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# EXPLORING SECONDARY SCHOOL STUDENTS' COGNITIVE STRUCTURES OF ENVIRONMENTAL POLLUTION AND THE FOOD CHAIN: AN ECOLOGICAL AND EDUCATIONAL PERSPECTIVE

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## ABSTRACT

Environmental components, including soil, water, air, and biodiversity, are vital for maintaining the balance of the ecosystem. However, environmental pollution is one of the most significant threats to these balances. With environmental pollution, the balance of ecosystems is disrupted, and the food chain is negatively affected. The food chain, which establishes equilibrium among plants, animals, and microorganisms, is of critical importance for the consumption of healthy food by humans. Understanding these relationships is crucial for grasping the cause-and-effect relationships underlying environmental issues. Consequently, the concepts of environmental pollution and the food chain are interconnected, and comprehending this relationship through education is necessary to cultivate more environmentally conscious generations. This study aims to determine the conceptual knowledge levels of 8th-grade students regarding the concepts of environmental pollution and food chain, as well as to reveal the conceptual schemas present in their cognitive structures. During the 2022-2023 academic year, the study was conducted with 286 eighth-grade students enrolled in schools within a district located in the eastern region of Türkiye. The research was conducted as a qualitative study using a survey model. The Word Association Test (WAT) was employed as the data collection instrument. The findings indicate that students established connections between "Environmental Pollution" and "Food Chain" but failed to fully grasp the relationships among these concepts and their interrelated effects. The results suggest that the cognitive relationships between environmental pollution and the food chain need to be emphasized more explicitly.

**Keywords:** *Environmental pollution, food chain, word association, conceptual knowledge, science education.*

## INTRODUCTION

Throughout human history, early humans strived to sustain their lives entirely within nature. These individuals lived in caves and/or tree hollows they found in their surroundings, fully immersed in the natural world (Ateş, 2009). They fulfilled their needs for nutrition, shelter, and protection entirely from their environment through various means. Hunting and gathering were fundamental aspects of their relationship with nature. By recognizing the plants, animals, and other living organisms around them, they developed survival strategies by utilizing these resources and coexisting harmoniously with nature (Mayr, 2008). During this period, humans relied on the knowledge they acquired from their environment to sustain their lives while also ensuring the sustainable consumption of nature's resources. This interaction with the environment allowed them to maintain a lifestyle in harmony with nature.

Since the existence of humans, the environment contains all the factors that affect the survival of a living creature (Yazgan, 2010). Ever since the emergence of humankind, the environment has represented a comprehensive system encompassing all vital elements (habitation, sustenance, and reproduction) that directly affect human existence as a constituent of the natural world (Uzun, 2022). In this context, the environment serves not only as a physical living space but also as a setting where human cultural and social interactions take shape. However, human interaction with nature has not always been limited to a positive relationship. Through their actions, consciously or unconsciously, humans have caused harm to nature, causing environmental degradation (Demir & Yalçın, 2014). Over time, the human impact on the environment has intensified, straining nature's ability to sustain itself. Excessive exploitation of natural resources has accelerated environmental destruction, disrupting ecosystems and destabilizing the natural balance. Thus, while the natural environment exists, human intervention threatens its integrity and sustainability (Kurt, 2017).

The deterioration of the natural environment has resulted in the destruction of habitats and the endangerment of various species (Lévéque & Mounolou, 2013). The loss of habitats has directly contributed to the decline of biodiversity, which represents the diversity of living organisms (Kurt, 2017). Additionally, the reduction in biodiversity disrupts ecosystems, causing fluctuations and disturbances in food chains, thereby directly impacting living organisms (Lévéque & Mounolou, 2013). If a particular species plays a keystone role within an ecosystem, its loss can have significant consequences for the survival of other populations (Lévéque & Mounolou, 2013). For this reason, preserving biodiversity has become a necessity, requiring active protection both by institutions and individuals to ensure ecological balance for future generations (Yüce, 2022). Maintaining a healthy ecological balance for future generations depends on preserving biodiversity, which is vital for the proper functioning of ecosystems.

In education, fostering environmental awareness is a crucial step toward preventing pollution and maintaining food chains. From an early age, raising individuals who are committed to protecting the environment and all living beings is essential for cultivating positive environmental attitudes. Therefore, environmental education has been proposed as a necessary approach (Demir & Yalçın, 2014). Educating students about environmental issues enhances their awareness of nature conservation, encouraging them to adopt protective behaviors. This, in turn, contributes to the development of an environmentally responsible generation on both individual and societal levels. It should be recognized that environmental preservation is not only essential for the current generation but also holds immense significance for the well-being of future generations. For this reason, within the scope of the research, it was tried to determine what kind of conceptual relationship the students established in their minds regarding the concepts of "environmental pollution" and "food chain", which are related to the environment and are interconnected with each other.

### *The Aim of the Study*

This study aims to determine the conceptual knowledge levels of 8th-grade students regarding the concepts of environmental pollution and the food chain, and to uncover the conceptual schemas present in their cognitive structures.

## METHODOLOGY

### *Model of the Study*

This study was qualitative with a survey model. The survey model is a research approach that aims to define and examine an existing situation as it is at a specific point in time (Büyüköztürk et al., 2013; Karasar, 2012). This model enables the collection of scientific data without any intervention, ensuring that decisions are made based on natural observations and allowing for an accurate understanding of the current state. Qualitative research is a method designed to gain an in-depth understanding of the experiences and meaning-making processes of individuals, groups, or institutions. It is particularly effective in exploring the complex structure of education and providing a deeper insight into educational processes. This approach not only focuses on gathering data but also aims to uncover the underlying meanings within the collected information. Merriam (2009) and Creswell (2014) emphasize that qualitative research is a particularly effective analytical method within educational contexts.

***Sample of the Study***

During the 2022-2023 academic year, the study was conducted with 8th-grade students enrolled in schools within a district located in the eastern region of Türkiye. A total of 286 students, 147 girls and 139 boys, participated in the study.

***Data Collection***

In this study, the Word Association Test (WAT), a qualitative data collection method, was employed to determine the cognitive structures, schemas, and relationships between concepts in 8th-grade students' understanding of environmental pollution and the food chain.

The WAT is one of the methods used to reveal individuals' mental schemas and understand their cognitive levels regarding concepts (Bahar et al., 1999). In this test, the hierarchical organization of the words provided by students reflects the semantic proximity of concepts within their mental schemas (Bahar et al., 1999).

In this study, the key concepts identified were "environmental pollution" and "food chain." These keywords were listed vertically five times, and students were asked to write down the words that these concepts evoked in their minds (Atasoy, 2004). Additionally, students were required to construct sentences related to the given keywords. A one-minute time limit was set for this task. The words written by the students were collected to form a data set for analysis.

To establish the reliability of the implementation, the initial phase involved practice activities with different concepts not included in the study. Subsequently, the main implementation was carried out using the study's key concepts.

The test structure used in the study is as follows:

| | |
|---|---|
| Environmental Pollution ..... | Food Chain ..... |
| Environmental Pollution ..... | Food Chain ..... |
| Environmental Pollution ..... | Food Chain ..... |
| Environmental Pollution ..... | Food Chain ..... |
| Environmental Pollution ..... | Food Chain ..... |
| Related Sentence ..... | Related Sentence ..... |

The WAT is particularly effective for analyzing students' existing cognitive structures in environmental awareness-based areas, such as environmental pollution and the food chain, in a comprehensive manner.

***Data Analysis and Procedures***

Content analysis and descriptive analysis methods were used in the data analysis. Initially, the two researchers independently examined the words written by the students and identified their frequencies. In calculating the overall word frequency, the ordinal position in which each word was listed by the students was also considered. Subsequently, these words were analyzed based on expert opinions and relevant literature in accordance with the key concepts, and irrelevant words were excluded. Based again on expert evaluations and the literature, the words that were conceptually related to the key concepts were grouped under appropriate superordinate-categories (inclusive concepts). During this process, the semantic relationships between words were taken into account. By analyzing the frequency of the words written by the students, the most prominent concepts and word usage patterns were identified. In line with the concept literature related to the key concepts, frequency tables were created, sub-concepts were identified, and superordinate concept categories were constructed. Finally, the semantic relationships and frequencies of the words were examined, and the connections between the words were visualized through the development of conceptual maps.

For a meaningful and valid analysis of the data obtained from the WAT, appropriate analytical techniques must be employed. In this context, the cut-off point technique is a crucial method used to determine

which concepts are more central in students' cognitive structures and to ensure the reliability of data analysis (Bahar et al., 1999).

During the construction of these concept networks, the cut-off point technique developed by Bahar et al. (1999) was employed. This technique involves setting a threshold based on the frequency of words written by students in the WAT and including only words that exceed this threshold in the analysis. The process eliminates infrequently used or contextually irrelevant words, leading to more meaningful results (Yıldırım & Şimşek, 2021). The cut-off point technique also helps filter out words written randomly or incorrectly, thereby increasing the accuracy of the dataset (Novak & Gowin, 1984).

In the cut-off point technique, the cut-off is initially determined as a specific value below the most frequently cited response for any given key concept in the frequency table. Concepts exceeding this threshold constitute the initial segment of the concept network. Subsequently, the cut-off point is gradually lowered at predetermined intervals, and this process continues until all key concepts are incorporated into the concept network.

The frequency count within each cut-off interval represents the number of students who provided responses falling within that specific range (Yılmaz, 2019).

In this study, the cut-off point technique threshold was set at 20, considering the highest and lowest frequency values of the words associated with the key concepts. Only words written by at least two or more students were included in the analysis. The cut-off point technique threshold was progressively lowered until all sub-concepts relevant to the key terms were identified (Ercan et al., 2010).

This technique has been widely used in numerous studies in the literature (Balbağ, 2018; Bahar & Özatlı, 2003; Bahar et al., 1999; Eren, 2012; Hakyoldaş, 2019; Kurt & Ekici, 2013; Nergiz, 2022; Önel & Yüce, 2016; Yıldızay, 2020; Yüce & Önel, 2015).

It has been observed that the cut-off point value varies across studies related to word association. The frequency distributions of the words provided in response to the key concepts play a significant role in determining this value. Therefore, the cut-off point may differ depending on the key concepts, the associated frequencies, and the judgments of the researchers. In their study, Çelik and Çakmak (2023) adopted a cut-off interval of 20. In contrast, Özyurt and Yalman (2020) set the cut-off interval at 50 in their research.

## FINDINGS

### *Descriptive Statistical Findings of the Participating Students*

Table 1 presents the demographic characteristics of the 286 students who participated in the study.

**Table 1.** *Frequency and Percentage Distribution of the Demographic Characteristics of the Students*

| | Variable | Frequency (f) | Percentage (%) |
|---|---|---|---|
| **Gender** | Girl | 147 | 51.4% |
| | Boy | 139 | 48.6% |
| **Schools** | S1 | 17 | 5.9% |
| | S2 | 17 | 5.9% |
| | S3 | 55 | 19.2% |
| | S4 | 38 | 13.3% |
| | S5 | 47 | 16.4% |
| | S6 | 112 | 39.2% |
| **Total** | | 286 | 100% |

An examination of Table 1 shows that 51.4% of the students are girls, while 48.6% are boys. In terms of school distribution, 5.9% of the students are from S1, 5.9% from S2, 19.2% from S3, 13.3% from S4, 16.4% from S5, and 39.2% from S6 secondary school.

***Frequency Tables and Conceptual Schemes Created Based on Data Obtained from the Concepts in the Word Association Test***

**Concepts Associated with the Environmental Pollution**

***Frequency and Percentage Distributions of Concepts Associated with the Environmental Pollution.*** As a result of the analysis of the data, 37 different words associated with environmental pollution in the word association test were collected under eight superordinate concept categories in total.

The frequency and percentage distributions of the concepts in each category are given in Table 2.

**Table 2.** *Frequency and Percentage Distribution of Words Associated with the Concept of Environmental Pollution*

| Superordinate Concept | Sub-concept | 1st Word | 2nd Word | 3rd Word | 4th Word | 5th Word | Associated Word Frequency | Percentage in Total Words Expected to Be Associated and Total Percentage | Total Associated Word Frequency | Percentage of Total Words Associated |
|---|---|---|---|---|---|---|---|---|---|---|
| **Environmental Pollutants** | Garbage | 80 | 23 | 14 | 11 | 3 | 131 | 9.16% | 398 | 57.02% |
| | Factory | 27 | 13 | 6 | 8 | 4 | 58 | 4.05% | | |
| | Plastic | 16 | 11 | 11 | 10 | 2 | 50 | 3.49% | | |
| | Polluted Gas | 10 | 9 | 1 | 7 | 4 | 31 | 2.16% | | |
| | Waste | 3 | 10 | 5 | 4 | 7 | 29 | 2.02% | | |
| | Exhaust | 3 | 7 | 5 | 1 | 4 | 18 | 1.25% | | |
| | Plastic Bag | 1 | 4 | 4 | 2 | 3 | 14 | 0.97% | | |
| | Smoke | 4 | 1 | 6 | 3 | - | 14 | 0.97% | | |
| | Glass | 1 | 3 | 4 | 1 | 3 | 12 | 0.83% | | |
| | Paper | - | 5 | 3 | 2 | 1 | 11 | 0.76% | | |
| | Battery | 1 | 2 | 4 | 2 | - | 9 | 0.62% | | |
| | Fossil Fuel | 1 | 2 | 2 | - | 2 | 7 | 0.48% | | |
| | Bottle | 1 | 1 | 3 | 1 | - | 6 | 0.41% | | |
| | Deodorant | - | 1 | 1 | 2 | - | 4 | 0.27% | | |
| | Metal-Tin | - | 1 | 1 | - | - | 2 | 0.13% | | |
| | Carbondioxide | - | - | 1 | - | 1 | 2 | 0.13% | | |
| **Result of Pollutants** | Pollution | 18 | 11 | 9 | 7 | 4 | 50 | 3.49% | 129 | 18.48% |
| | Air Pollution | 14 | 4 | 2 | 4 | 2 | 26 | 1.81% | | |
| | Water Pollution | 3 | 7 | 2 | - | 3 | 15 | 1.04% | | |
| | Global Warming | 1 | 3 | 1 | 2 | 5 | 12 | 0.84% | | |
| | Marine Pollution | 1 | 4 | 2 | 2 | 1 | 10 | 0.70% | | |
| | Noise Pollution | - | 1 | 4 | 3 | - | 8 | 0.55% | | |
| | Light Pollution | 2 | 1 | 3 | 1 | 1 | 8 | 0.55% | | |
| **Abiotic Elements** | Air | 6 | 11 | 5 | 3 | 2 | 27 | 1.88% | 67 | 9.60% |
| | Soil | 1 | 4 | 10 | 4 | 1 | 20 | 1.39% | | |
| | Water | 10 | 6 | - | 1 | 1 | 18 | 1.25% | | |
| | Climate | - | 1 | - | - | 1 | 2 | 0.13% | | |

**Table 2.** *Frequency and Percentage Distribution of Words Associated with the Concept of Environmental Pollution (Continued)*

| Superordinate Concept | Sub-concept | 1st Word | 2nd Word | 3rd Word | 4th Word | 5th Word | Associated Word Frequency | Percentage in Total Words Expected to Be Associated and Total Percentage | | Total Associated Word Frequency | Percentage of Total Words Associated |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Living Environments** | Nature | 6 | 3 | 5 | 4 | 1 | 19 | 1.32% | | | |
| | Forest | 4 | 3 | 3 | 1 | 3 | 14 | 0.98% | 2.92% | 42 | 6.02% |
| | Environment | 3 | - | 2 | 2 | 1 | 9 | 0.62% | | | |
| **Biotic Elements** | Human | 2 | 7 | 4 | 5 | 5 | 23 | 1.60% | | | |
| | Animal | 2 | 5 | 3 | 1 | 3 | 14 | 0.97% | 2.77% | 40 | 5.73% |
| | Living Being | 2 | - | - | 1 | - | 3 | 0.20% | | | |
| **Environmental Protection** | Bin | 1 | 3 | - | - | 3 | 9 | 0.62% | 1.03% | 15 | 2.15% |
| | Keeping Clean | 3 | 2 | - | 1 | - | 6 | 0.41% | | | |
| **Environmental Awareness** | Irresponsibility | 1 | - | 2 | 1 | 1 | 5 | 0.34% | 0.34% | 5 | 0.72% |
| **Result of Environmental Protection** | Clean Environment | 1 | - | - | 1 | - | 2 | 0.13% | 0.13% | 2 | 0.29% |
| **Number of Words Associated with Environmental Pollution** | | | | | | | 698 | 48.81% | | 698 | 100% |
| **Number of Words Not Associated with Environmental Pollution** | | | | | | | 732 | 51.19% | | | |
| **Total Number of Words Expected to Be Associated with the Environmental Pollution (286 students × 5 words)** | | | | | | | 1430 | 100% | | | |

The students who participated in the study associated a total of 37 different concepts with environmental pollution.

Among these associated concepts, the superordinate concept with the highest frequency was environmental pollutants (f=398). In this category, participants focused on the concepts of garbage, factory, plastic, polluted gas, waste, and exhaust. Within the environmental pollutants category, the three most frequently mentioned concepts were garbage (f=131), factory (f=58), plastic (f=50), and polluted gas (f=31). These results indicate that students most directly associate environmental pollution with garbage, factories, and plastic. Garbage includes all types of materials that can no longer be used (URL 1). Plastic refers to synthetic or semi-synthetic materials (URL 2). Based on this, it is evident that all the concepts in this category are interrelated. According to students' responses, these concepts can be categorized under the superordinate concept of "environmental pollutants".

Examining the sentences constructed by students, it is evident that they associated environmental pollutants with statements such as:

Student 4: Environmental pollution has spread all over the world.
Student 24: The garbage we throw on the ground pollutes the environment.
Student 31: There is a lot of plastic on the ground, which causes environmental pollution.
Student 40: Plastic bottles pollute the environment.
Student 92: To prevent environmental pollution, we should not litter.
Student 133: Factories cause environmental pollution.
Student 200: Do not throw garbage on the ground to prevent environmental pollution.

In the second category, it was observed that students associated environmental pollution with the results of pollutants (f=129). Within the "results of pollutants" category, the four most frequently mentioned concepts were pollution (f=50), air pollution (f=26), water pollution (f=15), and global warming (f=12). These results suggest that students recognize that pollution occurs as a result of pollutants.

Examining the sentences constructed by students, it is evident that they associated "results of pollutants" with statements such as:

Student 18: Air, water, and soil pollution are all forms of environmental pollution.
Student 68: We must prevent environmental pollution.
Student 103: To reduce environmental pollution, we can use public transportation.
Student 123: If we pollute the environment, it will be harder to breathe.
Student 167: The ozone layer is disappearing due to environmental pollution.

When examining the third most frequently repeated category, it was found that students associated environmental pollution with the concept of abiotic elements (f=67). Within the abiotic elements superordinate category, students focused on the concepts of air, soil, water, and climate. The most frequently mentioned concepts were air (f=27), soil (f=20), water (f=18), and climate (f=2). These results indicate that students directly associate environmental pollution with air, soil, water, and climate. Soil refers to non-living factors such as its physical structure, geology, heat, light, and humidity within ecosystems (Özügül, 2018). When the concepts are examined, it can be seen that all of them can be associated with abiotic elements. Thus, it is appropriate to classify them under the superordinate concept category of abiotic elements.

Examining the sentences constructed by students, it is evident that they associated abiotic elements with statements such as:

Student 181: Air, water, and soil pollution are environmental pollution.

When the next most frequently repeated category is examined, students associate environmental pollution with the living environment (f=42). In the general living environment category, students focused on living areas such as nature, forests, and the environment. The three most frequently mentioned concepts were nature (f=19), forests (f=14), and the environment (f=9). These results show that students establish a direct relationship between environmental pollution and living spaces such as nature, forests, and the environment. The environment can be defined as the place where living things interact to survive (Karaca, 2007). Nature, on the other hand, includes all living and non-living beings that continue their transformation and development within the framework of their own rules (TDK, 2024). Examining the concepts, it is seen that all of them can be associated with the living environment, and therefore, it would be appropriate to classify them under the superordinate concept category of living environment.

Examining the sentences constructed by students, it is evident that they associated living environment with statements such as:

| | |
|---|---|
| Student 2: | If people didn't throw garbage on the ground, nature wouldn't be polluted, and environmental pollution wouldn't exist. |
| Student 4: | Environmental pollution has spread all over the world. |
| Student 6: | One of the things that pollute our nature is the waste thrown away. |
| Student 10: | The spread of garbage/trash in nature is very bad. |
| Student 101: | Due to environmental pollution, the habitats of living beings are shrinking. |
| Student 250: | If there were no environmental pollution, forests wouldn't get polluted. |

In the fifth category, the concepts emphasize biotic elements (f=40). Here, students focused on the concepts of human, animal, and living beings. Under the superordinate category of biotic elements, the most frequently mentioned concepts were human (f=23), animal (f=14), and living being (f=3). A living being is an organism that sustains its existence by adapting its functions to life in a form containing simple structural molecules or organ systems (URL 3). When the concepts are examined, it can be seen that all of them can be associated with biotic elements, and therefore, it can be stated that the superordinate concept category of biotic elements is appropriate.

Examining the sentences constructed by students, it is evident that they associated biotic element with statements such as:

| | |
|---|---|
| Student 105: | Human do not care about environmental pollution at all. |
| Student 191: | Human pollute the environment. |
| Student 196: | Most environmental pollution is caused by humans. |
| Student 204: | Humans contribute to environmental pollution. |

The sixth category is one in which concepts related to environmental protection (f=15) have emerged. Here, students mentioned the concepts of bin (f=9) and keeping the environment clean (f=6). Recycling is the process by which a used material is processed through various steps and made reusable (Harman & Çelikler, 2016).

Examining the sentences constructed by students, it is evident that they associated "environmental protection" with statements such as:

| | |
|---|---|
| Student 77: | We must prevent environmental pollution. |
| Student 108: | Environmental pollution is very harmful. |
| Student 275: | We should increase recycling to prevent environmental pollution. |

The seventh category is the superordinate category of "environmental awareness (f=5)", under which the sub-category of irresponsibility (f=5) emerged.

Examining the sentences constructed by students, it is evident that they associated "environmental awareness" with statements such as:

Student 36: Let's end environmental pollution.
Student 53: We should be sensitive to environmental pollution.
Student 102: We need to reduce environmental pollution.

The last category is the superordinate category of environmental protection outcome (f=2). Under this inclusive concept category, the clean environment (f=2) sub-category has emerged.

Examining the sentences constructed by students, it is seen that they associate the result of not protecting the environment with the statements such as:

Student 109: Environmental pollution causes many diseases.
Student 278: If our environment gets polluted, everyone will get sick.

***Schematic Conceptual Networks Formed by Students in Their Minds Regarding the Concept of Environmental Pollution.*** Figure 1 presents the conceptual network constructed for the environmental pollution concept with a cut-off point of 122 and above.

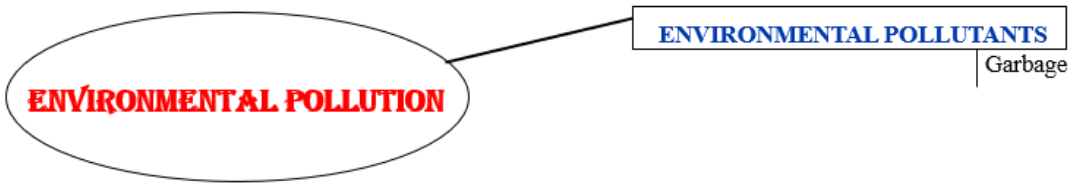


**Figure 1.** *Conceptual Network Constructed for the Cutoff Point of 122 and Above*

An examination of Figure 1 reveals that for a cutoff point of 122 and above, only the concept of garbage (f=131) has emerged under the superordinate category of environmental pollutants concerning the concept of environmental pollution. At this stage, no other concept has been formed.

Figure 2 presents the conceptual network constructed for the environmental pollution concept with a cut-off point of 42 and above.


**Figure 2.** *Conceptual Network Constructed for The Cutoff Point Of 42 and Above*

Figure 2 reveals that for a cut-off point of 42 and above, under the superordinate category of environmental pollutants, the concepts of factory (f=58) and plastic (f=50) have emerged. Additionally, under the superordinate category related to the consequences of pollutants, the concept of pollution (f=50) has been formed.

Figure 3 presents the conceptual network constructed for the environmental pollution concept with a cut-off point of 22 and above.

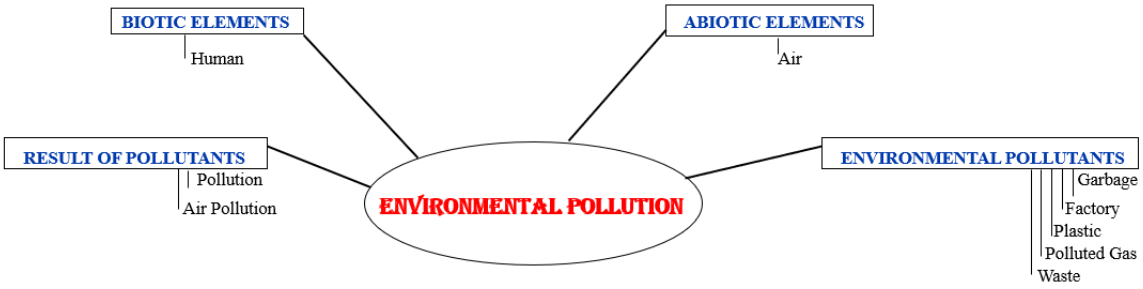


**Figure 3.** *Conceptual Network Constructed for the Cutoff Point of 22 and Above*

When examining Figure 3, it is observed that for the concept of "environmental pollution" under the superordinate categories of biotic and abiotic elements, as well as the consequences of pollutants, the concepts of human (f=23), air (f=27), and air pollution (f=26) emerge for the cut-off point of 22 and above. Additionally, new sub-concepts appear under the superordinate category of environmental pollutants.

Figure 4 presents the conceptual network constructed for the environmental pollution concept with a cut-off point of 2 and above.

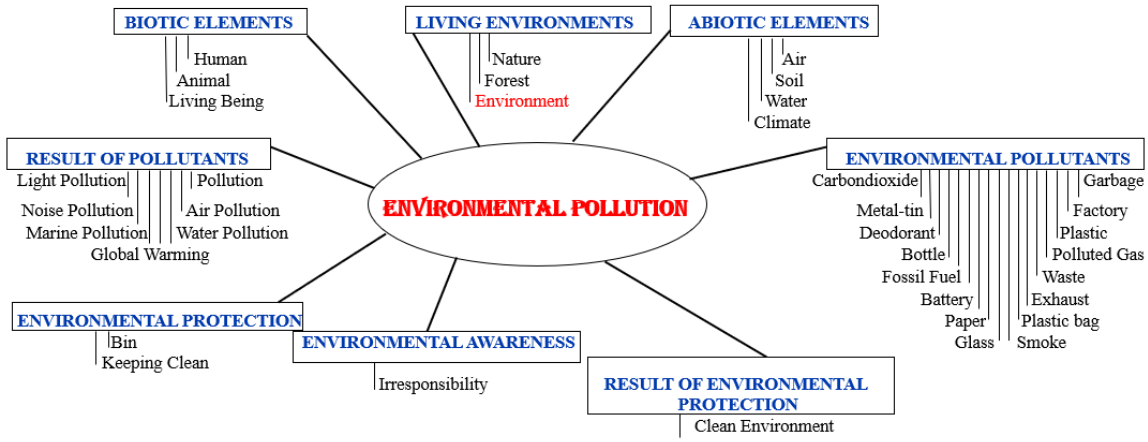


**Figure 4.** *Conceptual Network Constructed for the Cutoff Point Of 2 and Above*

When examining Figure 4, it is observed that for the concept of "environmental pollution," different concepts emerged under the superordinate categories of living environment, environmental protection, and results of environmental protection for the cut-off point of 2 and above.

It has been identified that the "environment" key concept has emerged under the living environment superordinate category. Based on this finding, it can be inferred that students have established cognitive connections between the concepts of "environmental pollution" and "environment."

Additionally, under the superordinate category related to environmental awareness, the concept of "irresponsibility" (f=5) has been observed.

In general, when examining the conceptual schema of environmental pollution constructed in students' minds, it is found that concepts under the superordinate category of environmental pollutants (f=398) have been cognitively constructed by students at a rate of 57.02%.

**Concepts Associated with the Food Chain**

***Frequency And Percentage Distributions of Concepts Associated with the Food Chain.*** As a result of the analysis of the data, 34 different words associated with the food chain in the word association test were collected under eight superordinate concept categories in total.

The frequency and percentage distributions of the concepts in each category are given in Table 3.

**Table 3.** *Frequency and Percentage Distribution of Words Associated with the Concept of Food Chain*

| Superordinate Concept | Sub-concept | 1st Word | 2nd Word | 3rd Word | 4th Word | 5th Word | Associated Word Frequency | Percentage in Total Words Expected to Be Associated and Total Percentage | | Total Associated Word Frequency | Percentage of Total Words Associated |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Biotic Elements** | Animal | 19 | 10 | 6 | 6 | 4 | 45 | 3.14% | 10.72% | 155 | 33.48% |
| | Plant | 8 | 10 | - | 7 | 4 | 29 | 2.02% | | | |
| | Living Being | 1 | 3 | 5 | 3 | 4 | 16 | 1.11% | | | |
| | Grass | 6 | 4 | 2 | 2 | 1 | 15 | 1.04% | | | |
| | Human | 4 | 1 | 4 | 4 | 2 | 15 | 1.04% | | | |
| | Mouse | 1 | 3 | 3 | 1 | - | 8 | 0.55% | | | |
| | Bird | - | 1 | 1 | 2 | 2 | 6 | 0.41% | | | |
| | Snake | 1 | 2 | - | 1 | 2 | 6 | 0.41% | | | |
| | Cat | - | - | 2 | 2 | - | 4 | 0.27% | | | |
| | Lion | 1 | - | 2 | - | 1 | 4 | 0.27% | | | |
| | Eagle | 2 | - | - | 1 | - | 3 | 0.20% | | | |
| | Dog | - | - | 1 | 1 | - | 2 | 0.13% | | | |
| | Species | - | - | 2 | - | - | 2 | 0.13% | | | |
| **Trophic Roles** | Consumer | 4 | 17 | 13 | 3 | 6 | 43 | 3.00% | 7.53% | 108 | 23.33% |
| | Producer | 17 | 13 | 6 | 4 | 1 | 41 | 2.86% | | | |
| | Decomposer | 5 | 3 | 10 | 4 | 2 | 24 | 1.67% | | | |
| **Nutrition** | Food | 30 | 5 | 5 | 2 | 2 | 44 | 3.07% | 5.48% | 79 | 17.06% |
| | Animal Feed | 12 | 2 | - | - | - | 14 | 0.97% | | | |
| | Nourishment | 3 | 1 | 1 | 2 | 5 | 12 | 0.83% | | | |
| | Meat | 3 | 2 | 1 | - | 1 | 7 | 0.48% | | | |
| | Milk | - | - | 1 | - | 1 | 2 | 0.13% | | | |
| **Consumers (Heterotrophs)** | Herbivore | 3 | 17 | 7 | 4 | 1 | 32 | 2.23% | 5.22% | 75 | 16.20% |
| | Carnivore | 14 | 8 | 5 | 2 | 2 | 31 | 2.16% | | | |
| | Omnivore | - | 1 | 10 | - | 1 | 12 | 0.83% | | | |

**Table 3.** *Frequency and Percentage Distribution of Words Associated with the Concept of Food Chain (Continued)*

| Superordinate Concept | Sub-concept | 1st Word | 2nd Word | 3rd Word | 4th Word | 5th Word | Associated Word Frequency | Percentage in Total Words Expected to Be Associated and Total Percentage | | Total Associated Word Frequency | Percentage of Total Words Associated |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ecological Functionality** | Cycle | 5 | 2 | 1 | 1 | - | 9 | 0.62% | 1.43% | 21 | 4.54% |
| | Chain | - | 2 | - | - | 5 | 7 | 0.48% | | | |
| | Transformation | 2 | - | - | 1 | - | 3 | 0.20% | | | |
| | Natural Selection | 2 | - | - | - | - | 2 | 0.13% | | | |
| **Competition/ Relationship** | Prey | 1 | 2 | 2 | 2 | - | 7 | 0.48% | 0.75% | 11 | 2.38% |
| | Predator | - | 2 | - | 1 | 1 | 4 | 0.27% | | | |
| **Abiotic Elements** | Sun | 2 | - | 1 | 1 | 1 | 5 | 0.34% | 0.47% | 7 | 1.51% |
| | Water | 1 | 1 | - | - | - | 2 | 0.13% | | | |
| **Living Environments** | Nature | 1 | 1 | 1 | 1 | 1 | 5 | 0.34% | 0.47% | 7 | 1.51% |
| | Environment | - | 2 | - | - | - | 2 | 0.13% | | | |
| **Number of Words Associated with Food Chain** | | | | | | | 463 | 31.7% | | 463 | 100% |
| **Number of Words Not Associated with Food Chain** | | | | | | | 967 | 68.3% | | | |
| **Total Number of Words Expected to Be Associated with the Food Chain (286 students × 5 words)** | | | | | | | 1430 | 100% | | | |

The students who participated in the study associated a total of 34 different concepts with the food chain.

Among these associated concepts, the most frequent superordinate category was biotic elements (f=155). In this category, participants focused on the concepts of animals, plants, living beings, and grass. Within the biotic elements superordinate category, the three most frequently repeated concepts were animal (f=45), plant (f=29), and living being (f=16). These results indicate that students mostly established a direct relationship between the food chain and the concepts of animal, plant, and living organism.

Examining the sentences constructed by students, it is evident that they associated "food chain" with statements such as:

Student 103: There are various animals in the food chain.
Student 197: There are many species in the food chain.

Based on these responses, it is appropriate to group these concepts under the biotic elements superordinate category.

The second most frequently repeated category shows that the relationship between the food chain and trophic roles was established. Under the trophic roles (*f*=108) superordinate category, students frequently repeated the concepts of consumer, producer, and decomposer. The frequency of the concepts in this category were consumer (*f*=43), producer (*f*=41), and decomposer (*f*=24). Consumers are organisms that deplete existing resources (URL 4). Producers, on the other hand, are organisms that generate or produce organic material using chemical or light energy (Lévéque & Mounolou, 2013). Based on this, the concepts in this category that students associate with the food chain can all be related to each other.

Examining the sentences constructed by students, it is evident that they associated "food chain" with statements such as:

Student 61: Consumers are abundant.
Student 83: Producers, decomposers, and consumers are part of the food chain.
Student 126: Consumers are at the top of the food chain.

The third most frequently repeated category indicates that students associated the food chain with nutrition (f=79). Under this superordinate category, students derived sub-concepts such as food (f=44), animal feed (f=14), nourishment (f=12), meat (f=7), and milk (f=2). These results show that students established a connection between the food chain and the concept of nutrition. Nutrition is the process of regularly consuming food in order to maintain life (URL 5).

Examining the sentences constructed by students, it is evident that they associated "food chain" with statements such as:

Student 1: The food chain is the consumption of living organisms by each other.
Student 78: Animals eat each other to survive.
Student 204: Without the food chain, we cannot survive.

The fourth most frequently repeated category is consumers (*f*=75). In this category, the sub-concepts of herbivore (*f*=32), carnivore (*f*=31), and omnivore (*f*=12) were repeated.

Examining the sentences constructed by students, it is evident that they associated "food chain" with statements such as:

Student 63: There are herbivores and carnivores in the food chain.

Student 69: Carnivores eat herbivores.
Student 101: The food chains of carnivores and herbivores may differ.

The fifth most frequently repeated category represents the ecological functionality (*f*=21) superordinate category, which indicates the cycle within the food chain. Under this category, students repeated sub-concepts such as cycle (*f*=9), chain (*f*=7), transformation (*f*=3), and natural selection (*f*=2). Natural selection refers to the potential for organisms producing fertile offspring to have varying amounts of progeny (Gürbüzoğlu Yalmancı, 2019).

Examining the sentences constructed by students, it is evident that they associated "food chain" with statements such as:

Student 11: Organisms develop through the food chain.
Student 16: The food chain helps maintain the balance of animals.
Student 18: Animals survive through the food chain.
Student 185: The food chain is part of a cycle.

The sixth most frequently repeated category involves competition/relationship (*f*=11), which expresses competitive relationships in the food chain. In this category, sub-concepts such as prey (*f*=7) and predator (*f*=4) emerged.

Examining the sentences constructed by students, it is evident that they associated "food chain" with statements such as:

Student 189: Animals prey on each other.
Student 193: There are prey and predators in the food chain.

Another frequently repeated category showed that students associated the food chain with abiotic elements (f=7). Under this superordinate category, students focused on the concepts of sun (f=5) and water (f=2). These results indicate that students established a direct relationship between the food chain and the concepts of water and sun. Abiotic components refer to non-living elements in ecosystems, such as soil (geology and physical structure, etc.) and climate (temperature, light, humidity, air) (Özügül, 2018).

Examining the sentences constructed by students, it is evident that they associated "food chain" with statements such as:

Student 33: The sun is important for the food chain.
Student 70: Animals in the food chain contain water.

The final category reflects the concepts emphasizing living environment (f=7). In this category, students focused on the concepts of nature and the environment. The most frequently mentioned concepts were nature (f=5) and environment (f=2). Nature refers to the physical dimension of the universe that forms, changes, and continues to exist on its own (URL 6). Environment includes factors that affect the survival of living organisms (Akçay, 2006). All of these concepts can be classified under the living environment superordinate category as they are related to it.

Examining the sentences constructed by students, it is evident that they associated "food chain" with statements such as:

Student 121: There is a food chain in nature.
Student 167: The food chain exists in nature.
Student 213: Our environment is very important for the food chain.

***Schematic Conceptual Networks Formed by Students in Their Minds Regarding the Concept of Food Chain***. Figure 5 presents the conceptual network constructed for the food chain concept with a cut-off point of 42 and above.

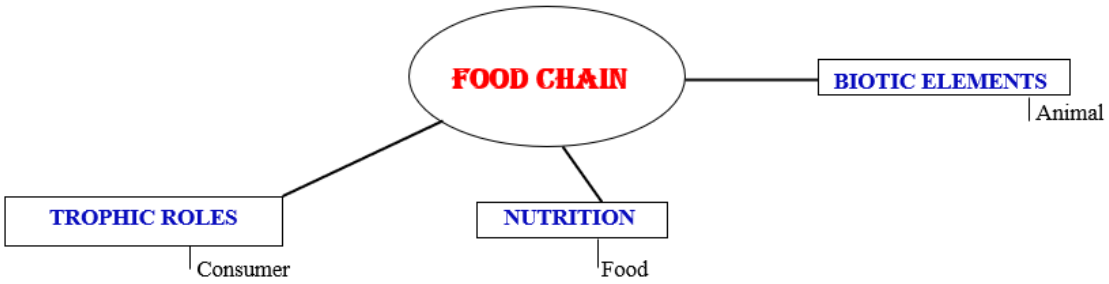


**Figure 5.** *Conceptual Network Constructed for the Cutoff Point of 42 and Above*

When examining Figure 5, it is observed that for the concept of "food chain" under the superordinate categories of biotic elements, nutrition, and trophic roles, only the concepts of animal (f=45), food (f=44), and consumer (f=43) emerged for the cut-off point of 42 and above. At this stage, no other concept has been formed.

Figure 6. presents the conceptual network constructed for the food chain concept with a cut-off point of 22 and above.

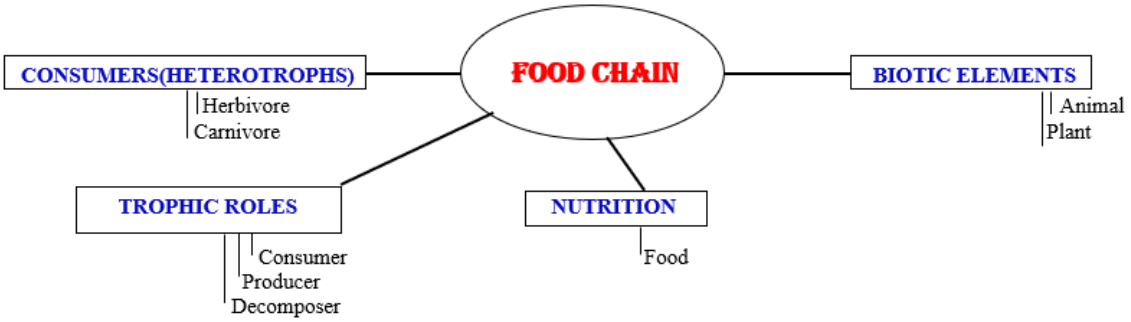


**Figure 6.** *Conceptual Network Constructed for The Cutoff Point Of 22 and Above*

When examining Figure 6, it is observed that for the concept of "food chain" under the superordinate categories of biotic elements, trophic roles, and consumers for the cut-off point of 22 and above, the concepts of plant (f=29), producer (f=41), decomposer (f=24), herbivore (f=32), and carnivore (f=31) emerged.

Figure 7. presents the conceptual network constructed for the food chain concept with a cut-off point of 2 and above.

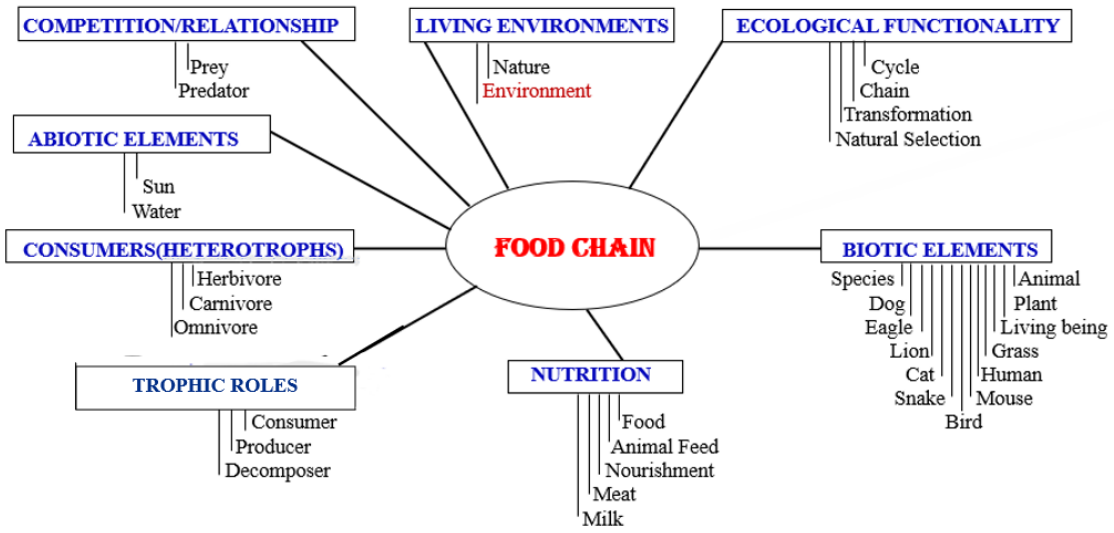


**Figure 7.** *Conceptual Network Constructed for the Cutoff Point of 2 and Above*

When examining Figure 7, it is observed that for the concept of "food chain," different concepts emerged at this stage under the superordinate categories of ecological functionality, competition/relationship, abiotic elements, and living environment, for the cut-off point of 2 and above.

It has been identified that the "environment" key concept emerged under the living environment superordinate category. Based on this finding, it can be inferred that students have established cognitive connections between the concepts of "food chain" and "environment."

In addition to these, new sub-concepts related to the superordinate categories of nutrition and biotic elements have also been observed.

In general, when examining the conceptual schema of the food chain constructed in students' minds, it is found that concepts under the superordinate category of biotic elements (f=155) have been cognitively constructed by students at a rate of 33.48%.

## DISCUSSION AND CONCLUSION

This study aimed to determine the conceptual knowledge level of 8th-grade students regarding the concepts of environmental pollution and food chain and to explore the conceptual schemas existing in their cognitive structures. How students perceive these concepts reflects their ecological awareness and their awareness of both environmental and ecosystem sustainability issues.

The concept of environmental pollution is an important indicator of students' awareness of environmental issues. In the word association test, students wrote 37 different words related to the key concept of "environmental pollution," accounting for 48.81% of the responses. According to the students' responses, 57.02% of the words associated with environmental pollution were linked to the environmental pollutants superordinate category, with garbage, factory, and plastic being the most repeated. The second most frequent superordinate category associated with environmental pollution was pollution, with it being the most repeated word under this category (18.48%). In a study conducted with middle school students, Çam (2022) addressed the concepts of the food chain, environmental issues, and environmental protection as related concepts. The findings revealed that students were able to establish a significant conceptual relationship between the key terms environmental issues and environmental protection. Per Çam (2022), it was found that the key concept of environmental issues was associated by 8th-grade students with sub-concepts such as pollution, waste, air pollution, water

pollution, exhaust fumes, factories, and recycling. The findings of the present study are consistent with those reported in Çam's research. In the study conducted by Erduran Avcı et al. (2013) with 8th-grade students, it was observed that students mostly perceive environmental pollution as air, water, soil, and visual pollution. Hence, it can be said that students assume environmental pollution consists of physical (directly observable) wastes and their consequences. However, environmental pollution also includes broader elements such as noise pollution, light pollution, radioactive pollution and biological pollution. In this study, although to a lesser extent, students also associated noise and light pollution with environmental pollution. Furthermore, it was observed that the environment concept emerged under the living environment superordinate category. This finding indicates that students connected the concepts of environment and environmental pollution.

Students' sentences related to the "environmental pollution" concept included:

Student 4: "Environmental pollution has spread all over the world."
Student 24: "The garbage we throw on the ground is polluting the environment."
Student 31: "There is too much plastic on the ground, and this causes environmental pollution."
Student 40: "Plastic bottles pollute the environment."
Student 92: "To prevent environmental pollution, we should not throw garbage/trash on the ground."
Student 133: "Factories cause environmental pollution."

In a study conducted with elementary school students, concepts related to environmental issues. Such as the environment, air pollution, water pollution, soil pollution, waste, and recycling were identified as key concepts, and students were found to associate these with humans (Atabek Yiğit et al., 2019). In this study, the concept of environmental pollution was similarly associated with humans by the students. Human beings are both factors that affect and are affected by environmental pollution. Environmental pollution is a factor that threatens not only biological and ecological interactions but also human health. Providing comprehensive education about the causes, consequences and solutions of pollution in science education can help students take an active role in protecting the environment.

The concept of the food chain plays a crucial role in understanding ecological systems. To comprehend the flow of energy and material cycles within an ecosystem, students must grasp the concept of the food chain correctly (Odum & Barrett, 2005). In this study, students wrote 34 different words associated with the food chain key concept, representing 31.7% of the responses.

According to the students' responses, 33.48% of the words associated with the food chain were linked to the biotic element superordinate category, with animal and plant being the most repeated words. The fact that students mostly express biotic elements, such as animals and plants, regarding the food chain shows that these concepts are perceived as a basic biological structure for the students. The second superordinate category is based on trophic roles, and the most repeated words (23.33%) are consumer and producer. The widespread use of the concepts of consumer and producer among students shows that students are very conscious of understanding the function of each level in the food chain. In the consumer category, herbivore and carnivore are the most frequently associated words. In a similar study conducted by Çam (2022), similar results were found in the responses of 8th-grade students to the word association test regarding the concept of the food chain. In this study, it was understood that students were not limited to the basic elements of the food chain concept (animals, plants, consumers and producers). In other words, not only the building blocks of the concept but also the interactions between these building blocks are emphasized.

Students' sentences related to the "food chain" concept included:

Student 1: "The food chain is the consumption of living organisms by each other."
Student 61: "There are many consumers."
Student 63: "There are carnivores and herbivores in the food chain."
Student 69: "Carnivores eat herbivores."
Student 83: "Producers, decomposers, and consumers are part of the food chain."

Student 101: "The food chains of carnivores and herbivores may differ."
Student 126: "Consumers are at the top of the food chain."
Student 121: "There is a food chain in nature."
Student 213: "Our environment is very important for the food chain."

In this research, per the words of the students and the relevant sentences made, it can be stated that the students see the concept of the food chain as a natural process, but they cannot fully understand the importance of this process for ecological balance. Students generally make a simple and superficial definition of the food chain as living things in nature eating each other, and they rarely mention the concepts of cycle and transformation. However, the food chain is an important process that regulates the flow of energy in ecosystems and ensures the cycling of substances. The food chain should be considered not only as a relationship between eating and being eaten but also as a system that regulates the material cycle and energy flow within the ecosystem (Odum & Barrett, 2005). These relationships between living things in ecosystems help maintain natural balance by maintaining a balance between biotic and abiotic elements.

Additionally, it was found that the environment concept emerged under the living environment superordinate category. This indicates that students have made a connection between the environment and the food chain. However, a strong relationship also exists between environmental pollution and the food chain. Environmental pollution directly affects the environment, and thus, all living organisms. Polluted environments disrupt the ecosystems where living beings reside, which negatively impacts the food chain. Damages to the food chain have a direct effect on humans, as they are one of the last links in the food chain. Therefore, environmental pollution threatens human health directly. This study has shown that students cannot establish a connection between environmental pollution and the food chain and cannot grasp the effects these concepts have on one another.

In this study, students associated 37 words with the environmental pollution concept and 34 words with the food chain concept. Students were able to associate 48.81% with environmental pollution and 31.7% with the food chain. These percentages are not considered sufficient.

Furthermore, students have made connections between the two key concepts: environmental pollution and the food chain. Animal, human, living being, nature, and water were the most commonly associated words across all two key concepts. However, associating only five words between the two concepts is insufficient. Environmental pollution and the food chain are interconnected concepts, where each affects and complements the other. Environmental pollution can disrupt the food chain, causing accumulation and toxic effects in every link. Disruptions to the food chain not only threaten ecosystems but also pose a danger to human health.

However, it was observed that students could not clearly grasp the relationships between these concepts or understand how they affect one another. This suggests that cognitive relationships between environmental pollution and the food chain should be emphasized more clearly.

The cognitive relationship between environmental pollution and the food chain is of significant importance for ecological sustainability and human health.

## RECOMMENDATIONS

To help students better grasp the relationships between environmental pollution and the food chain, it is essential to strengthen the connections between these concepts. The use of active learning methods is recommended to enhance these connections. Additionally, suitable teaching materials and activities should be developed. Students should gain a better understanding of how environmental pollution and ecosystem degradation influence each other.

Using an interdisciplinary approach, lesson plans can be developed that focus on directly discussing the effects of environmental problems on ecosystems and utilize knowledge from different disciplines.

To raise students' awareness, promote critical thinking on environmental issues, and foster deeper conceptual understanding, a variety of instructional tools, such as educational videos, documentaries, and interactive digital content, can be integrated into classroom practices.

**REFERENCES**


Akçay, I. (2006). *Environmental education for preschool students in different countries* [Unpublished master's thesis]. Uludağ University Institute of Social Sciences.

Atabek Yiğit, E., Balkan Kıyıcı, F., & Yavuz Topaloğlu, M. (2019). Determination of perceptions of primary school students about environmental problems. *Bolu Abant Izzet Baysal University Journal of Faculty of Education*, *19*(3), 732-744.

Atasoy, B. (2004). *Science learning and teaching* (2nd ed.). Asil Publishing.

Ateş, K. (2009). Theory of evolution yesterday and today. In K. Ateş (Ed.), *Theory of evolution yesterday and today* (pp.15-38). Evrensel Printing Publication.

Bahar, M., & Özatlı, N. S. (2003). Investigation of the cognitive structures of first-year high school students on the basic components of living things using the word association test method. *Journal of Balıkesir University Institute of Science and Technology, 5*(1), 75-85.

Bahar, M., Johnstone, A. H., & Sutcliffe, R. G. (1999) Investigation of students' cognitive structure in elementary genetics through word association tests. *Journal of Biological Education, 33*(3), 134-141. https://doi.org/10.1080/00219266.1999.9655653

Balbağ, M. Z. (2018). Cognitive constructs related to mass and weight concepts of science teacher candidates: Application of word association test (WAT). *Eskişehir Osmangazi University Turkish World Application and Research Center Education Journal, 3*(1), 71-81.

Büyüköztürk, Ş., Çakmak, E., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. (2013). *Scientific research methods.* Pegem Academy Publishing.

Çam, Z. (2022). *Comparative determination of middle school students' cognitive structures related to biological diversity* [Unpublished master's thesis]. Uludağ University Institute of Educational Sciences.

Çelik, B., & Çakmak, M. (2023). Examination of 8th grade students cognitive structures regarding natural disasters through the Word Association Test. *Mevzu: Journal of Social Sciences, 10*, 773-796.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative and mixed methods approaches (4th ed.).* Sage Publications.

Demir, E., & Yalçın, H. (2014). Environmental education in Turkey. *Turkish Journal of Scientific Reviews, 7*(2), 07-18.

Ercan, F., Taşdere, A., & Ercan, N. (2010). Observation of conceptual change in cognitive structure through word association test. *Turkish Science Education, 7*(2), 136-157.

Erduran Avcı, D., Demirekin, M., Hare, O., Özlü, S., & Özkan, I. (2013). 8. sınıf öğrencilerinin çevre sorunları algısının farklı tekniklerle incelenmesi. *Fen Eğitimi ve Araştırmaları Derneği Fen Bilimleri Öğretimi Dergisi*, *1*(2), 50-66.

Eren, F. (2012*). Analysis of perceptions of secondary school students about information technologies through word association test.* [Unpublished master's thesis]. Necmettin Erbakan University Institute of Educational Sciences.

Gürbüzoğlu Yalmancı, S. (2019). Population genetics. In A. Önel (Ed.), *Genetics and Biotechnology* (pp. 57-73). Pegem Academy Publishing.

Hakyoldaş, M. (2019). *Examination of secondary school students cognitive structures on the subject of "cell" by means of word association test (WAT)* [Unpublished master's thesis]. Ömer Halis Demir University Institute of Educational Sciences.

Harman, G. & Çelikler, D. (2016). Awareness of science teacher candidates on recycling. *AIBU Journal of Social Sciences, 16*(1), 331-353.

Karaca, C. (2007). Within environment, human and ethic framework approaches devoted to the solutions and environment issues. *Journal of Çukurova University Faculty of Economics and Administrative Sciences, 11*(1), 1-19.

Karasar, N. (2012). *Scientific research method*. Nobel Publishing.

Kurt, H., & Ekici, G. (2013). Determining biology student teachers' cognitive structure on the concept of "osmosis" through the free word-association test and the drawing-writing technique. *Turkish Studies*, *8*(12), 809-829.

Kurt, H. (2017). Biodiversity at the crossroads of environmental issues. *Süleyman Demirel University the Journal of Faculty of Economics and Administrative Sciences, 22*(3), 825-837.

Lévéque, C., & Mounolou, J. (2013). Biodiversity, biological movements and conservation. In H. Başıbüyük, A. Yılmaz, & S. Kılınç (Trans. Ed.), *Biodiversity and the functioning of ecological systems* (2nd edition) (pp.123-128). Palme Publishing.

Mayr, E. (2008). *This is biology.* Tübitak Popular Science Books.

Merriam, S.B. (2009). *Qualitative research: A guide to design and implementation.* Jossey-Bass.

Nergiz, H. (2022*). Determining the cognitive structures of pre-service science teachers' on the concept of "matter" through the word association test, drawing-writing technique, and concept maps* [Unpublished master's thesis]. Alaaddin Keykubat University Graduate School of Alanya.

Novak, J.D., & Gowin, D.B. (1984). *Learning how to learn*. Cambridge University Press.

Odum, E.P., & Barrett, G.W. (2005). *Fundamentals of ecology* (5th ed.). Thomson Brooks/Cole.

Önel, A., & Yüce, Z. (2016). Determining the cognitive structures of science teacher candidates on "evolution" through word association test. *Journal of Educational Sciences Research, 6*(1), 23-39.

Özügül, M. D. (2018). Suitability analysis parameters for site-selection in water-basin ecosystems. *National Environment Science Research Journal, 1*(4), 170-184.

Özyurt, Ö. G., & Yalman, F. E. (2020). Identifying cognitive structure related to renewable energy using word association test: The Mersin province case. *İnönü University Journal of the Faculty of Education, 21*(3), 1320-1338.

TDK (Türk Dil Kurumu/Turkish Language Association). (2024). *General Explanatory Dictionary.* TDK Publications.

Uzun, B. (2022). Türkiye's biodiversty of education. In Z. Yüce and A. Önel (Eds.), *Türkiye's Biological Riches* (pp. 523-561). Ertem KAFKARS Publishing.

Yazgan, Ç. Ü. (2010). Society-environment relations during the process of history and emergency of environment problems. *E- Journal of New World Sciences Academy*, *5*(1), 227-244.

Yıldırım, A., & Şimşek, H. (2021). *Qualitative research methods in the social sciences* (12th ed.). Seçkin Publishing.

Yıldızay, Y. (2020). *Determining of the students cognitive structures on the concept of heredity by word association test (WAT) and writing test* [Unpublished master's thesis]. Balıkesir University Institute of Science.

Yılmaz, H. (2019). *Examining the 5th grade students perceptions about regions of Turkey through the word association tests* [Unpublished master's thesis]. Niğde Ömer Halis Demir University Institute of Educational Sciences.

Yüce, Z. (2022). Biodiversity. In Z. Yüce and A. Önel (Eds.), *Türkiye's Biological Riches* (pp. 19-37), Ertem KAFKARS Publishing.

Yüce, Z., & Önel, A. (2015). The cognitive binding levels of the science teacher candidates in relation to biodiversity. *Bolu Abant İzzet Baysal University Journal of Faculty Education, 15*(1), 326-341.