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A Study to Determine the Mental Models in Preschool Children's Conceptualization of a Desert Environment

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Abstract

This study aimed to determine mental models and identify codes (schemes) used in conceptualizing a desert environment. The sample for this study consisted of 184 – out of a total population of 3,630 - children in preschool education in the central district of Kastamonu, Turkey. Within the scope of this study, the children were initially asked to draw a desert-themed picture, followed by a semi-structured interview to seek their opinions about the drawing and clarify what a desert environment meant to them. According to the findings, the children referred to 38 different codes relevant to the conceptualization of a desert environment; the most frequently used were the sun (*f*= 160, 86.9%), sand (*f*= 100, 54.3%), cacti (*f*= 74, 35.3%) and camels (*f*= 52, 28.6%). During the interview phase, 33 children described a desert as a place where there is no life, although a significant number of the children (*f*= 65, 39.1%) did describe a desert as a place where plants and animals live. Moreover, the sun and its rays were disproportionately bigger in size, in order to emphasize the excessive heat associated with the specific ecosystem found in a desert environment; to reinforce this, humans drenched in sweat, the absence of trees and the prevalence of cacti and exotic wildlife, including camels, scorpions and lizards, were all features of the children's drawings. Based on these findings, it was inferred that the mental models in some of the children (*f*= 72, 39.1%) were scientifically informed, with a degree of accuracy, about a desert environment. On the basis of the findings, it is considered that determining mental models in children in relation to different ecological concepts can be beneficial to teachers and curriculum programmers involved in environmental education.

Keywords: Desert, Mental model, Draw and explain, Child, Ecological concept.

Introduction

After every natural disaster, we are reminded that all the ecosystems in the biosphere are under threat as a result of the human exploitation of natural resources. Considering that the biosphere is essential to the preservation of all life forms (Callenbach, 2012), such a threat poses a shared and significant problem for humanity. An ecosystem is a natural system that originates from the regular and balanced interaction between all living and non-living things (abiotic elements), and which is static-oriented and self-renewing (Dinç

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& Özkaya, 2015; Kışlalıoğlu & Berkes, 2012). In numerous international forums, a wide range of administrative and scientific precautions have been taken in order to find solutions to the increasing number of environmental problems facing the planet (Özsoy, Özsoy & Kuruyer, 2011). According to the Intergovernmental Panel on Climate Change, factors, such as temperature, rain and soil moisture, wind, humidity, and nutrient cycle, determine the structure and features of an ecosystem (Noble, 2014). About 45% of the earth's surface is covered with desert and semi-desert areas (Shekhawat, et al., 2012). Most deserts occur between 20o and 40o latitude (Noble, 2014). Although it would appear that temperature determines the basic features of deserts, they are generally characterized by temperate climates with low annual rainfall, high evaporation, and large seasonal and daily temperature contrasts. They are also home to a significant number of endemic plants, reptiles, and fish (National Fish, Wildlife and Plants Climate Adaption Strategy, 2012).

Therefore, like forests or oceans, deserts need to be protected against man-made climate change. That said, in recent years, it has been forests, oceans and seas that have generated the most environmental concern; less attention has been given to desert ecosystems, which are also critical to the preservation of all life forms (Fenk, et al., 2014). It has been reported that the rise in global temperatures (Li, Chen, van der Tol, Luo & Su, 2014), leading to the melting of icebergs (Barrett, et al., 2008), the increase in rainfall levels, dry air, and changes in humidity rates, pose a significant threat to the fragile life forms found in deserts (United States Global Change Research Program, 2009). Exposure to tourism has also resulted in negative implications for the desert ecosystems. BBC Nature (Bardo, 2012) and The Independent (Connor, 2006) have published articles that bring this situation to light, warning that the human impact of tourism as well as off-road racing are particularly harmful to mammals and plants found in the desert. Moreover, desert ecosystems are unhelpfully compared with the notion of desertification, in which terrain that becomes infertile and unable to support living things is referred to as a desert (Abella, Chiquoine, Newton & Vanier, 2015): a notion that is both ignorant and anthropocentric in respect of desert ecosystems (World Resource Institute, 2005). There is a risk, however, that such a notion may infiltrate the education system and allow the perception that deserts are worthless terrain to prevail (Judson, 2011). In order to prevent against such a scenario, individuals need to acquire scientific-based knowledge at the earliest opportunity in life.

As part of the Belgrade Workshop (1975), six core aims were agreed in relation to environmental education (UNESCO, 1975), including raising awareness and shaping positive attitudes from the start of early childhood education (Kahriman-Öztürk, Olgan & Güler, 2012). Awareness, or the state of being aware, when examined in detail, involves the interaction between sensory and cognitive processes with schemes (Becker, Kleinböhl & Hölzl, 2012). Knowledge, conditioning and attention are required for awareness to develop properly (Ross & Nelson, 1973). In Piaget's (1970) study, it is understood that learning occurs by an individual's existing prior knowledge interacting with new data in order to create new structures of knowledge. It is also understood that learning has a strong relation with the individual's own world of concepts (Piaget, 1970). Learning biological and essentially ecological concepts follows a similar process. Knowledge concerning biological concepts can be found in the consciousness from early childhood and is defined as "naive biology" (Hatano & Inagaki, 1997). This kind of knowledge means that children can establish definitions that are compatible with the biological world, in a simplistic sense, allowing them to understand the nature of biological entities and processes (Inagaki & Hatano, 2006). Moreover, such knowledge relies on cognitive structures that are resistant to change (Sungur, Tekkaya & Geban, 2001). Carey (1985) emphasized that children cannot explain biological concepts scientifically before they are

10 years old (Akt. Prokop, Kubiatko & Fančovičová, 2007). Vosniadou and Brewer (1994), meanwhile, proposed that, when learning involves structured concepts of relative complexity, children segment the concepts' structure into units and compartmentalize them within mental structures. Similar cognitive processes are performed when learning about ecological concepts. It is particularly challenging, however, to learn about structured concepts, such as forests, deserts and the oceans, that involve terms such as habitat and abiotic elements (Hatano & Inaagaki, 1997; Palmer, 1994; Strommen, 1995). In other words, while concepts can be acquired more instinctively in early childhood, the scientific knowledge needed to properly explain them emerges in later years (Hatano & Inagaki, 1997; Inagaki & Hatano, 1993).

According to the constructivist approach, cognitive structures are schemes that emerge through heredity and regenerate quickly after the birth, before they are categorized and constructed (Gilbert, Pietrocola, Zylbersztajn & Franco, 2000). These structures establish a relation between cognitive schemes and reality; this schematic approach to dealing with reality is called a mental model (Gilbert, 2004). Gentner and Stevens (1983, s. 1) characterize mental models as "structures that are related to the knowledge of the human about the real world and knowledge processing phase". Given that memory units involve symbols that reflect knowledge, rather than knowledge itself, the determination and structure of mental models play a significant role in the process of learning (Brunning, Schraw & Norby, 2014). Furthermore, developments in cognitive psychology have led to the use of mental modeling in the educational field (Gentner & Stevns, 1983). In Johnson-Laird's (1983; s. 397) view, the most significant reason for expansion into education is that "mental models play a great role in the mental reflections of concepts, expressing problems, organizing the events, the ways of perceiving the world, and understanding the social and psychological situations in daily life". When we think of mental models as the reflection of reality in an individual's minds, every drawing that the individual makes about a subject, concept or phenomenon can be used in evaluating the mental models at work (Moseley, Desjean-Perrotta & Utley, 2010).

By activating the imagination and thinking processes, drawing allows for an efficient way of understanding an individual's mental structures (Vygotsky, 1971). Furthermore, drawings can reflect not only the knowledge schemes, but also those of feelings and instincts (Yavuzer, 2010). By drawing a picture, a child may reveal their feelings, values (Günindi, 2015), and mental models in visual terms, which can help determine their true thoughts, desires, and wishes (Coates, 2002; Einarsdottir, Dockett & Perry, 2009; Leonard, 2006; Piperno, Biasi & Levi, 2007). When a drawing is analyzed appropriately, the concept within it, no matter how complicated, is effective in revealing the schemes that exist in the drawer's mind and the relationship between these and other schemes, as well as the drawer's cognitive structures (Schafer, 2012).

The technique of drawing a picture has been increasingly used in determining mental models. The literature concerning mental models within the context of education focus generally on concepts related to astronomy (Kurnaz, Kıldan & Ahi, 2012; Nobes et al., 2003; Panagiotaki, Nobes & Potton, 2009; Samarapungavan, Vosniadou & Brewer, 1996; Straatemeier, van der Maas & Jansen, 2008; Saçkes & Korkmaz, 2015; Vosniadou & Brewer, 1992; 1994). Studies that are specifically concerned with environmental education tend to focus on the concept of "green" issues (Ahi, 2015; Liu & Lin, 2015; Moseley, Desjean-Perrotta & Utley, 2010; Shepardson, Wee, Priddy & Harbor, 2007). Palmer's (1994) work is widely considered to be the pioneering study into how children perceive concepts related to the environment and environmental problems, while subsequent studies have tended to focus on how different ecological and biological concepts are perceived (Braund, 1998; Prokop, Kubiatko & Fančovičová, 2007;

Shepardson, 2002). The concept of the forest has especially dominated research in this area (Ergazaki & Andriotou, 2010; Strommen, 1995; Ahi, Balcı & Özcan, 2015). While Judson's (2011) study sought to determine mental models in relation to the concept of the desert, it is more concerned with how deserts are perceived in different cultures, rather than being appreciated as an eco-system. For Strommen (1995), determining the level of knowledge in children and young people about the complexity of ecological and environmental structures ought to inform how educational programs are designed. Taking the aforementioned studies into account, it can be considered that determining how knowledge in the mind, which creates perceptions in accordance with developments in the neuroscientific field, is stored, and in which schemes are used to explain a concept, has more kinship with recent developments in the cognitive field, than efforts to determine perceptiveness towards a concept. The aim of this study, then, is to determine the mental models in children in preschool education in relation to the concept of the desert environment, and in so doing answer the following questions.

- What are the codes (schemes) that are used by children in their mental models about the concept of the desert environment?
- What are the mental models in children about the concept of the desert environment?

Method

This study is a qualitative study which aims to determine the mental models in children who are in preschool education about the concept of the desert environment. The study is also a phenomenological study based on social structuralist philosophy. According to Creswell (2007), social structuralist philosophy provides the historical background to all kinds of concepts and phenomena that are experienced by individuals in daily life, and these concepts and phenomena, along with new experiences, are shaped by individuals. A phenomenological study can also be a qualitative study given that it aims to determine the reactions of individuals towards a large variety of concepts and phenomena; in a more profound sense, it also seeks to establish the experience, knowledge and perception about phenomena from an individual's own perspective (Fraenkel & Wallen, 2009; Wiersma & Jurs, 2005). This study was conducted using a modified analytic induction approach. A modified analytic induction approach creates a narrowly scoped study question, whereby the study is expanded until it complies with the universal model in the way that it involves the inspected phenomenon (Wiersma & Jurs, 2005).

In this study, it was assumed that the children's knowledge about the concept of a desert was determined by their mental models. In response, the mental models concerning the concept, which are of interest to a social structuralist based phenomenological study, were examined thoroughly. Codes were identified and explanatory remarks collected from the participants in the course of the research.

Population and sample

The population for this study were children in preschool education within the central district of Kastamonu, Turkey. According to the Turkish Ministry of National Education (2015), 3,630 children in total were in preschool education in this district during the 2014-2015 school year when the study was conducted. According to Fraenkel and Wallen (2009), although a minimum of 100 participants are enough to create a sample, attention should be paid to the generalization issue. This study was conducted with 184 children and, while the sample can be considered as representative of the study population, the researcher acknowledges that the number of the participants was a limitation of the study. In response, the researcher took great care in ensuring that the demographic variables

were compatible with the population (Fraenkel & Wallen, 2009). The demographic characteristics of the children in the sample group are demonstrated in Table 1.

Table 1. *Demographic characteristics of the children in the sample*

	Girl		*Boy*		*Total*	
	f	*%*	*f*	*%*	*f*	*%*
Age 4	34	18.5	28	15.2	62	33.7
Age 5	42	22.8	59	32.1	101	54.9
Age 6	10	5.4	11	6.0	21	11.4
Total	86	46.7	98	53.3	184	100.0

47.6% of the 3,630 children in the total population were girls, while 52.4% were boys (MNE, 2015). In terms of gender, compatibility between the population and the sample group is considerably high. In both the population and the sample, the age range was between four and six years of age. In terms of age distribution, the largest age group in the population consisted of those aged six, with those aged four being the smallest; in the sample, however, the largest age group consisted of those aged five, while those aged six were the smallest. However, the difference in age distribution did not pose a significant problem given that no inferential claims were made on the basis of age.

Acquisition of data

In the study, the data were gathered using the draw and explain technique. In other words, the pictures that the children drew and the remarks they made about them during the interview stage, constituted the research data for the study. The technique of draw and explain is one of the methods that is frequently used in the study of mental models (Liu & Lin, 2015; Moseley, Desjean-Perrotta & Utley, 2010; Shepardson, Wee, Priddy & Harbor, 2007). In this technique, the drawing establishes the codes (schemes) that form mental models, while the interview explores the experience and knowledge behind the mental model.

The data was collected in preschools in the central district of Kastamonu, Turkey, during the spring semester of the 2014-2015 school year. A mutually convenient time for conducting the research was agreed with school management and teachers beforehand. The researcher was only present in the school during the appointed times. In order to minimize the impact upon the children's preschool day, the research took place during art activity sessions, thereby locating the process within a typical class setting. The pictures were drawn on tables, with four children sat at each; only crayons or chalk were permitted for the drawing at the direction of the teachers. During the drawing stage, interaction between the children was restricted in order to prevent them from influencing each other and exchanging ideas. This was followed by the interview stage, which took place with each child individually in the playroom area, where the children are felt to be most at ease. The children who did not wish to speak with the researcher were included in the interviews with their teachers. The data acquisition protocol is demonstrated in Table 2.

Table 2. *Data Acquisition Protocol*

Drawing a picture of a desert landscape
1) Ask the child to draw what comes to his/her mind when thinking of a desert.
2) Discuss the codes in the picture with the child about what they signify, and ask them to label these codes in writing on the drawing.
3) Discussed whether the codes drawn by the child have any relation to each other.
Questions asked during the verbal explanation
1) What comes to your mind when you think of a desert?
2) What is a desert like in your opinion?
3) Is there life in a desert?
4) Are the codes on your drawing related to each other?

Data analysis

Initially, the code determination was performed using the collected data. Within this process, the researcher recorded the codes identified in each picture. Later, the interviews in relation to each picture were analyzed, and themes regarding the remarks were collated and compared with the existing literature. Already, correlation between these themes and those identified in earlier studies (Judson, 2011; Moseley, Desjean-Perrotta & Utley, 2010; Shepardson, Wee, Priddy & Harbor, 2007) was observable.

The children's remarks were then placed alongside the relevant themes by the researcher. Another researcher, who is an expert on environmental education, conducted the same process simultaneously, and the theme lists of both the researcher and the expert were compared using the Kappa (κ) measure in SPSS; a high compatibility was detected with .93κ. An integrated list was then sent to another environmental education expert with the remarks, following which .92κ was achieved. Accordingly, in both comparative processes, a high compatibility was detected (Pallant, 2011).

Findings

Using the data collected in the study, the codes that were identified in the children's drawings are set out in Table 3 below.

According to Table 3, 38 different codes relating to the concept of the desert were identified in the children's drawings. When analyzing the codes according to ages, the age five group produced the maximum number of codes (38), followed by age 4 (21 codes), and finally, age 6 (15 codes). The most significant variance in the codes was for categories relating to animals and abiotic factors. Among the codes in the drawings, the sun (*f*= 160, 86.9%), sand (*f*= 100, 54.3%), cacti (*f*= 74, 40.2%), humans (*f*= 65, 35.3%) and camels (*f*= 52, 28.6%) were more prevalent than other codes. The fact that the most-drawn codes were also the most essential schemes within the concept of a desert ecosystem is noteworthy. In addition, the pyramid code (*f*= 28) within the artificial environment category is among the codes that also appears relatively often. Another notable finding was that the highest number of codes was drawn by the children in the age five group, while the lowest number of codes was drawn by the children in the age six group.

Table 3. *Codes(Schemes) Identified in the Drawings Regarding the Concept of the Desert*

Codes	Age 4		Age 5		Age 6		Total	
	f	%	*f*	%	*f*	%	*f*	%
Human	15	8.2	37	56.9	13	20.0	65	100.0
Animal								
Bird	5	45.5	6	54.5	0	0.0	11	100.0
Camel	17	32.7	29	55.8	6	11.5	52	100.0
Lizard	0	0.0	2	66.7	1	33.3	3	100.0
Butterfly	0	0.0	1	100.0	0	0.0	1	100.0
Insect	1	20.0	4	80.0	1	20.0	5	100.0
Fox	0	0.0	4	80.0	1	20.0	5	100.0
Ant	0	0.0	3	100.0	0	0.0	3	100.0
Spider	2	25.0	6	75.0	0	0.0	8	100.0
Cat	0	0.0	3	100.0	0	0.0	3	100.0
Snake	0	0.0	3	100.0	0	0.0	3	100.0
Bee	0	0.0	1	100.0	0	0.0	1	100.0
Lion	0	0.0	1	100.0	0	0.0	1	100.0
Scorpion	1	50.0	1	50.0	0	0.0	2	100.0
Rabbit	0	0.0	1	100.0	0	0.0	1	100.0
Dog	1	33.3	2	66.7	0	0.0	3	100.0
Plants								
Cactus	19	25.7	45	60.8	10	13.5	74	100.0
Tree	15	68.2	7	31.8	0	0.0	22	100.0
Palm Tree	0	0.0	4	100.0	0	0.0	4	100.0
Bush	3	42.9	4	57.1	0	0.0	7	100.0
Grass	5	41.7	7	58.3	0	0.0	12	100.0
Flower	14	66.7	7	33.3	0	0.0	21	100.0
Abiotic Factors								
Sun	54	33.8	88	55.0	18	11.3	160	100.0
Cloud	16	34.0	22	46.8	9	19.1	47	100.0
Star	0	0.0	6	100.0	0	0.0	6	100.0
Sky	6	21.4	18	64.3	4	14.3	28	100.0
Sea	0	0.0	5	100.0	0	0.0	5	100.0
Dune	2	8.0	21	84.0	2	8.0	25	100.0
Sand	35	35.0	52	52.0	13	13.0	100	100.0
Soil	5	29.4	12	70.6	0	0.0	17	100.0
Oasis	0	0.0	2	100.0	0	0.0	2	100.0
Fruit (Date Palm)	0	0.0	1	100.0	0	0.0	1	100.0
Natural Events								
Rainbow	0	0.0	4	100.0	0	0.0	4	100.0
Rain	1	25.0	1	25.0	4	50.0	4	100.0
Artificial Environment								
House	8	53.3	6	40.0	1	6.7	15	100.0
Car	2	16.7	10	83.3	0	0.0	12	100.0
Pyramid	0	0.0	19	67.9	9	32.1	28	100.0
Indian Tent	0	0.0	0	0.0	1	100.0	1	100.0

Mental Model Theme: The place where plants and animals live
The codes in the Picture: Sun, camel, sand, cactus, bush

Picture 1. *C6's desert drawing (Girl, age 4)*

It was also reported that the reason why the sun was disproportionately larger in size and colored orange in some of the drawings was to emphasize the excessive temperatures associated with a desert environment. It was also stated that the reason for drawing cacti or trees with a bent shape was because it is difficult to find water in a desert. In 24 of the human figures that were drawn, the faces were unhappy while in one picture the human figure appears to be sweating. Likewise, there are unhappy faces on the animal drawings. Furthermore, the children made more frequent use of the sand code (*f*= 100, 54.3%) than the soil code (*f*= 17, 9.2%); some of them even drew dunes (*f*= 25, 13.5%). The colors used in the drawings were mainly various shades of red and yellow, while some of the trees (*f*= 11, 5.9%) were drawn in the shape of palm trees rather than less exotic kinds of tree. It was also noted that every child in the sample perceived deserts as permanently hot. Based on the codes identified in the drawings, it can be said some of the children (*f*= 48, 26.0%) perceived the concept of the desert as a specific ecosystem, which indicates a scientifically-based mental model.

Mental Model Theme: The place where plants and animals live
The Codes in the Picture: Sun, camel, cactus, sand

Picture 2. *C43's desert drawing (Boy, age 5)*

The remarks made by the children in relation to their drawings and the categories regarding the mental models based on these remarks are set out in Table 4 below.

Table 4. *Mental Model Themes Regarding the Concept of Desert*

Categories	**Age**							
	Age 4		Age 5		Age 6		Total	
	f	%	*f*	%	*f*	%	*f*	%
A place where animals and plants live	23	31.9	40	55.6	9	12.5	72	100.0
There is no life	11	33.3	18	54.5	4	12.1	33	100.0
A place where plants live	9	37.5	14	58.3	1	4.2	24	100.0
A place where animals, plants, and humans live	6	30.0	9	45.0	5	25.0	20	100.0
Living/nonliving (everyday life)	6	33.3	11	61.1	1	5.6	18	100.0
A place where animals live	6	40.0	8	53.3	1	6.7	15	100.0
A place of nature, a natural area	1	50.0	1	50.0	0	0.0	2	100.0

It can be seen from Table 4 that the children in the sample group, in explaining their drawings, define the desert mostly (*f*= 72, 39.1%) as a place where animals and plants live. Some of the children (*f*= 33, 17.9%), however, stated that there is no life in the desert. Considering the table in terms of age groups, the theme of a place where animals and plants live was emphasized the most across all age groups. Commenting generally on Table 4, it can be stated that some of the children (*f*= 72, 39.1%) possessed a scientifically-accurate mental model, while the other 112 children (60.8%) have a non-scientific-based model.

With regard to the definition that a desert is 'a place where animals and plants live', C12 stated that, "*[....] this place is so hot that humans can't take it. Animals are stronger than humans, so they can live there. The plants there have thorns. Animals eat them, also they eat each other. But there can't be cities there*". Another child, C96, said that, "*Humans can't live there, there is sand everywhere. But flowers live in the soil, and also some animals live in the sand, like scorpion. So they [plants and animals] live in the desert*". Remarks made in reference to the desert being a place where 'there is no life' generally concerned the notion that a desert is too hot to live in, as exemplified by C48's comments that, "*Deserts are very hot places. They are so hot that everything gets dry. Rain gets dry in the air. Look at my drawing. Rain got dry in the air. Since it is hot, living beings can't live there*".

Mental Model Theme: The place where humans, plants and animals live
The codes in the picture: Sun, cloud, camel, pyramid, cactus, human

Picture 3. C45's desert drawing (boy, age 6)

The remarks about 'a place where plants live' were based on two different beliefs. The first was that plants were not regarded as living beings. C13 remarked that "*only plants live in desert and that's because they are not alive*", while C19 believed that plants "*are not like animals or us, they can't breathe. They are not affected by heat. So they exist in desert, but not many*". The second belief was that plants survive by absorbing water from the soil. As C57 stated, "*Roots of plants are far beneath the soil, since they are not affected by the heat, they live in the desert*", while C171 commented that "*Plants feed on the water in the soil. There is so much soil in the desert. So they take the water in the soil for themselves. But humans and animals can't*".

Mental Model Theme: The place where plants and animals live
The codes in the Picture: Sun, cloud, sand and dunes, human, cactus, camel

Picture 4. C4's desert drawing (Girl, age 5)

20 children who participated in the study described a desert as a place where humans, animals, and plants live. Some of the remarks made concerning this category were that:

- *"Deserts are not like cities, but all the living beings live there." (C5)*
- *"Deserts are very hot and people sweat very much, (...) and animals go outside at night. And there are cactuses, they store the water. Anyone can live there." (C174)*

- *"Not as many as in here, but there are living beings in the desert, (...) and humans live there." (C65)*

Meanwhile, 18 children did not regard a desert environment as a much different from their everyday living environment, reflected by their remarks in the living/non-living category:

- *"The desert is not a different place. There are cars, roads, houses. It is a place like here." (C123)*
- *"There are jeeps in there, roads are covered with sand, but there are houses, people don't go out of their houses because it is hot there."(C93)*

15 children who participated in the study defined the desert as a place where only animals live. A commonly held view was that animals are much more capable of enduring harsher climatic conditions than humans and plants, along with a belief that only animals are able to live in the desert for this reason. C76, for example, claimed that, "*There is very little water in the desert. Humans can't live without water. And plants can endure for a very short time. (...) animals are very powerful. They can endure the lack of water. There are only animals in the desert*". Some of the remarks in this category emphasize the capacity for animals to adapt to a desert environment. C138 gave an impressive explanation in biological terms by stating that, "*Humans and plants can't hide from the sun by going beneath the soil, but animal can. Camels store water on their backs, and drink it from there. So they can live there*". Only two children defined a desert environment as a natural habitat. One of the remarks in relation to this category came from C6, who said that, "*Deserts are places where there are no humans. Humans go there to picnic or visit (...) they are natural places, like forests, where there is no one*".

Discussion

The aim of this study was to determine mental models in children about the concept of a desert environment. In the first instance, the codes that inform the mental models relating to such an environment were identified. According to the findings, most of the children (*f*= 160, 86.9%) included the sun code, with codes for sand (*f*= 100, 54.3%), cacti (*f*= 74, 40.2%), humans (*f*= 65, 35.3%), and camels (*f*= 52, 28.6%) also significant used. 38 different codes were identified in total from the children in the sample. All codes were classified under seven different categories, each with sub-categories as follows: 15 different codes in the animal category, nine different codes in the abiotic element category, six different codes in the plant category, four different codes in the artificial environment category, and two different codes in the natural event category, along with single-coded categories for humans and fruit. In terms of the variety of codes and the frequency of their use, resonances exist between this study and previous studies in the field. For example, Barraza's (1999) study also found that children depicted the sun, animals and trees when asked to produce drawings about their concept of the environment. In the (2007) study carried by Shepardson, Wee, Priddy and Harbor, a significant number of the participating children also included the sun, animals and plants in their drawings, while Özsoy and Ahi's (2014) study showed not only the significant prevalence of the sun, animals and humans in children's drawings about today's environment but also that of the future. Taking all these findings into account, it is reasonable to claim there are common codes specific to the environment that frequently inform the mental models in children regarding the desert ecosystem. The main explanation for this is provided by Mason and Langenheim (1957), in that the concept of the desert and the concept of the environment are to some extent synonymous in ecological terms, which allows for the identification of common schemes in mental models that are not complicated by any differences between scientific disciples. Considering that mental models are active cognitive structures related to the

mental models of different structures (Freca & Moreira, 2000), it can be concluded that children store the concepts of both the desert and the environment associatively in their minds.

The presence of the human code in drawings regarding the environment should be interpreted carefully. It has been established in most of the similar studies in the existing literature that the human figure is pictured either rarely or routinized and unrelated (Ahi, 2015; Özsoy & Ahi, 2014; Liu & Lin, 2015; Moseley, Desjean-Perrotta & Utley, 2010; Shepardson, Wee, Priddy & Harbor, 2007). In this study, while some of the children (*f*= 65, 35.3%) included humans as a code, only 20 children during the interview stage described the desert as a place where humans, animals and plants live. When the drawings were examined more closely, it was observable that human figures were either drawn alone or riding a camel in most of the drawings. This finding has parallels with other studies in the literature (Littledyke, 2004; Loughland, Reid, & Petocz 2002; Shepardson et al., 2007; Yardımcı & Bağcı Kılıç, 2010). According to this study's findings, while very few children (*f*= 20, 10.8%) have a false mental model regarding people living in the desert, a significant number of them see humans as part of the desert environment even though they are unable to describe humans' relationship with that environment clearly. One of the main reasons for this is that the linear development of children is not at a sufficient level to make sense of such complexity at a young age (Yavuzer, 2010). As Dunlop et al. (2000) stated, another reason could be how an individual's perspective towards environment is manifest. In other words, the children who were able to accept the desert environment as including living and non-living phenomena and systems include humans in their drawings, whereas those who viewed humans as a more superior than other living things did not include humans (Brechignac, 2011; Herrmann, Vaxman & Medin, 2010).

After analyzing the codes acquired during the study thoroughly, the results are impressive. Some of the children gave inferences about their perception of the desert in their drawings. This is particularly true where the drawing of the sun was concerned. For example, the common depiction of the sun as orange, whose rays are thick and tall, emphasized that the desert environment is perceived as extremely hot. One of the significant findings reported by Ahi (2015) is that children include depictions of soil when asked to draw something about the concept of the environment. In this study, however, it was noteworthy that the children drew sand in their desert drawing instead of soil. Moreover, even in the studies that have sought to determine the perception and mental model regarding the environment (Ahi, 2015; Özsoy & Ahi, 2014; Shepardson, Wee, Priddy & Harbor, 2007) or evaluate knowledge regarding a forest habitat (Strommen, 1995; Ergazaki & Andriotou, 2010), camels, spiders, foxes, lizards and scorpions are hardly depicted; in the desert drawings, however, the camel was particularly prevalent. Where humans and animals were drawn, they were depicted as sweating excessively and with unhappy faces; even the sun was, on occasion, given an unhappy face in response to the perception of extreme heat. What these findings indicate is that the children in the sample group perceived the concept of a desert environment as a different type of ecosystem with specific conditions of its own.

The remarks made by the children concerning their drawings further support this conclusion. For example, although most of the children (*f*= 72, 39.1%) defined the desert as a place where plants and animals live, some (*f*= 33, 17.9%) defined it as a place where there is no life. The findings from the interview stage correspond to the results of Judson's (2011) study, involving older children, which found that 78% of the participants in the control group and 82% in the test group defined the desert as a place where plants and animals live. For Judson (2011), this kind of response demonstrated that the children who participated in his study possessed mental models that were appropriate to the concept of

a desert environment. Accordingly, it is considered that the children who participated in this study also possessed scientifically-based mental models about the concept. Although the age groups in this and Judson's (2011) studies differ, perceptions about a desert environment do not appear to change with age (Alerby, 2000). Indeed, as Liu and Lin (2015) stated, mental models are structures affected by experience and culture rather than age. Although cultures change perceptions towards the relation between humans and the natural environment (Loughland, Reid & Petocz, 2002), common perceptions have been found in all cultures when it comes to the core environmental concepts (Liu & Lin, 2014). This helps to explain why the findings of this study are similar to studies conducted in different cultures.

In light of the findings, the following comments are made. Firstly, when seeking to determine a mental model, a number of different methods can be used other than the draw and explain technique. While drawing and explaining techniques have their distinctive advantages, it can be argued that working with different techniques may reveal different types of mental model.

Regarding the dynamic structure of mental models, it is important to observe how a mental model developed. Understanding how and where the children structure the knowledge that they acquire should be beneficial both to the curriculum programmers and teachers.

One of the basic aims of environmental education is that children and other learners possess accurate knowledge about concepts regarding the environment. Furthermore, understanding the relation between knowledge and mental modeling in an individual's mind will inform developments in the fields of neurocognitive and cognitive psychology. For this reason, it is believed that studying concepts regarding ecology within different disciplines and how they can be applied in the classroom will improve the effectiveness of environmental education.

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References

Abella, S. R., Chiquoine, L. P., Newton, A. C. And Vanier, C. H. (2015). Restoring a desert ecosystem using soil salvage, revegetation, and irrigation. *Journal of Arid Environments, 115*, 44-52.

Ahi, B. (2015). Okul öncesi eğitim programına kaynaştırılan çevre eğitimi programının çocukların çevre kavramı hakkındaki zihinsel model gelişimine etkisi. (Unpublished doctoral dissertation). Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.

Ahi, B., Balcı, S. & Özcan, H. (2015). *Children and the environment: Young children's understanding of forest and deforestration*. Paper presented in 2015 International Business & Education Conferences (2-6 Ağustos 2015, New York, USA).

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

Bardo, M. (2012, September 7). Desert diversity cut by 'human activities'. BBC Nature. Retrevied from http://www.bbc.co.uk/nature/19466470

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

Barrett, J. E., Virginia, R. A., Wall, D. H., Dorans, P.T., Fountain, A.G., Welch, K. A. & Lyons, W.B. (2008). Persistent effects of a discrete warming event on a polar desert ecosystem. *Global Change Biology, 14*, 2249-2261.

Becker, S., Kleinböhl, D. & Hölzl, R. (2012). Awareness is awareness is awareness? Decomposing different aspects of awareness and their role in operant learning of pain sensitivity. *Consciounes and Cognition, 21*, 1073-1084.

Braund, M. (1991). Children's ideas in classifying animals. *Journal of Biological Education, 25*(2), 103–110.

Braund, M. (1998). Trends in children's concepts of vertebrate and invertebrate. *Journal of Biological Education, 32*(2), 112–118.

Brechignac, F. (2011). Technology and the forces of nature: A lesson of humility calling for ecocentrism. *Integrated Environmental Assessment and Management, 7*(3), 409-410.

Bruning, R. H., Schraw, G. J. & Norby, M. M. (2014). Bilişsel psikoloji ve öğretim. (Z. N. Ersözlü ve R. Ülker, Çev.). Ankara: Nobel.

Callenbach, E. (2012). *Ekoloji*. (Çev. E. Özkan). Ankara: Sinek Sekiz Yayınevi.

Coates, E. (2002). 'I forgot the sky' children's stories contained within their drawings. *International Journal of Early Years, 10*(1), 21-35.

Connar, S. (2006, June 5). Desert life threatened by climate change and human exploitation. The Indipendent. Retrevied from http://www.independent.co.uk/environment/desert-life-threatened-by-climate-change-and-human-exploitation-481116.html

Creswell, J. W. (2007). *Qualitative inquiry & research design: Choosing among five approaches*. (2nd Edition). London: SAGE.

Dinç, M. & Özkaya, A. (2009). Ekosistem. *Çevre bilimi* (Eds. M. Aydoğdu & K. Gezer) içinde. Ss.35-70. Ankara: Anı.

Dunlap, R. E., Van Liere, K. D., Mertig, A. G. & Jones, R. E. (2000). Measuring endorsement of the new ecological paradigm: A revised nep scale. *Journal of Social Issues, 56*(3), 425-442.

Einarsdottir, J., Dockett, S. & Perry, B. (2009). Making meaning: Children's perspectives expressed through drawings. *Early Child Development and Care, 179*(2), 217-232.

Ergazaki, M. & Andriotou, E. (2010). From "forest fire" and "hunting" to disturbing "habitats" and "food chains": Do young children come up with any ecological interpretations of human interventions within a forest? *Research in Science Education, 40*, 187-201.

Fenk, W., Zhang, Y., Jia, X., Wu, B., Zha, T., Qin, S., Wang, B., Shao, C., Liu, J. & Fa, K. (2014). Impact of environmental factors and biological soil crust types on soil respiration in a desert ecosystem. *Plosone, 9*(7), 1-10.

Fraenkel, J. R. & Wallen, N. E. (2008). *How to design and evaluate research in education*. (7th Edition). New York: McGraw-Hill.

Gentner, D. & Stevens, A., L. (1983). *Mental models*. East Sussex: Taylor & Francis.

Gilbert, J. K. (2004). Models and modelling: Routes to more authentic science education. *International Journal of Science and Mathematics Education, 2*, 115-130.

Gilbert, J. K. Pietrocola, M., Zylbersztajn, A. & Franco, C. (2000). Science and education: Notions of reality, theory and model. J. K. Gilbert ve C. J. Boulter (Eds.), in *Developing models in science education*, (pp.19-40). Dordrecht: Kluwer Academic Publishers.

Greca, I., M. & Moreira, M. A. (2000). Mental models, conceptual models, and modelling. *International Journal of Science Education, 22*(1), 1-11.

Günindi, Y. (2015). Preschool children's perceptions of the value of affection as seen in their drawings. *International Electronic Journal of Elementary Education, 7*(3), 371-382.

Hatano, G. & Inagaki, K. (1997). Qualitative changes in intuitive biology. *European Journal of Psychology of Education, 12*(2), 111-130.

Herrmann, P., Waxman, S. R. & Medin, D. L. (2010). Antropocentrism is not the first step in children's reasoning about the natural World. *PNAS, 107*(22), 9979-9984.

Inagaki, K. & Hatano, G. (1993). Young children's understanding of the mind-body distinction. *Child Development, 64*, 1534-1549.

Inagaki, K. & Hatano, G. (2006). Young children's conception of the biological world. *Current Direction in Psychological Science, 15*(4), 177-181.

Johnson-Laird, P. N. (1983). *Mental models*. Cambridge: Harvard University.

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.

Kahriman-Öztürk, D., Olgan, R. & Güler, T. (2012). Preschool Children's ideas on sustainable development: How preschool children perceive three pillars of sustainability with the regard to 7R. *Educational Sciences: Theory & Practice*, Special Issue, 2987-2995.

Kışlalıoğlu, M. & Berkes, F. (2012). Çevre ve ekoloji. (13. Basım) İstanbul: Remzi.

Kurnaz, A., Kıldan, A. O. & Ahi, B. (2012). Mental models of pre-school children regarding the sun, earth and moon. *The International Journal of Social Sciences, 7*(1), 136-143.

Leonard, M. (2006). Children's drawings as a methodological tool: reflections on the develop plus system in Northern Ireland. *Irish Journal of Sociology. 15*(2), 52-66.

Li, L., Chen, X., van der Tol, C., Luo, G. & Su, Z. (2014). Growing season net ecosystem CO2 exchange of two desert ecosystems with alkaline soils in Kazakhstan. *Ecology and Evolution, 4*(1), 14-26.

Littledyke, M. (2004). Primary children's view on science and environmental issues. Examples of environmental cognitive and moral development. *Environmental Education Research, 10*(2), 217-235.

Liu, S. C. & Lin, H. (2014). Undergraduate students' ideas about nature and human-nature relatiopships: An empirical analysis of environmental worldviews. *Environmental Education Research, 20*(3), 412-429.

Liu, S. C., & Lin, H. (2015). Exploring undergraduate students' mental models of the environment: Are they related to environmental affect and behavior? *The Journal of Environmental Education, 46*(1), 23-40.

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

Mason, H., L. ve Langenheim, J., H. (1957). Language analysis and the concept "environment". *Ecological Society of America, 38*(2), 325-340.

Ministry of National Education. (2015). National education statics. Formal education [Adobe Digital Editions version]. Retrieved from http://sgb.meb.gov.tr/ istatistik/ meb_istatistikleri_orgun_egitim_2014_2015.pdf

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.

National Fish, Wildlife and Plants Climate Adaption Strategy. (2012). Desert ecosystem. Retrieved from http://www.wildlifeadaptationstrategy.gov/pdf/Desert_Ecosystems_Paper.pdf

Nobes, G., Moore, D., G., Martin, A., E., Clifford, B., R., Butterworth, G., Panagiotaki, G., & Siegal, M. (2003). Children's understanding of the earth in a multicultural community: Mental models or fragments of knowledge?. *Developmental Science, 6*(1), 72-85.

Noble, I. R. (2014). Deserts in a changing climate: Impacts (Climate Change 2014 Synthesis Report). Retrevied from http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full.pdf

Özsoy, S. & Ahi, B. (2014). Elementary school students' perceptions of the future environment through artwork. *Educational Sciences: Theory & Practice, 14*(4), 1-26.

Özsoy, S., Özsoy, G. & Kuruyer, G. (2011). Turkish pre-service primary school teachers' environmental attitudes: Effects of gender and grade level. *Asia-Pacific Forum on Science Learning and Teaching, 12*(2), 1-21.

Pallant, J. (2011). SPSS survival manual. Australia: Allen & Unwin.

Palmer, J. A. (1994). Acquisition of environmental subject knowledge in pre-school children: An international study. *Children's Environments, 11*(3), 204-211.

Panagiotaki, G., Nobes, G. & Potton, A. (2009). Mental models and other misconceptions in children's understanding of the earth. *Journal of Experimental Child Psychology, 104*, 52-67.

Piaget, J. (1970). Genetic epistemology. New York: Norton & Company.

Piperno, F., Di Biassi, S., & Levi, G. (2007). Evaluation of family drawings of physically and sexually abused children. *European Child & Adolescent Psychiatry, 16*(6), 389-397.

Prokop, P., Kubiatko, M. & Fančovičová, J. (2007). Why do Cocks Crow? Children's Concepts About Birds. *Research in Science Education, 37*, 393-405.

Ross, L. E. & Nelson, M. N. (1973). The role of awareness in differential conditioning. *Psychophysiology, 10*(1), 91-94.

Saçkes, M. & Korkmaz, H. İ. (2015). Anaokulu çocuklarının dünyanın şekline ilişkin zihinsel modelleri. *İlköğretim Online, 14*(2), 734-743.

Samarapungavan, A. Vosniadou, S. & Brewer, W., F. (1996). Mental model of the earth, sun and moon: Indian children' s comologies. *Cognitive Development, 11*, 491-521.

Schafer, N. (2012). Finding ways to do research on, with and for children and young people. *Geography, 97*(3), 147-154.

Shekhawat, N. S., Phulwaria, M., Harish, Rai, M. K., Kataria, V., Shekhawat, S., Gupta, A. K., Rathore, N. S., Vyas, M., Rathore, N., Vibha, J. B., Choudhary, S. K., Patel, A. K., Lodha, D. & Modi, R. (2012). Bioresearchers of fragile ecosystem/desert. *Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci., 82*(2), 319-334.

Shepardson, D. P. (2002). Bugs, butterflies, and spiders: Children's understanding about insects. *International Journal of Science Education, 24*(6), 627–643.

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.

Straatemeier, M., van der Maas, H. L. J. ve Jansen, B. R. J. (2008). Children's knowledge of the earth: A new methodological and statistical approach. *Journal of Experimental Children Psychology, 100*, 276-296.

Strommen, E. (1995). Lions and tigers and bears, oh my! Children's conceptions on forests and their inhabitants. *Journal of Research in Science Teaching, 32*(7), 683–689.

Sungur, S., Tekkaya, C. & Geban, Ö. (2001). The contribution of conceptual change texts accompanied by concept mapping to students' understanding of the human circulatory system. *School Science and Mathematics, 101*(2), 91-101.

United Nations Educational, Scientific and Cultural Organization- United Nations Environment Programme. (1975). The international workshop on environmental education. Belgrade final report. Paris: UNESCO.

United States Global Change Research Program. (2009). Global climate impacts in the United States. (Eds. T.R. Karl, J.M. Melillo, and T.C. Peterson). Cambridge University Press.

Vosniadou, S. & Brewer, W. F. (1992). Mental models of the earth: A study of conceptual change in childhood. Cognitive Psychology, 24, 535-585.

Vosniadou, S. & Brewer, W. F. (1994). Mental models of the day/night cycle. *Cognitive Science, 18*, 123-183.

Vygotsky, L. S. (1971). *The psychology of art*. Cambridge: The MIT.

Wiersma, W and Jurs, S. G. (2008). *Research methods in education: An introduction*. (9th Edition). Boston: Pearson.

World Resource Institue. (2005). Ecosystems and human well-being. Wasginton DC. WRI Press. Retrevied from http://www.millenniumassessment.org/documents/document.355.aspx.pdf

Yardımcı, E. & Bağcı Kılıç, G. (2010). Çocukların gözünden çevre ve çevre sorunları. *Elementary Education Online, 9*(3), 1122-1136.

Yavuzer, H. (2010). *Resimleriyle çocuğu tanıma*. (10. Baskı). İstanbul: Remzi.

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