Chapter 13

# Mental Models of Aquatic and Terrestrial Ecosystems in Preschool Children[1]

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**Abstract**

The main purpose of this study is to identify preschool children's awareness of aquatic and terrestrial ecosystems, describe the living and non-living components they recognize within these ecosystems, and evaluate the relationships they establish between these components. The sample consists of 60 children aged 60-72 months attending a public preschool in Van, Turkey, during the 2021-2022 academic year. The study group was formed using a convenience sampling method. The children's drawings related to aquatic and terrestrial ecosystems, created on blank A4 paper, were analyzed using the *Draw An Environment Test-Rubric* (DAET-R, DAME-R) adapted from an Environmental Drawing Test Rubric. Descriptive analysis was conducted to categorize the drawings into themes. Findings revealed that the most frequently depicted elements in aquatic ecosystem drawings were human figures (f=35), octopus (f=47), seaweed (f=27), shark (f=16), sun (f=37), and clouds (f=15), while in terrestrial ecosystem drawings, the most common elements were trees (f=40), grass (f=37), flowers (f=23), and butterflies (f=14). The analysis of both aquatic and terrestrial ecosystem drawings showed that although children included both biotic and abiotic components, they struggled to establish interconnections between components from two or more groups within an ecological system.

1 This book chapter is based on the first author's master's thesis completed under the supervision of the second author.

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## 1. Introduction

It would be beneficial for the continuity of the ecosystem if children were encouraged to become individuals who know and love nature and living things, and thus try to protect the natural balance. Many scientists believe the growing disconnect between modern society and the natural world presents a significant challenge to achieving sustainability (Muhr, 2020). In this context, one of the reasons why children may have incomplete and inadequate knowledge about the environment, environmental diversity, ecosystems and their elements could be interpreted as a potentially weak or broken connection between nature and society (Snaddon et al., 2008). It is often said that childhood learning forms the foundation for our future lives. With this in mind, it seems valuable to approach these formative years with greater awareness and engagement. It would be constructive for children to have the opportunity to appreciate the full richness of nature rather than seeing it only as a picnic area. It would also be beneficial for children to understand the interactions between natural assets and to be informed about plant and animal species so that they can recognise endangered species in the future (Göka, 1993). While awareness alone does not necessarily guarantee conservation, a lack of awareness will likely make it more challenging to protect endangered environments and species (Balmford et al., 2002). It would be beneficial for the continued stability of our natural environment if we could find ways to address the various environmental issues we face. It is becoming increasingly clear that the right interventions can significantly impact our planet. It would be beneficial to create tiny sparks of awareness in children, which could potentially contribute to them becoming individuals equipped with the skills to find solutions to problems when they become adults in the future (Melis et al., 2020). Furthermore, an examination of how children's understanding of natural areas and the environment is shaped may potentially provide insights that could inform more effective teaching in this field (Bonnett 2007). Some of the studies conducted for this purpose provide information about children's perceptions of nature and the environment and the factors that can shape these perceptions (Wals 1994, Bonnett & Williams 1998, Payne 1998, Kahn 1999, Ahi, 2016; Ahi & Alisinanoğlu, 2016; Köşker, 2019).

It is reasonable to conclude that preschool children's comprehension of ecology is constrained and/or erroneous. The field of ecology, which encompasses the notion of an ecosystem, is replete with many intricate and multifaceted concepts, and numerous challenges are inherent to its pedagogical and didactic processes (Özkan, Tekkaya, & Geban, 2004). Earth boasts a vast array of habitats and a plethora of species that have adapted to

these conditions. The intricate relationships between organisms and their environment are complex and challenging to comprehend. To grasp the underlying order within this diversity, the concept of an ecosystem has been developed with a system understanding (Warren, 2007). An ecosystem is comprised of two primary categories of elements: living (biotic) and non-living (abiotic). The biotic elements can be further classified as producers and consumers. The abiotic elements encompass a range of substances, including organic and inorganic materials, as well as the cycles and climate that shape their interactions (Odum, 1999).

Biriukova (2005) argues that teaching in the field of ecology in early childhood can be enriched enhanced through the integration of sensory activities, educational games, and an array of visual aids, including images, posters, videos, and other multimedia resources. The use of pictures, drawings and visuals, which we use to teach concepts in the beginning, to evaluate children's knowledge and attitudes at the end of the process is considered appropriate for the age group we are working with. When researches on early childhood environment are examined, it is seen that expressing the conceptual frameworks of the subject area by drawing pictures for children is both more useful and more instructive (Barraza, 1999; Moseley, et al. 2010; Halmatov et al., 2012; Özsoy, 2012; Ahi, 2016). The data collection method using children's drawings is frequently preferred in research due to its positive and applicable aspects. As it encompasses non-verbal elements such as painting, drama, and music, these art-based research methods allow participants to express their cognitive and affective connections with nature (Flowers et al., 2015; Muhr, 2020).

This study aimed to ascertain the awareness of biotic and abiotic elements in aquatic and terrestrial ecosystems among children between the ages of 60 and 72 months. To this end, the drawings produced by the children and their accompanying verbal explanations were subjected to analysis. This analysis aimed to ascertain the concept of elements in ecosystems, the diversity of elements (e.g., biotic, abiotic, human-made, etc.), and their thoughts about the relationships between elements.

In this context, the current research is expected to provide insights that will assist researchers and educators in shaping the educational processes of young children. Specifically, it will offer insights into preschool children's understanding of biotic and abiotic elements in ecosystems and the relationships among them.

## 2. Method

### 2.1. Research Design

The research model of the study is phenomenological design. This research method is used to examine in depth how participants make sense of, feel and experience a particular experience or phenomenon. In this design, researchers focus on the experiences of participants through direct observation or interviews and try to understand these experiences from their subjective perspectives. Phenomenological design aims to reveal how "reality" is seen through the eyes of individuals by focusing on their life experiences, perceptions and meanings shaped by these perceptions (Larsson & Holmström, 2007).

### 2.3. Working Group

In the formation of the study group, the convenience sampling method was selected from the non-random sampling methods. Accordingly, the study group consisted of 60 children aged 60-72 months attending a state kindergarten in the central İpekyolu district of Van province. Approximately 75% of the families of the participant children had undergraduate or graduate degrees.

### 2.2. Data Collection and Analysis

The children in the study group were given blank sheets of paper consisting of a single page and were asked to draw 'a sea' to represent the aquatic ecosystem and 'a forest' to represent the terrestrial ecosystem, taking into account their cognitive levels. Explanations were given to the children for both drawings to encourage them to think and to help them elaborate their drawings.

"'You have started a journey in the sea...What do you think exists in the sea? Can you draw the living and non-living beings you encounter on this journey and how they are affected by each other and how they feed?

"You have started a walk in the forest...What do you think is in the forest? Can you draw the living and non-living things you encounter during this walk and how they are affected by each other and how they feed?

The drawings completed by the children were interviewed one-on-one with the children within the scope of the draw-and-tell technique, focusing on the human, biotic and abiotic beings and human-constructed elements in their drawings and their expressions of the relationships between these elements. To be sure of the results, the coding of the drawings was created

together with the students. Children were asked to describe their drawings with sentences such as 'My Environmental Drawing....'. After the drawings, each student was interviewed for about 10 minutes to explain their drawings and coding was done based on the figures they drew.

Terrestrial ecosystem drawings were evaluated with the DAET-R (Draw-An-Enviroment Test) 'Draw an Environment Test' rubric adapted by Moseley et al. (2010), and aquatic ecosystem drawings were evaluated with the DAME-R (Draw-An-Marine-Enviroment Test) 'Draw a Sea' rubric adapted by Atasoy et al. Although the evaluation rubric prepared by Moseley et al. (2010) was designed to reveal the existing mental states, personal beliefs and attitudes towards the environment of pre-service teachers, it was deemed appropriate to be used for preschool age group in various studies (Ahi and Balcı 2017; Ahi and Atasoy 2019). It consists of 4 factors: biotic elements, abiotic elements, human elements and human constructions (artificial environments) in children's drawings. Children who drew elements that could be classified under these factors were evaluated as 1 point, drawings that could show the relationship between the drawn elements were evaluated as 2 points, and drawings that showed these relationships with various symbols and expressed a system understanding were evaluated as 3 points. In the rubric, four factors are scored on this 3-point system. The rubric was designed over 12 full points. In order to ensure reliability, scoring was also done by a scorer other than the researcher. Expert opinion was taken on the differences in scoring and a common point was agreed upon.

## 3. Findings

The results of the analysis of the data obtained from children's drawings and narratives about their drawings are presented in two sections: aquatic and terrestrial ecosystems.

### 3.1. Findings Related to Children's Aquatic Ecosystem Drawings

The elements in children's drawings of aquatic ecosystems were analyzed and 79 codes were obtained. Table 1 shows the frequency of depiction of figures in their drawings under the categories of Human, Living Elements, Nonliving Elements, Designed Environment, Imaginary Elements and Other Elements that cannot be classified.

It is noteworthy that the elements in the students' drawings are detailed and numerous. While the most frequently used codes in the human category (*f=28*) were mostly depicted as swimming people, children themselves and their mothers, *the* most frequently repeated items in the living creature

category were octopus (*f=47*), algae (*f=27*), and shark (*f=16*). The shapes that children drew most frequently to symbolize abiotic beings were sun (*f=37*) and cloud (*f=15*). In terms of code diversity, the biotic element (living thing) category stands out with 27 different codes. Especially the figures of animals living in the sea were more common. It was determined that students did not include marine mammals in their drawings.

***Table 1. Codes in Aquatic Ecosystem Drawings and Frequency of Repetition***

| Category/Codes | f | % | Codes | f | % | Codes | F | % |
|---|---|---|---|---|---|---|---|---|
| Human | 28 | 46,6 | Live Elements | 58 | 96,6 | Abiotic Elements | 42 | 70 |
| A floating one | 9 | | Octopus | 47 | | Sun | 37 | |
| Himself | 7 | | Moss | 20 | | Cloud | 15 | |
| Anne | 5 | | Fish | 35 | | Rainbow | 6 | |
| Father | 4 | | Shark | 16 | | Stone | 5 | |
| Good person | 3 | | Baby fish | 5 | | Wave | 4 | |
| Ship passenger | 2 | | Anchovy | 3 | | Kaya | 3 | |
| Diver | 2 | | Dolphin fish | 4 | | Sky | 3 | |
| Big brother | 2 | | Shoal of fish | 2 | | Beach | 3 | |
| Brother | 2 | | Eel | 2 | | Sand | 3 | |
| Drowning human | 1 | | Piranha | 1 | | Ada | 1 | |
| Family | 1 | | Hammerfish | 1 | | Moon | 1 | |
| Bewildered human | 1 | | Invisiblefish. | 1 | | Soil | 1 | |
| Imaginary Elements | 2 | 3,3 | Clowningfish | 1 | | Volcano | 1 | |
| Mermaid | 3 | | Bird | 4 | | Extinct Volcano | 1 | |
| Imaginary Characters | 2 | | Scorpion | 1 | | Rain | 1 | |
| | | | Crab | 1 | | Lightning | 1 | |
| | | | Snail | 1 | | Star | 1 | |
| Other Elements | 25 | 41,6 | Frog | 1 | | | | |
| | | | Crocodile | 1 | | Artificial Environment | 20 | 33,3 |
| | | | Seagull | 1 | | Ship | 6 | |
| | | | Seahorse | 1 | | Submarine | 5 | |
| | | | Tree | 1 | | Crate | 5 | |
| | | | Grass | 1 | | Kayak | 1 | |
| | | | Flower | 1 | | Tank | 1 | |
| | | | | | | Home | 1 | |
| | | | | | | Watchtower | 1 | |
| | | | | | | Undersea Camera | 1 | |
| | | | | | | Aquarium | 1 | |

After the coding of children's drawings of aquatic ecosystems, the relationships between the figures in the drawings were scored with the DAME-R rubric and these data are presented in Table 2.

***Table 2. Scoring of Children's Drawings of Aquatic Ecosystems***

| | 0 Points | | 1 point | | 2 Points | | 3 Points | |
|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % |
| Biotic element | 4 | 6,6 | 9 | 15 | 41 | 68,3 | 6 | 10 |
| Abiotic element | 11 | 18,3 | 38 | 63,3 | 8 | 13,3 | 3 | 5 |
| Human | 34 | 56,6 | 2 | 3,3 | 23 | 38,3 | 1 | 1,6 |
| Artificial Env. | 45 | 75 | 5 | 8,3 | 7 | 11,6 | 3 | 5 |

It is seen that children focus more on biotic and abiotic elements in their drawings and less on elements such as human beings and human structure.

Biotic Element: 68.3% of the children scored 2 points for living things, indicating that they perceived living things as a part of the aquatic ecosystem. It is understood that they mostly made drawings with moderate level of detail.

Abiotic Element: 63.3% of the children scored 1 point for abiotic elements. This shows that children were able to identify non-living elements in the aquatic ecosystem in limited number and detail, but they were able to recognize them clearly.

Human and Human Structure: Human and human structure elements are rare in children's drawings (56.6% and 75% scored 0, respectively). This shows that children tend to perceive the aquatic ecosystem as a more natural area and do not consider the human factor as a part of the ecosystem.

***Table 3. Children's Total Score Obtained from DAME-R with Aquatic Ecosystem Drawings***

| Total Score | N | % |
|---|---|---|
| 0-4 points | 36 | 60 |
| 5-8 points | 24 | 40 |
| 9-12 points | 0 | 0 |
| Total | 60 | 100 |

When the data obtained are analyzed, it can be stated that 60% of the children's drawings included the elements one by one. This shows that

children have a basic perception of the aquatic ecosystem, but this perception is not detailed. The 40% in the 5-8 point range shows that they were able to identify more elements. However, the fact that there were no participants in the 9-12 score range indicates that children have difficulty in comprehending the aquatic ecosystem in detail.

### 3.1.1.Children's Aquatic Ecosystem Drawing Examples

In this section, examples of drawings of aquatic ecosystems are given and information about the scoring system and students' perspectives are presented.

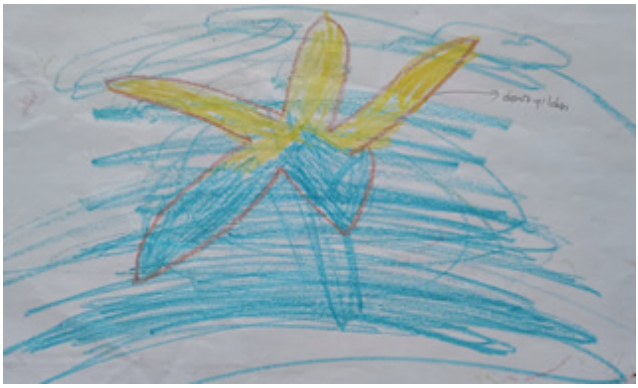

***Figure 1. DAME-R total score=2 (drawing without relationship between categories)***

Chid:47: "*There is a huge starfish in the sea, it feeds on things that fall into the sea.*" The student only pictured an item belonging to the category of living things and could not express it clearly enough.

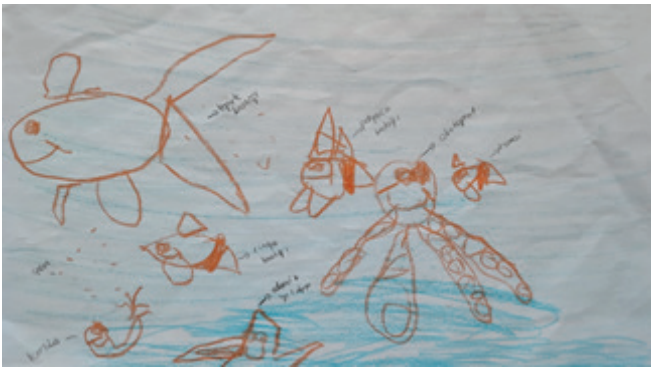

***Figure 2. DAME-R total score= 5 (drawing with relationship between categories)***

Child:59: "*There are living things in the sea, and living things feed by eating each other. The shark eats the octopus, the octopus eats the fish, the fish eat the shrimp, and the shrimp eat the vitamins in the sea sand*." Although the student expressed the food chain by establishing more than one living creature-living binary relations in this picture, he could not clearly express his understanding of the system because he could not establish the third connection.

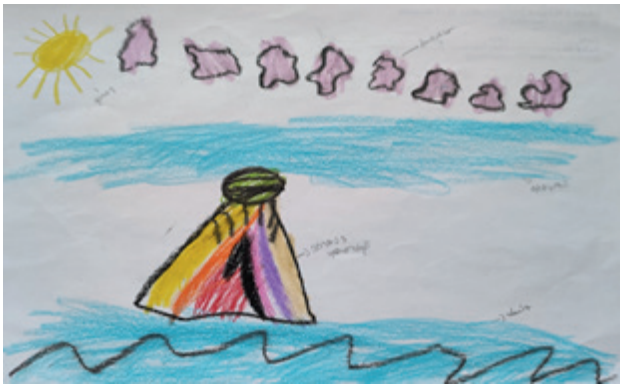

***Figure 3. DAME-R total score= 7 (drawing with relationship between categories)***

Child:36: "*There is a magic volcano, but it is extinct, this volcano gives oxygen to the sea, so it feeds both the fish and the sea. I watched it in a documentary*." The student made only one three-connected relationship, that is, the volcano, which is an abiotic element, affects both the fish, which is a living being, and the sea, which is an abiotic entity; but since the picture did not include any human figure or designed environmental element, it remained at the limit score in the rubric scoring.

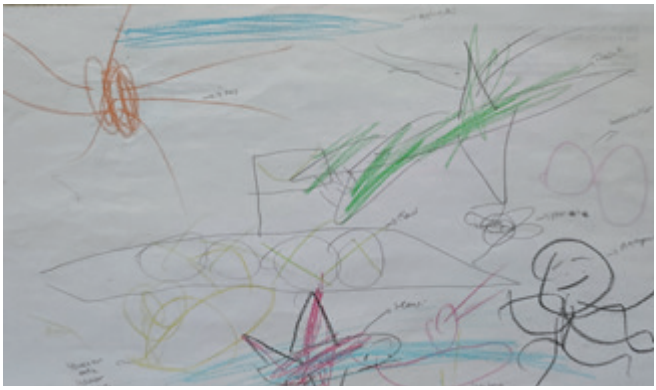

***Figure 4. DAME-R total score= 8 (drawing with relationship between categories)***

Q:36: "*I drew a sea, people threw away the food left on their plates. The fish were fed with what people threw away, but the bad waste damaged the octopuses and killed them, only one of them is alive. Also, the cruise ship coming to the sea always causes pollution*." This is a sample of drawings with all code groups. Since it did not include a drawing of a human element, it was not included in the 9-12 point category.

***Table 4. Children's Mental Themes towards Aquatic Ecosystem***

| Categories | Frequency (f) | Percentage (%) |
|---|---|---|
| Natural area where people and living things benefit together | 27 | 45 |
| Where sea creatures live | 25 | 41,9 |
| Natural area where flying animals benefit | 2 | 3,3 |
| Natural space for people to enjoy | 2 | 3,3 |
| Place of war | 2 | 3,3 |
| Unrelated image | 1 | 1,6 |
| The area where human and human-made elements are present | 1 | 1,6 |
| Total | 60 | 100 |

When the children's narratives about their drawings were thematically classified, their understanding of the aquatic ecosystem was tried to be described in Table 4. It was observed that students who included cartoon characters in their drawings were in the unrelated drawing category. In some drawings, it was determined that the students established relationships between the elements; however, it was noteworthy that the relationships they established were incorrect. For example; expressing that the creatures in the sea are fed with the bait thrown by humans or that a "magical extinct volcano" gives oxygen to the sea, thus feeding both the fish and the sea. It is seen that children have alternative theories about nutritional relationships and the function of abiotic elements in the ecosystem.

### 3.2. Findings Related to Children's Terrestrial Ecosystem Drawings

Table 5 shows 78 different codes obtained from children's terrestrial ecosystem drawings. The most frequently used codes are human figure (*f=25*), tree (*f=40*), grass (*f=37*), flower (*f=23*), butterfly (*f=14*) and sun (*f=42*) from the category of living things.

The table shows how many children depicted the figures in their drawings under the categories of Human, Living Elements, Nonliving Elements, Designed Environment, Imaginary Elements and Other Elements that cannot be classified.

In terms of code diversity, the biotic element category stands out with 35 different codes. It was determined that all children in the study group included a living element in their drawings. The fact that forests are more accessible and observable for children increased the accuracy of the relationships established.

***Table 5. Terrestrial Ecosystem Codes Codes and Frequency of Repetition***

| Codes | f | % | Codes | f | % | Codes | f | % |
|---|---|---|---|---|---|---|---|---|
| Human | 25 | 41,6 | Kaplan | 3 | | Artificial Environment | 10 | 16,6 |
| Himself | 8 | | Bee | 3 | | Cycling | 3 | |
| Child | 8 | | Sapling | 3 | | Home | 2 | |
| Father | 3 | | Snake | 2 | | Road | 1 | |
| Brother | 2 | | Hedgehog | 1 | | Water machine | 1 | |
| Anne | 2 | | Mole | 1 | | Water fountain | 1 | |
| Picnicking Human | 1 | | Kangaroo | 1 | | Fence | 1 | |
| Friend | 1 | | Panda | 1 | | Tent | 1 | |
| Biotic Elements | 60 | 100 | Dog | 1 | | Imaginary Elements | 4 | 6,6 |
| Tree | 40 | | Cow | 1 | | Cartoon character | 1 | |
| Sycamore tree | 4 | | Sheep | 1 | | Bad guy | 1 | |
| Apple tree | 7 | | Fly | 1 | | Talking tree | 1 | |
| Apricot tree | 1 | | Insect | 1 | | Magician tree | 1 | |
| Cherry tree | 1 | | Poppy flower | 1 | | Flying tree | 1 | |
| Poplar tree | 1 | | Squirrel | 1 | | Other Elements | 6 | 10 |
| Pine tree | 1 | | Abiotic Elements | 48 | 80 | | | |
| Grass | 37 | | Sun | 42 | | | | |
| Flower | 23 | | Sky | 23 | | | | |
| Butterfly | 14 | | Cloud | 17 | | | | |
| Cat | 9 | | Soil | 16 | | | | |
| Giraffe | 8 | | Rainbow | 5 | | | | |
| Bird | 7 | | Tree hollow | 3 | | | | |
| Rabbit | 7 | | Fruit | 3 | | | | |
| Bear | 6 | | Rain | 2 | | | | |
| Turtle | 6 | | Moon | 2 | | | | |
| Seed | 5 | | Stone | 1 | | | | |
| Spider | 4 | | Star | 1 | | | | |
| Ant | 4 | | Water | 1 | | | | |
| Worm | 3 | | River | 1 | | | | |
| | | | Volcano | 1 | | | | |

After the coding of children's drawings of terrestrial ecosystems, the relationships between the figures in the drawings were scored with DAET-R and these data are presented in Table 6.

***Table 6. Scoring of Children's Terrestrial Ecosystem Drawings***

| | 0 Points | | 1 Point | | 2 Points | | 3 Points | |
|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % |
| Bioticelement | 1 | 1,6 | 20 | 33,3 | 31 | 51,6 | 8 | 13,3 |
| Abiotic element | 2 | 3,2 | 48 | 80 | 9 | 15 | 1 | 1,6 |
| Human | 53 | 88,3 | 2 | 3,2 | 31 | 51,6 | 4 | 6,6 |
| Artificial Env. | 21 | 35 | 6 | 10 | 3 | 5 | 0 | 0 |

When the distribution of points regarding the elements of terrestrial ecosystems in children's drawings is analyzed, it is seen that living and non-living elements are focused on more, while elements such as humans and human structures are drawn less frequently.

Biotic Elements: 51.6% of the children scored 2 points for living things, indicating that they developed a moderate level of awareness in identifying living things in the terrestrial ecosystem. 13.3% of the children scored 3 points and made more detailed drawings, while 33.3% of the children scored 1 point and made more superficial drawings.

Abiotic Element: 80% of the children scored 1 for non-living elements, indicating that most of the children clearly identified non-living elements but did not provide detailed information. This implies that non-living elements are recognized as part of the terrestrial ecosystem, but not elaborated.

Human and Artificial Environment: 88.3% of the drawings did not include human elements (0 points), indicating that children perceive the terrestrial ecosystem more as a natural environment and do not see human elements as part of the ecosystem. Man-made elements were not drawn at all by 35% of the students.

***Table.7 Total score obtained by children from DAET-R with terrestrial ecosystem drawings***

| Total Score | n | % |
|---|---|---|
| 0-4 points | 35 | 58,3 |
| 5-8 points | 25 | 41,7 |
| 9-12 points | 0 | 0 |
| Total | 60 | 100 |

When the total score distribution of children's terrestrial ecosystem drawings is evaluated, 58.3% of the children scored between 0-4 points, while 41.7% scored between 5-8 points. However, there were no participants in the 9-12 point range. This shows that children have a basic awareness of the terrestrial ecosystem, but this perception is not deep and comprehensive. The fact that the children's drawings did not establish a connection between two or more elements within a system understanding reveals that the students in the study group were not aware of the system understanding in the terrestrial environment.

Examples of drawings of terrestrial ecosystems are given below and information about the scoring system and students' perspectives on the drawings is presented.

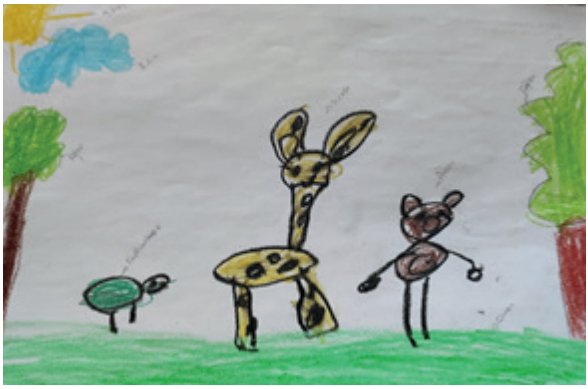

***Figure 5. DAET-R total score= 6 (drawing with relationship between categories)***

Child 1: "*Animals are very happy in the forest because people have never polluted it. Also, all animals have food. The giraffe eats tree leaves, the turtle hides in a tree stump, and the bear loves honey.*" In the verbal expression of the picture, the student included every figure except the designed element and made binary connections.

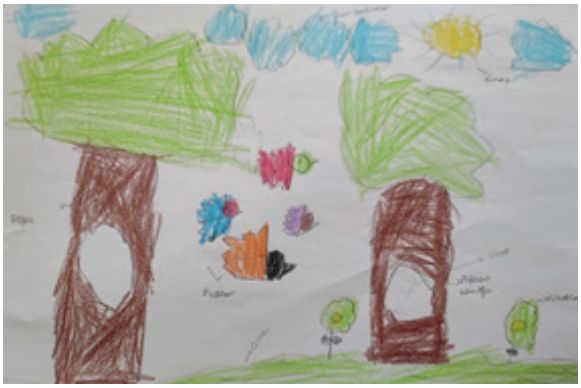

***Figure 6. DAET-R total score= 5 (drawing with relationship between categories)***

Child 42: "*Animals are fed from the feed prepared by people. Other people come and plant seeds, trees and flowers grow. The growing trees became a home for squirrels*." In the picture, binary connections between human and biotic elements are expressed; however, there is no understanding of a system.

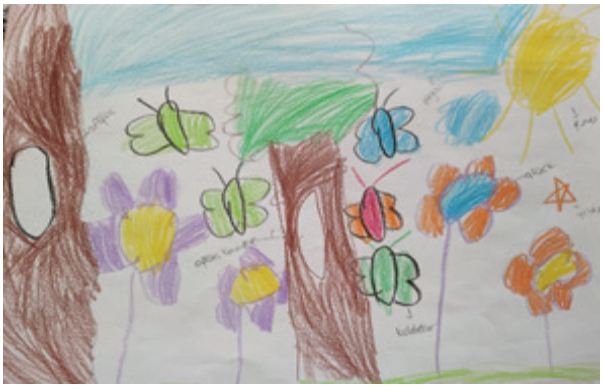

***Figure 7. DAET-R total score= 5 (drawing with relationship between categories)***

Child 20: "*We went for a walk in the forest and I saw a flock of butterflies there. Butterflies feed on the pollen of flowers.*" The student established a one-way relationship between biotic and abiotic elements in his/her drawing.

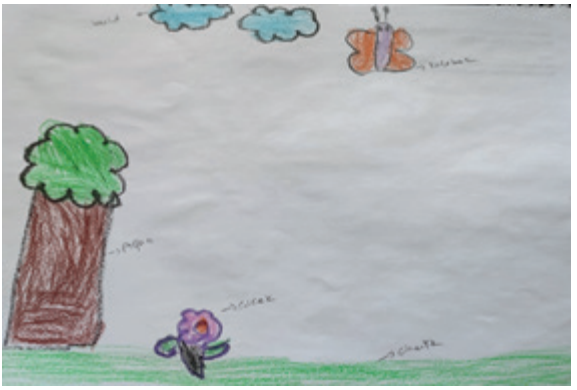

***Figure 8. DAET-R total score= 3 (drawing without relationship between categories)***

Child 15: "*Butterflies are flying in the forest.*" The student depicted biotic and abiotic elements but did not establish any relationship between them.

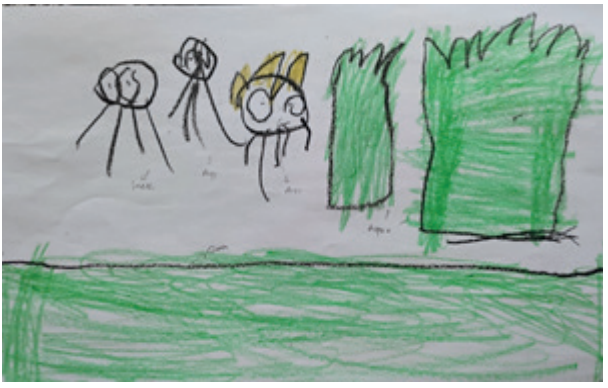

***Figure 9. DAET-R total score= 2 (drawing without relationship between categories)***

Child 38: "*Animals are just waiting for people to give them food.*" There are human and animal figures in the drawing, but no relationship is established.

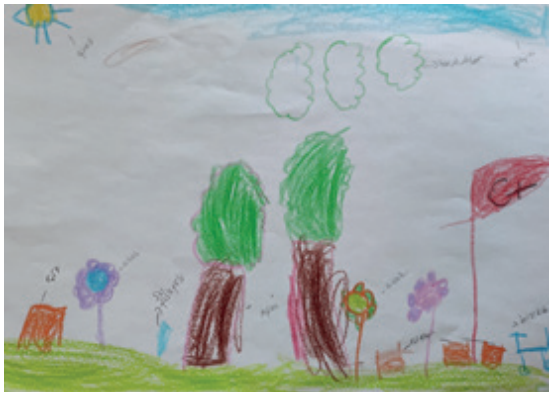

***Figure 10. DAET-R total score= 8 (drawing with relationship between categories)***

Child 31: "*I go to the forest on my bicycle, the fountain of water from the ground makes the flowers and trees grow. The fences were built to protect the forests from people, so that they don't come here.*" The student included all the elements in his drawing and made more than one binary connection; however, there was no expression of a three-stage system understanding.

***Table 8. Children's Mental Themes towards Terrestrial Ecosystem***

| Categories | f | % |
|---|---|---|
| Natural area where animals live | 6 | 10 |
| Natural space for people to enjoy | 6 | 10 |
| Natural area with plant life | 1 | 1,6 |
| An area where plants and animals live together | 17 | 28,3 |
| An area where plants and humans co-exist | 7 | 11,8 |
| The area where humans and animals live together | 6 | 10 |
| An area where humans, animals and plants live together | 15 | 25 |
| Unrelated | 2 | 3,3 |
| Total | 60 | 100 |

Students' verbal expressions about forest drawings were interpreted according to the factors they included and categorized as shown in the Table 8. The highest value belongs to the idea that forests are the habitat of plants and animals with a rate of 28.3%. In the biotic category, the plant population was elaborated with the diversification of tree species, seeds and flower species. Although there were children who included animal-human and plant drawings in their drawings and made drawings from all elements,

it was determined that they could not express an understanding of a system in their verbal expressions and that they usually included the elements one by one. The drawings of two students consisted entirely of imaginary elements and did not include any of the elements in the rubric.

## 4.Conclusion and Discussion

### 4.1. Conclusion and Discussions Regarding the Codes Children Included in Their Drawings

The drawings were used to determine children's awareness of the elements in aquatic and terrestrial ecosystems and their ability to identify the relationships between the elements. As a general evaluation of the research, it should be said that the children in the study group were aware of the biotic and abiotic elements in the ecosystem, as well as distinguishing human and human structures or the designed environment among these elements. Apart from this, it is also seen that the children attributed magical or imaginary properties to the elements in all three categories with imaginary elements in their drawings. This is a normal situation for the cognitive level of the age group. Similar to the current study, studies conducted with preschool children have reported that the elements in children's drawings of the environment are distinguished into categories called biotic, abiotic, and anthropic (Carretón Sanchis et al., 2021; Alaçam, 2024). Moreover, the analysis of combinations of different categories revealed that due to the variety of possible combinations of drawn items, almost half of the subjects added many different categories as well as items with a high level of complexity ( Carretón Sanchis et al., 202 1) .

In the present study, it was observed that less than half of the children's drawings contained elements of different categories together. However, it should be noted that the relationships between the elements belonging to different categories were reflected in the drawings and children's narratives about their drawings in a very limited way.

Regarding the drawings of aquatic ecosystems, it can be stated that the majority of the children depicted the marine ecosystem in a rich and varied way due to their imagination about the sea, their interest in underwater life and the influence of the cartoons they watched. However, it can be said that children have some alternative conceptions about the marine environment chosen as an aquatic ecosystem. While describing their drawings, the children generally likened the marine life to an aquarium and stated that people feed the fish with food. This may have been due to the fact that the aquarium was

an aquatic environment that they could observe more closely and was more familiar to them in daily life.

Students portrayed aquatic environments as natural areas where humans and living things benefit together. The common idea in the drawings was that people usually prefer them for swimming. Braund and Reiss (2006) state that technological tools such as the internet and television enable students to access a wide range of information and may have an impact on students' naming skills. It can be said that some children included biotic and abiotic elements with characteristics other than the reality of the aquatic environment in their drawings under the influence of the cartoons they watched and the computer games they played. Louv (2010) calls the emerging separation between children and nature a 'nature-deficit disorder', in other words, he emphasizes the distance between children and nature. According to Louv (2010), this separation can lead to negative consequences for children, such as underutilization of the senses and difficulties with attention. If we consider this situation together with the development of science process skills, it can be said that spending time in natural environments has a positive effect on the development of these skills.

As a result of the coding of children's drawings of the aquatic ecosystem, it was observed that there were drawings for all categories in the rubric (human, biotic elements, abiotic elements and artificial environment) and the category that children included the most was biotic elements. Almost all of the students depicted a living creature living in the sea in their drawings. Yörek et al. (2009), as a result of their research, it was stated that the situation that most expresses the state of being alive is thought to be the concept of mobility by the students, and therefore, when it comes to living things, relationships are established first with human life, then with animals and then with plants. In the present study, the same situation was also the case, and the students gave very little space to plant drawings and expressed only the existence of mosses. Children have difficulty in classifying plants as living things due to the inability to observe their developmental differences and immobility (Öztürk & Tulum, 2021). Nyberg et al. (2019) argue that children's perceptions of plants are often based on pre-existing experiences with plants in early childhood, rather than an 'inability' or 'plant blindness' to see plants or perceive plants as important. Consistent with this claim, it can be argued that students' mental schemas of plants in aquatic ecosystems are incomplete and that their opportunities to observe plants in aquatic environments are limited.

The most frequently depicted animal elements in the drawings were octopuses and fish. Animals as biotic elements are the group with the most diversity. In the findings of the study conducted by Atasoy et al. (2020) to reveal primary school students' mental models of the marine ecosystem, it was observed that students mostly included biotic elements and there were similarities in terms of code diversity. The diversification of fish species in some pictures (anchovy, shark, hammerfish, etc.) attracted attention. The fact that the students included fish species that they could not observe live and established correct relationships suggests that they may have been influenced by the drawings in storybooks and science magazines.

Of the total number of the study group, 47% were human figures, 70% were abiotic objects, and 33.3% of the children who drew human structure designs. The human elements drawn in the drawings were generally depicted as swimming in the sea or feeding animals. In addition, some children depicted human figures as individuals who help sea creatures by collecting waste. Although it was observed that drawings of the sun and clouds were made as abiotic elements, it was noted that these drawings did not express any relationship in verbal expressions and were included in the drawings as a single factor. Drawings of ships, submarines, tanks, watchtowers and treasure chests, which were made for man-made elements (designed environment), were rarely included, but did not reflect the realism in the ecosystem in children's verbal expressions. Some elements that were not included in the rubric but were included in the children's drawings were categorized into different codes. Children drew cartoon figures that do not exist in reality (nup, stiff, mermaid) or abiotic objects that do not exist spontaneously in nature (ice cream, flag, heart, waste). Since these items did not belong to any category in the rubric, these drawings could not be scored. In the interview phase, they did not make any connection with other elements of the ecosystem in their verbal expressions about these elements. A similar situation was observed in other studies. For a sustainable early childhood program, preschool students were asked to draw pictures showing the human-environment relationship, and evaluations were made based on repeated drawings and interviews with students after the program. It was observed that children conceptualized the environment with fantastic elements out of the ordinary (Cengizoğlu et al., 2020). It was thought that children's use of technology could cause these views.

One of the important findings of the terrestrial ecosystem drawings is that almost all of the students had a lived experience with the forest, which provided richness in terms of drawing diversity and led them to depict it as a place that hosts living things that represent green in general. However, it

was observed that they had some alternative concepts about the terrestrial environment. The idea that living creatures in the forest feed only on the water and food left by humans emerged. It is thought that children see the forest as an entity that interferes with other beings from the outside without involving people in forest life. The research conducted by C. Sanchis et al. (2022) also supports this view. In the research conducted to reveal the belonging images of the current students of the kindergarten located in a wetland park area in Spain towards their natural environment, the students were asked to draw a place they liked and their environmental perceptions were analyzed according to various categories. It was observed that children had difficulty in perceiving this natural area, which they visit every day and with which they have close relationships, as a valuable part of their environment and often drew other areas. As a result of their study, Ergazaki and Adriotou (2009) found that young children can accurately express how living creatures in nutrition relationships in the forest ecosystem affect the flow in the forest if the right learning environment is created.

Students depicted terrestrial environments as natural areas where humans and plants benefit together. The common idea in the drawings was that people generally prefer to go to the forest for picnics. It should be stated that the fact that a small number of students were influenced by the cartoons they watched and the computer games they played and reflected this situation in their drawings (talking tree, magician tree, etc.) is an expected situation in terms of the cognitive development level of the age group.

As a result of the examination of children's drawings of terrestrial ecosystems, it was observed that there were figures for all categories in the rubric (human, living thing, non-living thing and human structure) and all of the children depicted a figure representing a living thing living in the forest in their drawings. The most frequently depicted living element in the drawings was coded as a tree. In the concept maps created by Ahi and Balcı (2017) in their study on forest and deforestation with children in the same period, students similarly defined the forest as a place with many trees. There are pictures in which tree species are expressed in detail (sycamore, apple, apricot, etc.). Emphasizing the presence of herbaceous plants, 37% of the children included grass in their pictures. This shows that children think that green is common in terrestrial ecosystems. Various animal figures were also preferred as living elements, with butterflies being the most preferred animal (f=14). The diversity and similarity of the codes obtained from the environmental drawings of preschool students by Günindi (2012) were found to be highly compatible with the results of the study. While figures such as cat, giraffe, bird and bear were included in animal drawings, no child mentioned insects.

This situation showed that although the students included drawings of living things, they could not reflect biodiversity sufficiently. van Heel et al. (2022) reached similar results in terms of living diversity in their study. In order to have information about the daily nature experiences of urbanized children, they had 1532 children draw their favorite areas. In addition to the low number of drawings of natural areas, it was observed that artificial playgrounds that do not reflect biodiversity are generally preferred. Against this risk, it was revealed that areas should be opened where children's daily nature experiences can be increased without the need for adult supervision.

In the study group, the human figure represented 42%, abiotic objects 80%, and children who drew human-made design products 10%. The human elements drawn in the drawings were generally depicted as people planting seeds or playing games in the forest. It is considered important for sustainability that children think of enriching the soil by planting seeds. Although it was observed that (f=42) drawings of the sun and (f=23) drawings of the sky were made as abiotic elements, it was noted that these drawings did not express any relationship in verbal expressions and were included in the drawings as a single factor. Although bicycles, roads, water fountains, fences and tents were rarely included in the drawings of man-made elements (designed environment), they did not reflect children's connections with the ecosystem in their verbal expressions.

### 4.2 Conclusions and Discussions Regarding the Mental Themes Children Construct in Their Verbal Expressions about Ecosystems

As a result of the scoring of the drawings made by the students for both ecosystems with test rubrics, quantitative data of the research result were obtained and evaluations were made.

As a result of the scoring of children's drawings of aquatic ecosystems with DAME-R and their verbal expressions, the schemas formed in their minds by the drawings were grouped under certain subheadings and interpreted in the context of the relationships established. As a result of the analysis of the drawings, it was observed that the participant children did not draw all the elements (human, living, non-living and designed elements) and even if they drew the elements, sometimes they did not establish any relationship. Considering the rubric total scores of the drawings, the drawings of the children who scored between 0-4 (f=36) were single-factor; in other words, only drawings were made without establishing a relationship with any element. On the other hand, the children who scored between 5-8 points (f=24) established bilateral relationships in their drawings and stated that

the factors in nature affect each other. By establishing the most relationship between the human and living factor (f=27), the verbal expression that people in the aquatic ecosystem are important for the nutrition of living creatures living in the sea and that pollution of the sea affects living creatures were frequently used. On the other hand, 40% of the students depicted the sea as an area where only living creatures live. Although very rare, there were also children who described the seas as a place where water needs are met for flying animals, a natural area where only people have fun, and an area where designed elements are used. There were no pictures that scored between 9 and 12, which is the highest evaluation criterion of DAME-R. In other words, although the students established bilateral relationships, they could not express this in a system understanding, and they could not adequately express that the elements belonging to all entity groups in the aquatic ecosystem affect each other.

As a result of the scoring of children's terrestrial ecosystem drawings with DAET-R and verbal expressions of their drawings, the schemas formed in their minds by the drawings were grouped under certain subheadings and interpreted in the context of the established relationships.

As a result of the analysis of the drawings, it was observed that the participant children did not draw all the elements (human, biotic, abiotic and designed elements) and even if they drew the elements, sometimes they did not establish any relationship. Considering the rubric total scores of the drawings, the drawings of the children who scored between 0-4 (f=35) were single-factor; in other words, only drawings were made without establishing a relationship with any element. On the other hand, the children who scored between 5-8 points (f=25) established bilateral relationships in their drawings and stated that the factors in nature affected each other. The most common relationship was established with the association of plant and animal population (living-living) between the living factor with a rate of 28.3%. The verbal expressions that the terrestrial ecosystem is important for the nutrition of the creatures living in the forest and that people go there for picnics were frequently used. Another 25% of the students depicted forests as a living habitat where people, animals and plants live together. Two drawings received 0 points because they did not contain any real elements and relationships. No drawing received a score between 9 and 12, which is the highest evaluation criterion of the rubric. In other words, although the students established bilateral relationships, they could not express this in a system understanding and could not adequately express that the existence of all elements in the terrestrial ecosystem affects each other.

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