection process, the school administration, the teachers and the parents of the students were informed about the study. Since the study was planned to be carried out in the classrooms of eight different teachers, a calendar was prepared for data collection. Necessary tools and materials (painting paper, crayons, pencils and erasers) were provided to students for their drawing. One of the researchers personally participated in the data collection process. Before starting the application, the students were informed about the research and it was stated that participation was on a voluntary basis and that the participation would not have any effect on the participation or exam grades. The drawings were made in the classrooms so that the students would feel comfortable and safe. Before the application, the students in the study group were clearly told what to do during the study, and the study started when it was ensured that the students understood the study. During the data collection process, students were asked to draw a picture of the environment and write down the items in their pictures. At the beginning of drawing, verbal questions such as "What are the concepts that come to your mind when you think of the environment?", "What do you think constitutes the environment?" asked to students to ensure that they reflect their mental models about the environment on their drawings. During the study, the students participating in the research were not asked to write their names and surnames, but they were only asked to write their gender on the back of the paper. Participants were asked to write the items in their drawings and explain their drawings in the area reserved for this purpose. The researcher confirmed the items with the students who completed the drawings. Students' explanations were used to describe the codes they used in their drawings. Due to the large number of students, writing the items they used in their pictures in the section provided allowed the researcher to confirm the codes in a short time. Care was taken not to allow students to interact with each other while drawing their pictures so that students would not be affected by each other.

Analysis of the Data

As the first step in the analysis of the data, the interpretative content analysis method was used. For this purpose, the data were first conceptualized and then the concepts were categorized according to their relationship. The frequencies and percentages of the items drawn in the pictures are presented. Then the drawings of the students were converted into quantitative data and scored with the Draw an Environment Test Rubric (DAET-R). For this, the drawings were scored between 0-3 points for each factor of DAET-R; human, biotic, abiotic and artificial environment. Four factors were scored in this way and the total scores obtained from the DAET-R were calculated. In order to ensure the reliability of the scores taken from the rubric, the drawings were evaluated separately by a field expert. To calculate the reliability between the raters, the reliability coefficient of Miles and Huberman (1994) was used. According to this calculation, the reliability among raters in the current study was calculated as .89. The raters discussed the drawings coded differently and conflicts were solved in this discussion. After scoring the drawings, inferential statistics were used to determine whether the data obtained from the participants differed according to gender and grade level. It was found that the scores obtained from DAET-R did not show a normal distribution. For this reason, Mann-Whitney U test, which is one of the non-parametric techniques, was used to find out whether there was a significant difference according to the gender or grade level in terms of the total scores obtained from the drawings.

Findings

Research Problem 1: What are the codes used by the 3rd and 4th grade primary school students in their drawings about the concept of environment?

The codes in the mental models of the students regarding the concept of environment were extracted by the analysis of the drawings. The frequencies and percentages of 110 different codes obtained in the study are given in Table 3. In addition, the codes in the children's drawings were examined according to four factors (human, abiotic, biotic and artificial environment). The results showed that 30 different codes related to biotic factors were obtained from the drawings. From biotic codes, 25 different codes were used for animals and 5 different codes were used for plants. The most used code for plants is tree (f=295) and the most used code for animals is bird (f=117). From the drawings, 11 different codes of abiotic elements such as sea, sun, cloud, mountain etc. were obtained. Among the codes of abiotic factor, the most used element was the sun (f=285) and the least elements were waterfall and star (f=1). There were 50 different codes for the artificial environment and some of these codes were; institutions and organizations, traffic elements, means of transportation and etc.

According to the data obtained from students' drawings, when students drew plants, animals, sun, sky and clouds in their natural colors, they expressed this as a livable, beautiful environment. They drew a blue sky, a yellow sun and colorful flowers to represent a clean environment. However, a sky covered with black and gray tones of smoke, clouds that appear black due to these smokes, were used to represent a polluted environment. A sad face was drawn as an expression of unhappiness on living and non-living things in the polluted environment. One of the most striking points in the findings was the depiction of living things and their nests. For example, the students reflected in their drawings the bee-honey hive, animals-huts, bird-birdhouses and people-houses together.

Table 3.

The Frequencies and Percentages of the Codes Obtained From Students' Drawings

Concepts	f	%	Concepts	f	%	Concepts	f	%
Biotic			Mountain	16	4	Airplane	4	1
Butterfly	98	24,5	Sky	252	63	Car	83	20,8
Bird	117	29,3	River	18	4,5	Metro	1	0,3
Dog	25	6,3	Soil	7	1,8	Bus	2	0,5
Cat	13	3,3	Rock	8	2	Ambulance	1	0,3
Rabbit	24	6	Lake	2	0,5	Mass Communicatio n		
Snake	3	0,8	Waterfall	1	0,3	Newspaper	2	0,5
Sheep	6	1,5	Star	1	0,3	Book	2	0,5
Turtle	2	0,5	Natural Events			Television	3	0,8
Chicken	2	0,5	Weather Events	9	2,3	Home		

Table 3 continued

Concepts	f	%	Concepts	f	%	Concepts	f	%
Chick	1	0,3	Rainbow	3	0,8	House	190	47,5
Bee	7	1,8	Artificial Environment			Shack	1	0,3
Octopus	1	0,3	Institution and Organization			Beehive	4	1
Bear	3	0,8	Mosque	1	0,3	Bird Nest	3	0,8
Fish	7	1,8	Bank	2	0,5	Pollution		
Snail	3	0,8	Hospital	15	3,8	Chimney	40	10
Giraffe	3	0,8	Patisserie	2	0,5	Bomb	11	2,8
Hedgehog	1	0,3	Fabrika	3	0,8	Fire	3	0,8
Duck	1	0,3	School	34	8,5	Garbage	64	16
Caterpillar	1	0,3	Police Station	2	0,5	Wastebin	74	18,5
Cow	1	0,3	Pharmacy	3	0,8	Recycle	11	2,8
Monkey	2	0,5	The Health Clinic	2	0,5	Garbage Bag	1	0,3
Donkey	1	0,3	Hardware	2	0,5	Goods and Objects		
Frog	1	0,3	Football field	9	2,3	Pot	2	0,5
Owl	1	0,3	Shop	1	0,3	Bench	3	0,8
Tree	295	73,8	Canteen	2	0,5	Ball	15	3,8
Grass	213	53,3	Market	11	2,8	Table	6	1,5
Forest	19	4,8	Pool	6	1,5	Kite	3	0,8
Flower	165	41,3	Trafic Elements			String	1	0,3
Mushroom	2	0,5	Sidewalk	3	0,8	Umbrella	1	0,3
Human			Trackway	76	19	Fishing Rod	2	0,5
Individual	232	58	Crosswalk	3	0,8	Balloon	1	0,3
Family	6	1,5	Warning Signs	2	0,5	Flag	22	5,5
Teacher	3	0,8	Traffic Lights	12	3	Swing	2	0,5
Police	2	0,5	Gas Station	1	0,3	Stairs	6	1,5
Abiotic Factors			Station	2	0,5	Desk	1	0,3
Sea	13	3,3	Vehicles			Other		
Sun	285	71,3	Bicycle	5	1,3	Bird Egg	1	0,3
Cloud	273	68,3	Ship	2	0,5	Heart	7	1,8

Research Problem 2: What are the mental models of the 3rd grade and 4th grade primary school students about the concept of environment?

When the scores obtained from DAET-R were examined (see Table 4), it was seen that a great majority (89.5%) of the students in the third grade drew a biotic element on its own, unrelated to other factors. Again, a significant portion of the 3rd grade students (86%) drew abiotic elements (eg, cloud, sun, sky, lake, soil, etc.) alone, unrelated to other entities. While the 4th grade students in the research group mostly used abiotic elements (79%), a significant part of this group (78%) drew biotic elements unrelated to other factors. Despite this, few students in the 4th grade represented the environment as a system. Considering the 4th grade students only 10 of them (5%) got 3 points from the human factor, 2 (1%) of them got 3 points from the biotic factor, 1 (0,5%) of them got 3 points from the abiotic factor and 1 of them got 3 points from artificial environment factor.

Table 4. Distribution of Students' DAET-R Sub Dimension Scores Obtained From Drawings

	F1 (Human)				F2 (Biotic)				F3 (Abiotic)				F4 (Artifical Environment)			
	3rd Grade		4th Grade		3rd Grade		4th Grade		3rd Grade		4th Grade		3rd Grade		4th Grade	
Score	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
0	73	36,5	75	37,5	19	9,5	28	14	27	13,5	31	15,5	71	35,5	48	24
1	57	28,5	43	21,5	179	89,5	156	78	172	86	158	79	158	57,5	135	67,5
2	68	34	72	36	2	1	14	7	1	0,5	10	5	10	7	16	8
3	2	1	10	5	0	0	2	1	0	0	1	0,5	0	0.0	1	0,5

When the total scores obtained from DAET-R (see Table 5) were examined, it was seen that a very important part of the participants (f= 297, 74,25%) got a total of 0-4 points. In the light of these data, it can be said that the children in this study drew the elements that make up the environment either alone or without any relation to other elements. Some participants (f=103, 25,75%) got scores between 5-8. In these drawings, there is no student who draws people in interaction with another person or other factor. This situation reflects the view that the concept of environment in the minds of children is incomplete and far from scientific realities. Some examples of students' drawings are represented below (See Figure 1, 2, 3 and 4).

Table 5. The distribution of total scores obtained from the DAET-R

Total Score	f	%
0-4	297	74,25
5-8	103	25,75
9-12	0	0
Total	400	100

Figure 1: Environmental Drawing of a Girl in the 3rd Grade

The child's total score rom DAET-R: 4
The drawing included biotic, abiotic items and artificial environment. The human factor is not included. The scoring of the drawing: 0 point for the human factor, 1 point for biotic and 1 point for abiotic factors and 2 points for the artificial environment (houses are represented in relation to another factor, smoke coming out of the building's chimney).

Figure 2: Environmental Drawing of a Boy in 4th Grade

The child's total score from DAET-R: 3
This drawing included the artificial environment and abiotic elements. The scoring of drawing; 0 point for human and biotic factors, 1 point for abiotic factor and 2 points for

the artificial environment (houses are represented in relation to another factor, smoke coming out of the building's chimney). a total of 3 points.

Figure 3: Environmental Drawing of a Girl in Fourth Grade

The child's total score from DAET-R: 2
The human figure is included in the drawing. The side with healthy foods is described as happy and the other half as unhappy.

Figure 4: Environmental drawing of a Boy in Fourth Grade

The child's total score from DAET-R: 8
In the drawing, man interacts with another factor by fishing. Smoke coming out of the ship's chimney and the sea and waves are also examples of related factors.

Research Problem 3: Is there a significant difference according to gender in terms of the total scores obtained by the students from the drawings?

Mann-Whitney U Test was applied to compare the scores of male and female students. According to the results of the test, it was determined that there was no significant

difference (U=18632,50, p=.29) in total scores between female students (MD_{girls}=205,92 n=219,) and male students (MD_{boys}=193,94 n=181) (p>0.05).

Table 6. Mann-Whitney U Test Result for Comparison of Female and Male Students in terms of Total Scores

Gender	n	Mean Rank	Sum of Rank	U	p
Female	219	205,92	45096,50	18632.50	0,29
Male	181	193,94	35103,50		

Research Problem 4: Is there a significant difference according to grade level in terms of the total scores obtained by the students from the drawings?

Mann-Whitney U Test was applied to compare the total scores of the students according to their grade levels. According to the results of the test, there is a significant difference (U=17792, p=.04) between the 3rd grades ($MD_{3rd\ grade}$=189,46 n=200), and the 4th grades ($MD_{4th\ grade}$ = 211,54 n=200) in terms of the total scores obtained. The total mean score of the 4th grade students is higher than the 3rd grade students.

Table 7.

Mann-Whitney U Test Result for Comparison of 3rd Grade and 4th Grade Students in terms of Total Scores

Grade Level	n	Mean Rank	Sum of Rank	U	p
3rd Grade	200	189.46	37892.00	17792	0,049
4th Grade	200	211.54	42308.00		

Discussion

The current study aimed to determine environmental mental models of primary school students and if these mental models are related to gender and grade level. For this purpose, students' drawings about environment were used. When the items in the drawings are examined the diversity of codes shows similar results with the studies in the literature. Items such as sun, tree, grass, cloud, bird, mountain are the ones which are mostly used by students in their drawings (Alerby, 2000; Barraza, 1999; Fleer, 2002; Özsoy, 2012; Shepardson, 2005). Şahin (2018) explains this situation as in their drawings, children, give place to objects and assets that they frequently encounter and see in their environment. Alerby (2000) and Keinath (2004) explains that students draw the environment as they see and experience with their nearby. Özsoy (2012) associates this situation with the daily lives of students. The conclusion we need to draw from here is to increase the diversity of codes and to enable students to develop more advanced mental models about the environment, we have to provide learning environments in which students can improve their experiences about environment.

The results of the study revealed that students reflect their mental models about environment on their drawings by representing human, biotic elements, abiotic elements and designed environment. However the results also showed that few interactions between these factors are represented in the drawings. In the literature review, the human figure has an important place in the representation of the environment. Thinking about the environment holistically; individuals who defend the view that living and non-living things are valuable as a whole include humans in their drawings. However, individuals who consider human beings superior to other living things, who think that the environment belongs to them think that human is not a part of the environment and reflect this thought in their drawings (Ahi, 2015). In the current study since the human figure was not drawn in a relationship with the other factors it can be concluded that students believe that human is not a part of the environment. Similar results were obtained in the related literature. Ahi (2015) stated that the children in the experimental and control groups usually portrayed abiotic and biotic elements as unrelated. Moseley, Desjean-Perotta and Utley (2010) stated that 66.4% of the individuals in the study group depicted biotic elements and 57% abiotic elements as unrelated. According to Liu and Lin's (2015) research, 39.9% of the participants pictured biotic elements and 72.5% pictured abiotic elements as unrelated. In addition, in all these studies, the percentage of drawing environmental elements in a system is very low. Considering that the mental models of individuals develop at a young age, it becomes necessary to provide learning environments where students can experience the interaction between biotic elements, abiotic elements, human and artificial environment. Children who cannot develop a correct mental model at a young age will become adults who cannot correctly define the relationship between the elements that make up the environment, and therefore have incomplete and unscientific mental models about the environment.

The inferential statistics were conducted if there are significant differences between students' total scores obtained from DAET-R with respect to their gender and grade level. The results revealed that there is a significant difference between 3rd grade and 4th grade students in terms of the total scores obtained from their drawings. This result shows that students have improved mental models as their grade level and age increases. This difference may be due to the education they received. In primary school, students are taking science courses in the 3rd and 4th grades and in these courses many concepts about environment are handled. Despite this, it should be reminded once again, that students do not perceive the environment as a system. So it is important to question the way of instruction used to explain environmental concepts. It can be proposed that student-centered methods and outdoor education should be implemented in environmental/science education carried out in primary schools. By this way students will find a chance to increase their experiences and will have improved and scientifically correct mental models.

The inferential statistics also revealed that there is no significant difference according to gender in terms of the total scores obtained from students' drawings. In the literature, some studies reported no gender difference (Özsoy, 2012) and some of them reported gender difference usually in favor of females. In the study of Gül (2010), it was determined that female students were more concerned about the environmental problems than the male students. In the study of Tecer (2007), it was determined that the rate of participation of female students in environmental groups is higher than male students due to environmental awareness and environmental concern. Although no significant difference was found in terms of total scores according to the gender variable in the current study gender is one of the most important factors that should be studied in environmental studies.

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İlkokul Öğrencilerinin "Çevre" Kavramı Hakkındaki Zihinsel Modelleri

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Özet

Bu araştırmanın amacı, ilkokul öğrencilerinin çevre kavramına ilişkin zihinsel modellerini belirlemektir. Çalışmaya, İstanbul ilinde bulunan bir ilkokulun 3. ve 4. sınıfına devam eden 219 kız ve 181 erkek olmak üzere 400 öğrenci katılmıştır. Çalışmaya katılan öğrencilerden "çevre" ile ilgili bir resim çizmeleri ve çizdikleri resimleri açıklamaları istenmiştir. Öğrencilerin çizimleri Bir Çevre Çiz Test Rubriği ile nicel verilere dönüştürülmüş ve puanlanmıştır. Çizimler incelendiğinde öğrencilerin çizimlerinde çevre kavramı ile ilgili 110 farklı ögeye yer verdikleri tespit edilmiştir. Öğrencilerin çizimleri, insan, hayvan ve bitki türleri gibi biyotik ögelerin yanı sıra güneş, bulut, yağmur ve deniz gibi abiyotik ögeleri içermektedir. Çizimlerde ev, araba, okul, fabrika ve yol gibi yapay çevre ögelerinin de olduğu görülmüştür. Çizimlerden alınan toplam puanların sınıf düzeyine ve cinsiyete göre farkını belirlemek için Mann-Whitney U Testi kullanılmıştır. Sınıf düzeyine göre yapılan karşılaştırmalar 3. ve 4. sınıf öğrencilerinin puanları arasında ($MD_{3.sınıf}$=189.46 n=200, $MD_{4.sınıf}$=211.54 n=200, U=17792, p=.04) anlamlı fark olduğunu gösterirken cinsiyete göre yapılan karşılaştırmalar ($MD_{kız}$=205.92 n=219, MD_{erkek}=193.94 n=181, U=18632.50, p=.29) kız ve erkek öğrencilerin çizimlerinde anlamlı bir fark olmadığını göstermektedir. Çizimler öğrencilerin büyük çoğunluğunun insanı çevrenin bir parçası olarak görmediğini ve çevre ile ilgili bilimsel olmayan ve eksik zihinsel modellere sahip olduklarını göstermektedir.

Anahtar Kelimeler: Çevre, Zihinsel Model, Çevre Eğitimi