

How is the Concept of "Environment" Cognitively Structured by Secondary School Students?

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Abstract:

Introduction: The environment, which is the habitat of all living things and contains the natural resources necessary to sustain life, is an issue of vital importance for humanity.

Methods: This study was conducted to examine the conceptual structures that form the concept of "environment" in the minds of 8th grade students and to reveal their cognitive understanding and perceptions. The study was conducted in a district located in eastern Türkiye.

Results: Although students have a solid understanding of ecological concepts, especially those related to biotic elements, there is a clear need to deepen their awareness of the interconnectedness of environmental components, including abiotic factors and human impacts.

Discussion: According to the results obtained from the study, although students have a certain level of conceptual structure, this is not considered sufficient. In addition, the fact that students associate the concept of environment with a narrow group of words suggests that their conceptual structures may be underdeveloped.

Limitations: There may be some limitations in this study due to the scope of the study and the sample group. The subject of studying with a larger sample group and different techniques can be investigated.

Conclusions: Using active learning strategies can deepen students' understanding and emotional connection to the environment.

Key words: environment, word association, conceptual knowledge, science education.

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Introduction

Environment, it is all of the biotic and abiotic factors that affect a living organism or a living community throughout its life (Yücel & Morgil, 1998). Albert Einstein defined the environment as "everything that is outside of me," emphasising that the concept of the environment actually carries a very broad meaning (Miller & Spoolman, 2010).

The concept of environment is one of the fundamental constructs through which individuals understand the natural world, and its comprehension plays a pivotal role in science education. In the context of science education, particularly at the secondary school level, the development of cognitive structures around the concept of environment is crucial for students to engage with ecological phenomena, environmental processes, and the implications of human activities on the planet. The term "environment" extends beyond ecological or biological domains, encompassing economic, cultural, and social dimensions. Therefore, the cognitive structures surrounding the environment are closely tied to how students perceive and conceptualize environmental issues and the ways in which they apply their understanding of the environment in real-life contexts.

The process of environmental education in science classrooms emphasizes the activation of prior knowledge and the structuring of this knowledge into more complex and abstract environmental concepts. In addition to natural science knowledge, environmental education in science also incorporates ethical considerations, sustainability practices, and the broader human-environment relationship, providing students with a holistic perspective on the environment.

In parallel with increasing environmental problems, studies in the field of environmental education need to be constantly supported (Husamah, Suwono, Nur, & Dharmawan, 2022). Science education aims not only to transfer knowledge but also to raise responsible and knowledgeable citizens who can critically deal with environmental problems (Bilčík, Bilčíková, Lajčín, & Barnová, 2023). In this context, the correct cognitive structuring of the concept of the environment encourages a deeper interaction with the natural world and, at the same time, develops the necessary skills and awareness to promote sustainability. Therefore, environmental education is not only about transferring knowledge, but also about developing an environmentally sensitive and action-oriented mindset in students.

1 Purpose of the study

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

2 Method

2.1 Model of the study

This study was conducted as qualitative research using the survey model. In the scanning model, data are collected without any intervention, and the current situation is understood as it is. Qualitative research is a method designed to provide an in-depth understanding of experiences and meaning-making processes on a topic of interest. It is especially effective in education, in discovering complex structures and gaining a deeper perspective. This approach not only focuses on data collection, but also aims to reveal the underlying meanings of the information obtained. It is emphasized that qualitative research is an effective analytical method, especially in the educational context (Merriam, 2009; Creswell, 2014).

2.2 Participants

The study was conducted with a total of 286 students, 139 males and 147 females. The study was conducted with 8th-grade students in a district located in eastern Türkiye in the 2022-2023 academic year.

2.3 Data collection

In this study, Word Association Test (WAT), a qualitative data collection method, was used to determine 8th-grade students' cognitive structures, schemas and relationships between concepts regarding the concept of environment.

Word association test is one of the methods used to understand individuals' cognitive levels and reveal their schemas. The hierarchical organization of words stated by students reflects the semantic closeness of concepts within their cognitive schemas (Bahar, Johnstone, & Sutcliffe, 1999).

In this study, "environment" was determined as the key concept. This keyword was listed five times, one below the other, and the students were asked to write the words that this concept evoked in their minds (Atasoy, 2004). In addition, students were asked to make sentences related to the given keyword. A total of 30 seconds is given for these. The words written by the students were collected for analysis.

The test structure used in the study is as follows:

Environment
Environment
Environment
Environment
Environment
Related Sentence

WAT is particularly effective in comprehensively analyzing students' current cognitive structures in awareness-based domains such as the environment.

2.4 Data analysis and procedures

In this study, descriptive analysis and content analysis were performed to analyze the data obtained. The frequency of words written by students was examined to determine which concepts were more prominent. Additionally, semantic relationship criteria and word usage frequencies were considered to construct categories. Based on this, frequency tables were generated, sub-concepts were identified, and upper concept categories were established in alignment with the literature. Subsequently, the semantic relationships and frequency of the words were analyzed, and conceptual schemas were constructed by visualizing the connections between words.

The cut-off point technique was used for meaningful and valid analysis of the data obtained from the word association test. The cut-off point technique is an important method used to determine which concepts are more central and to ensure the reliability of data analysis (Bahar, Johnstone, & Sutcliffe, 1999). With this technique, a threshold is determined based on the frequency of words written by students in WAT.

In this study, the lowest and highest frequency values of the words written by the students regarding the key concept were taken into account. Accordingly, the cutoff point threshold was determined as 20. Only words written at least twice were included in the analysis. The cut-off point threshold was gradually lowered until all words related to the key concepts emerged (Ercan, Taşdere, & Ercan, 2010). Studies using this technique are available in the literature (Bahar & Özatlı, 2003; Kurt & Ekici, 2013; Yüce & Önel, 2015; Önel & Yüce, 2016; Balbağ, 2018; Hakyoldaş, 2019; Yıldızay, 2020).

3 Findings

3.1 Frequency and percentage distributions of words related to the environment

As a result of the analysis of the data obtained from the word association test, it was determined that there were 36 different words associated with the concept of environment by the students. These associated words are grouped under nine upper concept categories. The frequency and percentage distributions of words in each category are given in Table 1.

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Table 1

Frequency and percentage distribution of words associated with the concept of environment

<u>Upper Concept</u>	<u>Concept</u>	<u>1st Word</u>	<u>2nd Word</u>	<u>3rd Word</u>	<u>4th Word</u>	<u>5th Word</u>	<u>Associated Word Frequency</u>	<u>Percentage in Total Words Expected to Be Associated and Total Percentage</u>	<u>Total Associated Word Frequency</u>	<u>Percentage of Total Words Associated</u>	
Biotic Elements	Animal	11	23	29	29	11	103	7.20%	29.94%	428	50.71%
	Tree	42	22	15	7	3	89	6.22%			
	Plant	4	12	20	10	13	59	4.13%			
	Human	7	8	6	9	17	47	3.29%			
	Flower	1	11	21	9	3	45	3.15%			
	Greenery	6	4	3	6	5	24	1.68%			
	Living Being	-	3	6	5	6	20	1.40%			
	Insect	-	4	4	7	4	19	1.33%			
	Grass	2	4	3	2	5	16	1.12%			
	Bird	-	1	3	1	1	6	0.42%			
Living Environments	Nature	55	23	12	9	4	103	7.20%	14.91%	214	25.36%
	Forest	14	10	5	7	4	40	2.79%			
	Mountain	1	4	6	3	10	24	1.67%			
	Habitat	8	7	1	3	5	24	1.67%			
	Surroundings	6	2	1	-	2	11	0.76%			
	Lake	-	2	2	3	1	8	0.55%			
	Ecosystem	-	1	1	1	1	4	0.27%			
Result of Pollutants	Pollution	36	18	12	6	8	80	5.60%	6.24%	87	10.31%
	Air Pollution	-	-	2	1	2	5	0.34%			
	Global Warming	2	-	-	-	-	2	0.13%			
Environmental Protection	Cleanliness	10	10	5	2	3	30	2.09%	3.25%	47	5.57%
	Conservation	4	4	1	2	-	11	0.76%			
	Eco-friendly	-	-	1	2	1	4	0.27%			
	Recycling	1	-	1	-	-	2	0.13%			
Environmental Pollutants	Garbage	7	10	3	4	2	26	1.81%	2.14%	31	3.67%
	Plastic	-	-	1	1	1	3	0.20%			
	Exhaust	-	1	1	-	-	2	0.13%			
Abiotic Elements	Soil	1	1	5	4	2	13	1	1.51%	22	2.61%
	Water	-	-	2	1	2	5	-			
	Air	-	1	1	2	-	4	-			
Ecological Functionality	Diversity	1	1	-	-	-	2	1	0.39%	6	0.71%
	Biodiversity	-	-	-	1	1	2	-			
	Migration	1	-	1	-	-	2	1			
Environmental Awareness	Sensitivity	-	-	1	2	-	3	-	0.33%	5	0.59%
	Consciousness	2	-	-	-	-	2	2			
Institutions/ Organizations for Environmental	Ministry	-	1	-	2	1	4	-	0.27%	4	0.47%

Protection				
Number of words associated with environment	844	59.02%	844	100%
Number of words not associated with environment	586	40.98%		
Total number of words expected to be associated with the environment (286 students × 5 words)	1430	100%		

The students participating in the study associated 36 different concepts with the environment. Among these associated concepts, the upper concept with the highest frequency was the biotic element ($f=428$). Within this category, participants focused on the concepts of animal, tree, plant, human, and flower. Among the biotic element category, the three most frequently repeated concepts were animal ($f=103$), tree ($f=89$), and plant ($f=59$). These results indicate that students primarily establish a direct relationship between the environment and animals, trees, and plants. The biotic element encompasses all living entities (Özügül, 2018). Based on this definition, it was observed that all concepts associated by students within this category align with the biotic element classification. According to the responses given by students, these concepts can be categorized under the upper concept of "biotic element." Examining the sentences constructed by students, it is evident that they associated biotic elements with statements such as:

Student 18: *"All animals interact with each other."*

Student 25: *"There are trees in our environment."*

Student 95: *"Our environment is full of living beings."*

Student 123: *"There are many flowers around me."*

Student 204: *"The living beings in our environment are beautiful."*

The second most frequently repeated category was the concept of living environment ($f=214$) in relation to the environment. Within the overarching concept of living environment, the most frequently mentioned concepts were nature ($f=103$), forest ($f=40$), mountain ($f=24$), and habitat ($f=24$). These results indicate that students primarily establish a direct relationship between the environment and nature, forests, mountains, and habitats. The environment refers to the setting in which living beings directly or indirectly influence one another throughout their lives (Demir & Yalçın, 2014). Nature, on the other hand, encompasses entities that develop and change within their own set of rules (Turkish Language Association, 2024). A forest is defined as a wooded area with no distinct beginning or end (Sevgi, 2013). Given that all these concepts are associated with the living environment, categorizing them under the upper concept of "living environment" is deemed appropriate. The students' responses reflect this association, as illustrated in the following statements:

Student 6: *"One of the things that pollutes our nature is littering."*

Student 193: *"The forests in our environment are very fertile."*

Student 203: *"There are mountains around us."*

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The third category examined was students' association of the environment with conditions resulting from pollutants (f=87). Within the upper concept of pollution, students primarily focused on pollution (f=80), air pollution (f=5), and global warming (f=2). These results indicate that students primarily associate the environment with pollution, air pollution, and global warming. Pollution refers to various forms of residue left behind by consumed resources (Yazgan, 2010). Given that all these concepts relate to environmental pollution caused by pollutants, categorizing them under the upper concept of "result of pollutants" is appropriate. The students' responses include:

Student 6: *"One of the things that polutes our environment is littering."*

Student 23: *"Water gets polluted due to environmental pollution."*

Student 63: *"The environment is the greatest value given to us."*

Student 77: *"Let's not pollute the environment."*

Student 123: *"If we pollute the environment, it will be difficult to breathe."*

The fourth category focused on concepts emphasizing environmental protection, such as conservation, cleanliness, eco-friendliness, and recycling. Under the upper concept of environmental protection (f=47), the most frequently repeated concepts were cleanliness (f=30), conservation (f=11), and eco-friendly (f=4). The students' responses in this category include:

Student 25: *"We must protect the environment."*

Student 66: *"We must prioritize environmental cleanliness."*

Student 75: *"We should not litter to prevent environmental pollution."*

Student 200: *"If people litter, the environment will become polluted."*

The fifth category emphasized environmental pollutants that contribute to pollution. The upper concept here was environmental pollutants (f=31), where students mentioned waste (f=26), plastic (f=3), and exhaust emissions (f=2). Given that all these concepts align with the category of environmental pollutants, their categorization under this upper concept is appropriate. The students' responses include:

Student 1: *"People litter and pollute the environment."*

Student 31: *"There is a lot of plastic on the ground, which pollutes the environment."*

Student 40: *"Plastic bottles pollute the environment."*

The sixth category highlighted abiotic elements (f=22). Here, students associated the environment with soil (f=13), water (f=5), and air (f=4). Abiotic elements refer to non-living components influenced by soil and climate (Ozugul, 2018). Given that all these concepts align with abiotic components, categorizing them under the upper concept of "abiotic elements" is deemed appropriate. The students' responses include:

Student 8: *"Water levels in our environment are decreasing."*

Student 97: *"The soil around our school is very fertile."*

The seventh category emphasized ecological functionality ($f=6$) in relation to environmental sustainability. Within this upper concept, students mentioned diversity ($f=2$), biodiversity ($f=2$), and migration ($f=2$). Biodiversity refers to the variety of living beings within ecosystems (Erten, 2004). Given that all these concepts relate to ecological functionality, categorizing them under the upper concept of "ecological functionality" is deemed appropriate. The students' responses include:

Student 46: *"There are species in the environment."*

Student 173: *"There are many different species around me."*

The eighth category focused on concepts emphasizing awareness. At this stage, sensitivity ($f=3$) and consciousness ($f=2$) emerged, leading to the use of the upper concept "environmental awareness" ($f=5$). The students' responses include:

Student 121: *"Environmental pollution is bad."*

Student 171: *"We must keep our environment clean."*

Student 198: *"We must be sensitive towards the environment."*

The last category encompassed institutions and organizations responsible for environmental protection. This category was categorized under the upper concept "institutions/organizations for environmental protection," with the term ministry ($f=4$) emerging as the primary reference.

3.2 Schematic conceptual networks formed by students in their minds regarding the concept of environment

Figure 1 presents the conceptual network constructed for the environment concept with a cut-off point of 102 and above.

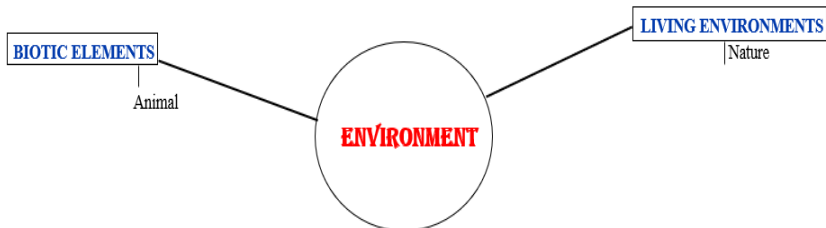


Figure 1. Conceptual network constructed for the cutoff point of 102 and above.

When examining Figure 1, it is observed that for the cutoff point of 102 and above, only the concepts of animal ($f=103$) and nature ($f=103$) emerge under the upper concepts of biotic element and living environment in relation to the concept of environment. At this stage, no other concept has been formed.

Figure 2 presents the conceptual network constructed for the environment concept with a cut-off point of 82 and above.

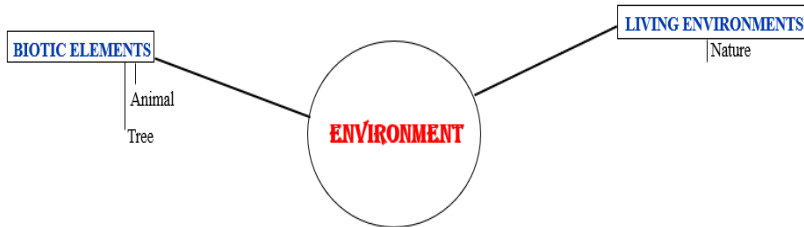


Figure 2. Conceptual network constructed for the cutoff point of 82 and above.

When examining Figure 2, it reveals that for a cutoff point of 82 and above, the concept of tree ($f=89$) has also emerged under the upper concept of biotic element in relation to the environment.

Figure 3 presents the conceptual network constructed for the environment concept with a cut-off point of 62 and above.

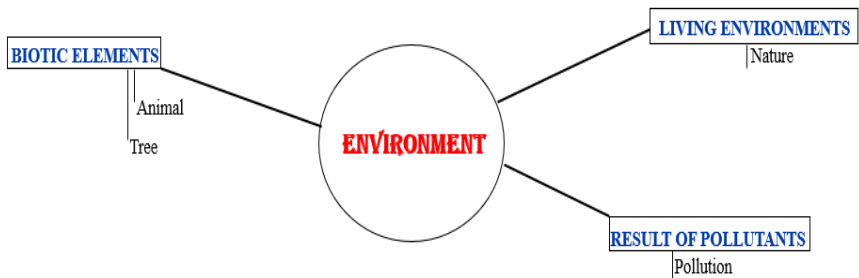


Figure 3. Conceptual network constructed for the cutoff point of 62 and above.

When examining Figure 3, it is seen that for the cut-off point of 62 and above, the concept of pollution ($f=80$) emerges under the upper concept of result of pollutants for the environment.

Figure 4 presents the conceptual network constructed for the environment concept with a cut-off point of 42 and above.

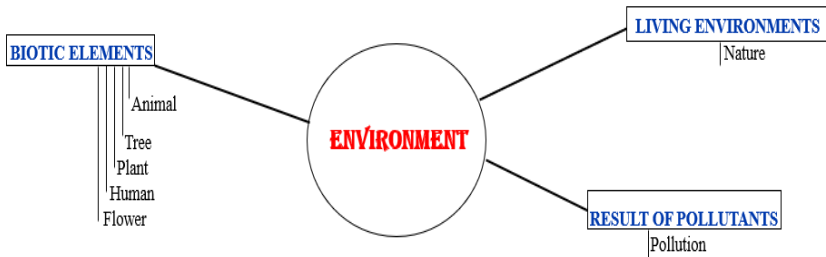


Figure 4. Conceptual network constructed for the cutoff point of 42 and above.

When examining Figure 4, it reveals the conceptual network constructed for the concept of environment with a cutoff point of 42 and above.

Figure 5 presents the conceptual network constructed for the environment concept with a cut-off point of 22 and above.

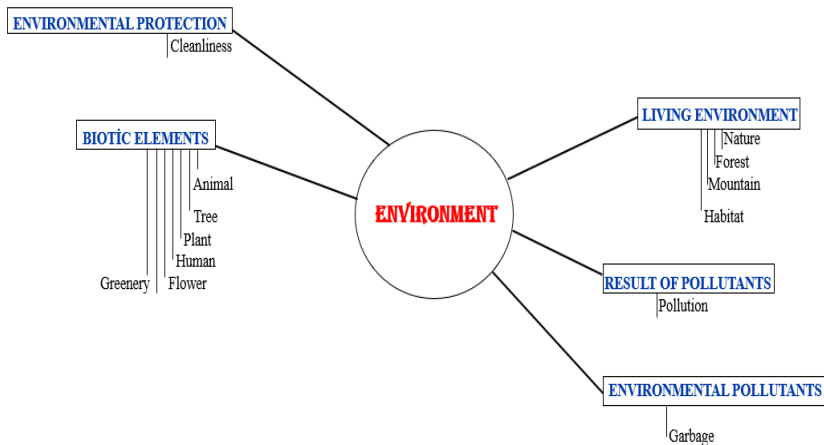


Figure 5. Conceptual network constructed for the cutoff point of 22 and above.

When examining Figure 5, it reveals that for a cutoff point of 22 and above, the concepts of cleanliness ($f=30$) and garbage ($f=26$) have emerged under the upper concepts related to environmental protection and environmental pollutants, respectively.

Figure 6 presents the conceptual network constructed for the environment concept with a cut-off point of 2 and above.

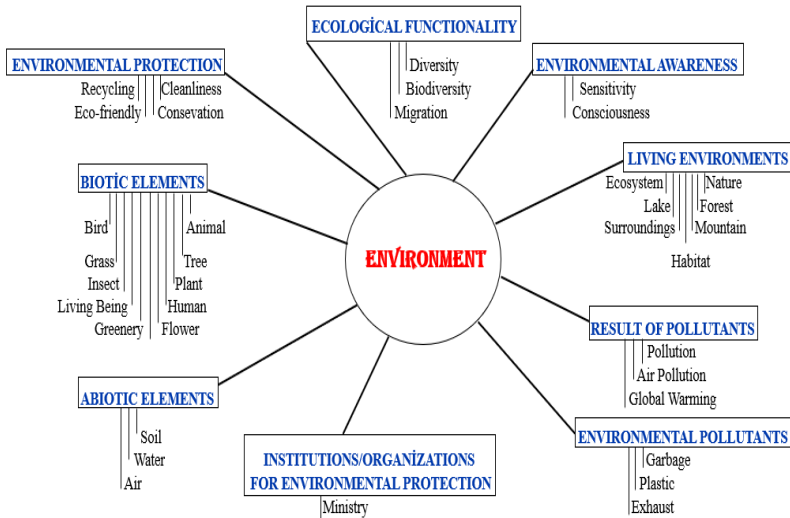


Figure 6. Conceptual network constructed for the cutoff point of 2 and above.

When examining Figure 6, it reveals that for a cutoff point of 2 and above, additional concepts have emerged under the upper categories of ecological functionality, environmental awareness, and institutions/organizations for environmental protection. Additionally, the emergence of the abiotic element category at this stage is also observed.

In general, when examining the conceptual schema of the environment constructed in students' minds, it is found that concepts under the upper category of biotic element ($f=428$) have been cognitively constructed by students at a rate of 50.71%.

4 Results and discussion

This study was conducted to determine the conceptual knowledge levels of 8th-grade students regarding the concept of environment and to reveal the conceptual schemes they created in their cognitive structures. How students perceive this concept reflects their ecological awareness and their awareness of both environmental and ecosystem sustainability issues.

The key concept of the word association test, “environment”, is a powerful tool that we can use to determine students' knowledge and perceptions about the environment. The results shed light on how students perceive the environment and to what extent their conceptual structures about the environment are developed. Students wrote 36 different words related to the environment,

accounting for 59.02% of the total responses. The environment is defined as the space in which living and non-living entities coexist and continuously interact with each other (Akçay, 2006; Özata Yücel & Özkan, 2018). The concept of environment should be considered not only as a physical environment where natural elements come together, but also as a dynamic whole of biological, chemical and physical interactions. According to students' responses, 50.71% of the words associated with the environment were linked to the biotic component upper category, with the most frequently repeated words being animal, tree, and plant. This shows that students tend to understand the environment more at the ecosystem level, through biological elements. From a science education perspective, biotic elements form the basic building blocks of the environment and play a critical role in the functioning of ecosystems. The fact that the second most frequent upper category that students associate with the environment is the living environment, with a rate of 25.36%, reveals that the environment is perceived not only as biological elements, but also as an area where all living things can survive. In science education, the concept of "living environment" is generally associated with ecosystems and the sustainability of natural resources in these ecosystems. Students' frequent use of the word "nature" indicates that they see the environment not only as a biological system, but also as an environment in which this system can survive. Also, under the upper category of consequences of pollutants, pollution was the most frequently mentioned word. Pollution is an important indicator of threats to the environment and how human activities disrupt the natural balance. Students' association of pollution with the environment shows that they are aware of environmental disasters, decreases in biodiversity and threats to ecosystem functioning.

Students' sentences related to the "environment" concept included:

Student 1: *"People throw trash into the environment and pollute it."*

Student 18: *"All animals are in interaction."*

Student 25: *"There are trees in our environment."*

Student 25: *"We must protect the environment."*

Student 77: *"It is necessary to prevent environmental pollution."*

Student 95: *"Our environment is full of living beings."*

The environment is a system that humans are a part of and actively shape. As a result of this study, it was understood that students were able to associate humans with the environment. This finding is consistent with the ecological perspective, which views humans as an integral part of the environment rather than separate from it. As Odum and Barrett (2005) state, humans play an important role in shaping environmental processes, and their actions can affect the sustainability of ecosystems both positively and negatively. This shows that students can associate the concept of environment with the human factor and that awareness of the effects of humans on the environment has increased.

In this study, students associated 36 words with the concept of environment. The rate of words associated with the students is 59.02%. Although this percentage indicates a certain level of conceptual connotation, it is not considered sufficient to fully reflect students' understanding of the environment. A solid understanding of the concept of environment requires not only recognition of basic components such as biotic and abiotic elements, but also an understanding of the relationships and processes that connect these elements within ecological systems. In addition, the fact that students associate the concept of environment with a narrow group of words suggests that their conceptual structures may be underdeveloped. In conclusion, although it is promising that students recognize the role of humans in environmental issues, there is a need to expand their conceptual frameworks. Not only secondary school students but also pre-service science teachers, in a study conducted, have predominantly focused on the concept of the environment as one of the situations that threatens daily life (Ürek & Çoramık, 2022). This highlights the significance of the environment. Therefore, the cognitive structuring of the concept of the environment, starting from teachers and extending to students, will also influence their future approaches to environmental issues.

Conclusion

It is crucial in science education to go beyond textbook knowledge and provide students with hands-on opportunities to engage with environmental issues. Students should be encouraged to participate in environmental conservation projects such as tree planting, waste reduction, or efforts to protect local habitats. This can help them see the direct impact of their actions and understand the importance of sustainable living. That is, using active learning strategies can deepen students' understanding and emotional connection to the environment and environmental issues. The concept of environment intersects with various branches of science such as chemistry, physics, and biology. Therefore, students should be helped to understand the interdisciplinary nature of environmental science.

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