

An Innovative Approach to Teaching Environmental Education Through Mind-Mapping and Creating Radio Programming

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Abstract

The primary aims of environmental education and courses at universities are for students to develop an environmental mentality and to be able to apply that mindset to solving real-world issues. In this study, pre-service elementary students participated in active learning environments through creating educational radio program activities by researching scientific information on seven topics: water, air soil, global warming, population, green chemistry and artificial intelligence. Presentations of their radio programs were followed by construction of mind maps to exhibit knowledge of the environmental concepts they had learned. This approach demonstrated useful knowledge for future classroom applications for teaching about environmental issues. Mind maps were used to help university students establish patterns between concepts and thoughts, understand cause-effect relationships, and organize and systematize their complex knowledge about environmental issues. A case study design was implemented. Participants were second-year students enrolled in a public university's Elementary Teaching Program in Izmir, Turkey. Results indicated that the incorporation of educational radio activities with mind maps to consider the most prominent environmental education issues and their alternative solutions raised students' awareness of how lesser-known issues are related to the environment. Students concentrated on a cognitive and affective process; learning to look at multidimensional environmental issues from many viewpoints by adding new concepts to those they previously knew.

Keywords: educational radio program activity, environmental issues, environmental education, mind map, university student

Introduction

Numerous recent changes have increased several challenges that affect human life. The degree of the relationship between humans and the environment is one of these challenges because people have direct interactions with their surroundings. Humans make use of the benefits that come from using natural resources including air, water, land and mining. However, increased consumption has several negative effects on the environment and human health, including an increase in global pollution, climate change, and biodiversity (Barouki et al., 2021; Koehler et al., 2005; Soran et al., 2000).

These issues have an impact on the ecosystem, the entire living and non-living environment, and disturb the natural ecological equilibrium; thus, environmental sustainability is in jeopardy. It is crucial to foster personal qualities in people; such could include environmental awareness, environmental sensitivity, environmental entrepreneurship and active problem-solving (Akkuzu, 2016; Akkuzu Güven & Uyulgan, 2021a; Ezimah, 2021; Ongon et al., 2021). This could be made feasible by sustainable environmental education (Ezimah, 2021). Sustainability in environmental education ensures that students accept and uphold their lifelong duty for environmental protection. There is no special environmental education policy or standard education infrastructure formulated and implemented at the national level in our country aimed for higher education. As a result, universities offer their own courses and content to address environmental challenges (Keinonen et al., 2016; Oğuz et al., 2011). Considering that higher education institutions are responsible for providing education at a modern level, it is critical that individuals obtain a solid environmental consciousness through their education. Teachers prepare the next generation to fill key social responsibilities in an efficient manner; as a result, they have an essential role in improving human behavior and encouraging pro-environmental activity (Corcoran & Wals, 2004; Frank & Meyer, 2007). For this purpose, it is considered appropriate to offer elective environmental courses which provide information on environmental issues due to their multi-disciplinary nature; not only in environmental departments, but in other departments as well (Silveira & Cruz, 2012). This issue increases a person's knowledge of and favorable attitudes and values toward the environment; as part of the process of environmental education. It is also regarded to be vital to contribute to the development of environmental awareness among university students by establishing direct and indirect environmental associations in various areas (Demir & Yalçın, 2014). In addition, it is foreseen that teacher candidates should be educated about the environment first, since they would be educators in the future. In this manner, environmental awareness could be developed (Yıldırım et al., 2012).

Environmental education in our country is generally a spontaneous process, so the degree of education is not at the required level. Many factors that contribute to inability to achieve the desired goals include social and cultural characteristics that are not well analysed; provision of insufficient information, underdeveloped presentation techniques, individual and institutional lack of adequate tools fit for public education, and lack of provision of necessary opportunities. As a result, the society's awareness and sensitivity to the environment and environmental problems remains at an extremely low level (Gürkan, 2019). Developing environmental awareness is connected to the strategies, techniques and practices used in environmental education. A person should study and enrich their viewpoint and sensitivity to the environment while receiving a good environmental education, which is primarily learned in the classroom. By establishing the relationship between ideas and concepts, it is simple to develop students' knowledge by providing active learning settings in the classroom. When this connection includes conceptual and visual components relating to events and circumstances, the mind is given the opportunity to identify relationships that might otherwise go unnoticed. Additionally, inorganized and complex information is transformed into regular, organized and systematic information. This modification encourages people to think more creatively and critically by identifying cause-and-effect relationships, which fosters permanent learning. In this study, educational radio program activities were used to ensure students' active participation in environmental issues. The educational radio program, which was first conceived for the benefit of

people without formal education in rural areas, has become an effective source of teaching over time due to its educational and enjoyable messages (Anele et al., 2019; Sanusi et al., 2021). In addition to supporting the development of social skills, educational radio programs help participants learn to take responsibility for a shared project, including skills such as delegation of tasks, punctuality and sincerity. They also provide an environment for the acquisition of basic competencies such as oral and written comprehension and expression (Penabade, 2018).

In this study, active learning environments were created for students in classrooms with educational radio program activities. This enabled the students to easily construct their knowledge about environmental issues through interaction. At this point, mind maps that include conceptual and visual elements were utilized in order to enable individuals to establish patterns between concepts and thoughts; to increase their reasoning ability by establishing cause-effect relationships; and to transform their complex knowledge about environmental issues into organized and systematic information. Mind mapping is one of the various tools and materials used during education and training in order to comprehend what is in the mind of the individual about the subject. Upon examining the recent studies on environmental issues, it was discovered that mind maps are one of the important educational tools that develops environmental awareness and environmental attitudes (Al-Asfour & Al-Helailah, 2018; Muhlisin et. al, 2020; Susilawati et al., 2017). In an active learning environment, the mind map, a two-dimensional visual tool, is one of the learning aids with cognitive, creative, interactive and analytical properties (Buzan, 2013). Mind maps are one of the meaningful ways to guide students towards finding ways of teaching that help them develop their learning skills; they help students organize their intellectual capital in a meaningful way while developing their ability to associate terms or facts (Ruskova & Vaskova, 2019). In this context, mind maps were used in this study in order to reveal the development of students' thoughts at both conceptual and visual levels within the scope of the environmental education course.

A mind map is a visual tool used to display the words, concepts, or other related ideas grouped around a main idea or core issue in a hierarchical manner (Siochos & Papatheodorou, 2011, p. 39). "Mind maps guide and inform us in our actions and decisions" (De Blij, 2019, p. 98). It is possible to study, comprehend and transfer knowledge using this powerful and visual tool for students to construct a base for understanding verbal and visual knowledge (Balım, 2013; Crowe & Sheppard, 2012). Aydın (2010) describes mind mapping as a useful technique that organizes the workings of the mind by putting it on paper and bringing the knowledge that was retained in the memory; by listening then bringing the mind map to the forefront with all of its features when needed. Mind maps are one of the tools that provide information about students' cognitive structures on certain subjects. From this viewpoint, our purpose is to use mind maps to determine how the students' ideas about environmental issues and potential solutions, which are covered in the context of an environmental education course, are represented conceptually and visually. According to our predictions, this study will help university students become more environmentally conscious and give them the knowledge they need to be able to solve environmental issues.

Methodology

The study employed a case study design; one of the qualitative research methods. A case study is defined as the in-depth description and investigation of a time-limited system with data collection tools (Creswell, 2007; Merriam & Tisdell, 2015). A single situation, event or phenomenon is examined under its own natural conditions and data are collected systematically. Thus, the expectation is that the connection between the situation and real life is decipher adequately. In this context, the situation discussed in this research shows how the mental structures of the students enrolled in the Elementary Teaching Program are conceptually and visually related to some environmental issues and problems within the scope of the environmental education course.

Participants

The participants of the study were the second-year students enrolled in the Elementary Teaching Program at one state university in Izmir, Turkey. These students were in two different branches, referred to as A and B. The research was conducted at the same time in both branches. The total number of the participants comprised 91 Environmental Chemistry students; males constituted 33% (N=30) and females 67% (N=61). These students participated voluntarily in this study.

Data Collection Tools

The data in the study were generated by two different data collection tools. Mind maps were used to reveal university students' visual and conceptual awareness, and structured interviews were used to determine their comments and thoughts on environmental problems. Hence, the environmental minds of the students were investigated.

Mind Maps

The mind map is one of the tools that demonstrates the relationship between known keywords related to a subject: it presents concepts together and classifies them (Buzan, 2013). With its numerous colours and graphics that are specific to the subject, it organizes knowledge in the person's mind and helps to create connections between concepts (Kara, 2014). As a result, learning to remember things becomes easy; thinking abilities advance, and the process of organizing information progresses favourably. In consideration of these characteristics, the mind map was utilized to show the perspectives of the students' ideas regarding environmental issues and potential solutions in the research.

Structured Interviews

Interview data were collected through the "Written Interview Form" developed by the researchers. After the form was prepared, it was presented to an expert in the field of qualitative research and educational sciences. In line with the expert suggestions, the form items were revised and finalized. The final form consists of 4 questions about the educational radio programs and mind map activities applied during the research

process. University students who volunteered to participate in the research recorded their opinions in the interview form within a period of 30-45 minutes at the end of the research process.

Research Process

The process of the study was carried out in ten weeks. The process steps were carried out in these ten weeks and the points taken into consideration regarding the activities are summarized in 13 steps and presented in Table 1 respectively.

Each group created its own content and everyone in the group took responsibility. In addition, some group students prepared scenarios and played some roles in the scenarios and presented them in the form of drama in an educational radio program. For example, in the activity, one person in the group acted as a presenter while others played the roles of expert speakers such as minister of environment, president of an environmental organization, teacher, journalist, artist, villager. This provided opportunities to present their own discussions, watch the debates, share information, and learn more about the environmental issue from different perspectives. While the educational radio programs activity provided students with these opportunities, it also focused on revealing key concepts related to this issue.

Table 1
The Process Steps and Their Explanations

Process Steps	Explanation of Applications
1	The students were initially informed about educational radio programs. The questions of "how to create an educational radio program text" and "what should be the features of the text's content" were clarified by the researchers.
2	Information was given about the features of mind mapping technique and its benefits for learning and sample mind maps related to education were shown to the students.
3	A total of 14 groups were created, with 7 groups in branch A and 7 groups in branch B. Each group was created for 6-7 participants considering the class size and themes.
4	One of the environmental issues listed in Figure 1 was assigned to student groups. They were asked to prepare an educational radio program activity related to environmental issue. It was also emphasized that the students who took part as listeners should do research on the issue to be covered each week. Environmental issues were selected by considering the content and outcomes of the Environmental Education course.
5	While preparing the radio program activity, the students were asked to pay attention to the concepts related to the environmental issue they dealt with, and not to deal with different concepts or issues that were distantly related to the issue, and therefore the students were asked to create certain boundaries related to the issue they were working on. To avoid deviating from the subject, the researchers served as mentors and assisted the students during this procedure.

- 6 When creating the radio text, they were advised to be attentive to the text features. The researchers reemphasized the concerns that should be considered while writing texts, and they also examined the texts, then gave them back to the students for revision.
- 7 At this point, the researchers
- ✓ paid attention to the fact that the texts written by the students were not only didactic but also concise and interesting in a way that could not allow the listener to get bored and asked the students to make corrections accordingly.
 - ✓ advised students to be aware of the usage of colloquial language in their texts and to correct any non-colloquial or purely transmissive writings.
 - ✓ stressed that they can create texts that incorporate extracurricular activities such as music and drama in order to be engaging and keep audience's attention. They especially underlined that texts for radio programs may include elements such as arousing curiosity; creating vitality; creating conflict and tension and using humor.
- 8 After the texts were prepared by the student groups, each group presented their issue within the framework of the radio activity. In these texts, students utilized methods and activities such as discussion, drama, interviews, music, games and competition.
- 9 Each group presented the radio program in 25-30 minutes. At the end of each radio program activity, the students who were listeners were asked "what concepts they remembered about the issue ". Thus, within the framework of the radio programs activity, students were asked to reveal the concepts related to the environmental issues in an active learning environment.
- 10 Students who listened to the radio program in the classroom took wrote the concepts on the board. The missing concepts were completed by the students presenting the radio program.
- 11 Students were invited to develop a mind map regarding the issue in the remaining 60 min. of the course. They were instructed to use the concepts written on the board while creating their mind map.
- 12 The researchers supplied A3-sized papers, and each group of students created their mental maps with the crayons they brought. The mind maps related to the issues they listened to for 7 weeks were collected respectively at the end of each week.
- For each environmental issue, 14 mind maps belonging to a total of 14 groups in two branches were drawn. A total of 98 mind maps were collected during the period in which 7 issues were studied and evaluated as the main data source of the research. From the first group to the fourteenth group, the mind maps were classified as MMap1, MMap2, and MMap3...
- Some samples from student groups' mind maps were added to the Appendix.
- 13 Following the educational radio and mind mapping activities, students were given an interview form and were asked to write their thoughts on the application.

With regard to the educational radio program activity, one auditory media was employed as a teaching aid. The purpose of using educational radio programs was to provide an environment that allows an individual to learn by supporting a visual material at the auditory level. In addition, it contributes to the development of cognitive and social development characteristics of the individual as a result of interaction with peers. This shows that this research was also based on the social learning theory. Within the framework of the radio programs activity, each student group discussed an environmental issue in Figure 1.

Figure 1
Environmental Issues Handled by Students within the Scope of the Research

Issue 1	• Water Pollution
Issue 2	• Air Pollution
Issue 3	• Soil Pollution
Issue 4	• Global Warming
Issue 5	• Population Pollution
Issue 6	• Green Chemistry and Its Applications in Environmental Pollution
Issue 7	• Artificial Intelligence and Its Applications in Environmental Pollution

Figure 2 shows sample photographs of student groups presenting the educational radio program during the environmental education course.

Figure 2
Photos from Educational Radio Program Activities



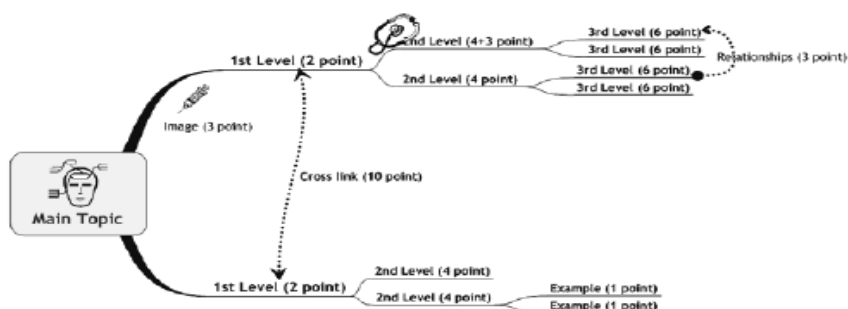
Data Analysis

The scoring system for mind maps that was employed in this study was created by D'Antoni et al. (2009): it is a quantitative scoring system even though content analysis was used as a qualitative method. Figure 3 displays quantitative study of mind maps. This means that the primary idea in the mind map is related to the first level relationships that have been developed, which are worth 2 points; second level relations are worth 4 points; third level relationships are worth 6 points, and cross connections are worth 10 points. We scored 1 point for providing an example that relates to the concept; 3 points for establishing an inter-level relationship; and 3 points for drawing a picture, image or figure. We scored 0 points if the idea, image or shape were invalid. The mind maps prepared by the student groups for each subject were scored separately by two researchers; the aforementioned scoring system was utilized. The reliability of the scoring was made based on the analysis of Miles and Hubermann (1994). The Agreement among the researchers was determined as 99.8%.

The descriptive property was considered when analyzing the content of mind maps. According to Büyüköztürk (2008), content can be analysed by aspects that are descriptive, explanatory and predictive. This research has a descriptive property because it aimed at revealing the students' thoughts on environmental problems and alternative solutions covered within the scope of the Environmental Education course. For this reason, the concepts that the students used were presented in their mind maps in relation with the subject.

Figure 3

The Scoring System of Mind Maps (D'Antoni et al., 2009)



Interrater reliability was calculated with the formula by Miles and Hubermann (1994) ($\text{Reliability} = \frac{\text{Agreement}}{\text{Agreement} + \text{Disagreement}}$). The agreement rate among the researchers was found as 0.96. The researchers used descriptive analysis to analyse the written interview form. In descriptive analysis, the data is defined in an understandable language according to predetermined dimensions, and it is interpreted with interesting and striking quotations of the opinions.

Research Findings

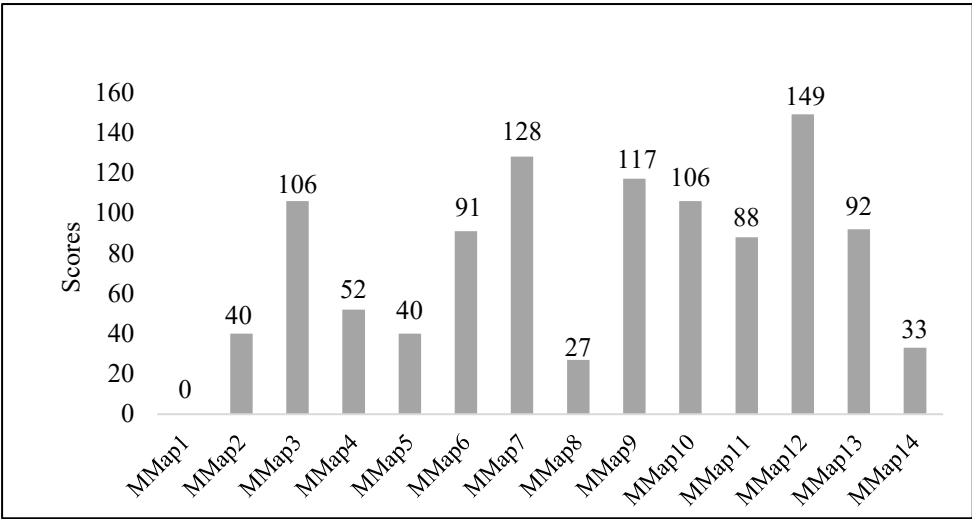
Findings of Mind Maps

The results pertaining to the mind maps created by the students are grouped into both quantitative and qualitative categories in this section. In this context, the results of

the mind maps that the student groups produced for each subject are provided along with the concepts that they included in the maps.

First, the students' mental models of water pollution were shown in conceptual and visual form. When the students' mind maps were assessed, it was discovered that the average score for the mind maps on this subject was 76.36, indicating that the student scores were not particularly high (Figure 4).

Figure 4
Mind Map Scores of Water Pollution



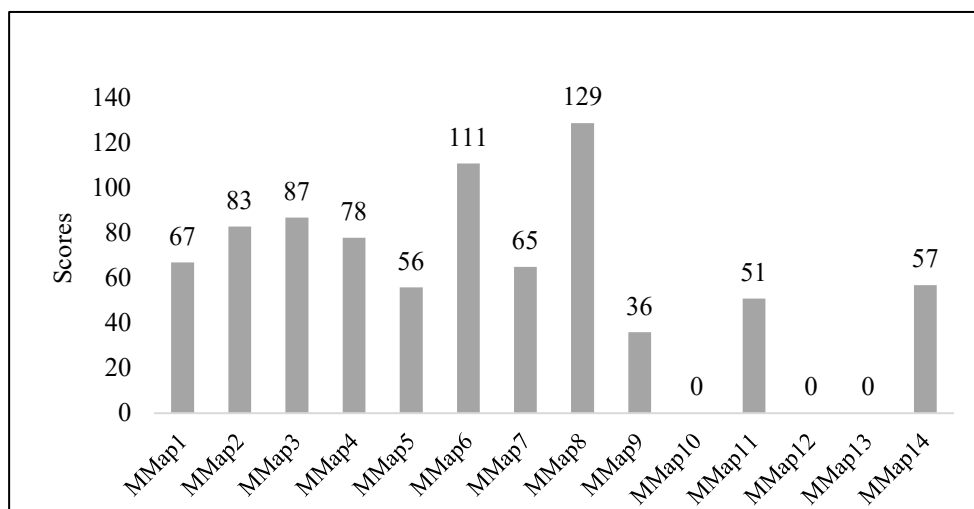
It could be noticed that while 1st Level relationships were simpler for students to develop, 2nd and 3rd Level relationships were found to be more challenging. The construction of 2nd Level relationships and the provision of examples could be the reasons behind the few mind maps (MMap7, MMap12, and MMap9) receiving high scores.

Table 2 shows that students could only construct two degrees of relationships at most. The 1st Level conceptions of water pollution are the natural impacts of water pollution; its chemical causes; the precautions to be taken; industry and diseases. The 2nd Level conceptions of water pollution include the human factor; domestic wastes and heavy metals. Following these concepts, the students included examples in their maps; the majority were represented by images.

Table 2*Relationship Levels Concepts and Examples in Mind Maps Related to Water Pollution*

Relationship Levels	Concepts	Samples
1st Level	The natural impacts	Factory
	The chemical causes	Cyanide
	The precautions	Nickel
	Industry	Mercury
	Diseases	Lead
	Agricultural use	Cadmium
	Deaths	Zinc
2nd Level	Human factor	Bacterium
	Domestic wastes	Plastic bottle
	Heavy metals	Fertilizer
	Aquatic ecosystem	Waste oil
	Purification	Oil Detergent

Following the examination of the students' mind maps about air pollution, it was disclosed that most of them were at the 1st Level relationship level and did not obtain a high score. The mind maps had an overall average score of 58.57. The evaluation of the mind maps indicated that the three MMaps—MMap10, MMap12 and MMap13 were similarly invalid (Figure 5).

Figure 5*Mind Map Scores of Air Pollution*

At the 1st Level, the students concentrated on the concepts such as causes, effects, safety measures, environmental factors and health; at the 2nd Level, they focused on the concepts of afforestation, fuels, traffic and renewable energy. In their mind maps they presented examples of lead, filters, public transportation vehicles and illnesses like

lung cancer and asthma brought on by commuting in dirty air (Table 3).

Table 3
Relationship Levels, Concepts and Examples in Mind Maps Related to Air Pollution

Relationship Levels	Concepts	Samples
1st Level	The causes	Public transport
	The effects	Filter
	Safety measures	Natural gas
	Health	Forest fires
	Environmental factors	Poor quality coal
	Transport	Exhaust
	Natural disasters	Lung cancer
	Urban sprawl	Asthma
	Global warming	Heart diseases
	Acid rains	WHO (World Health Organi-
		zation)
2nd Level	Afforestation	TEMA Foundation
	Fuels	
	Traffic	
	Renewable energy	

One of the environmental problems addressed in the research is soil pollution. According to the students' results on the mind maps they created about soil pollution; the average score was 85.36 and the scores were high in general (Figure 6). This occurred as a result of the students' extensive use of examples and thoughtful consideration of both the 1st Level and 2nd Level relationships.

Figure 6
Mind Map Scores of Soil Pollution

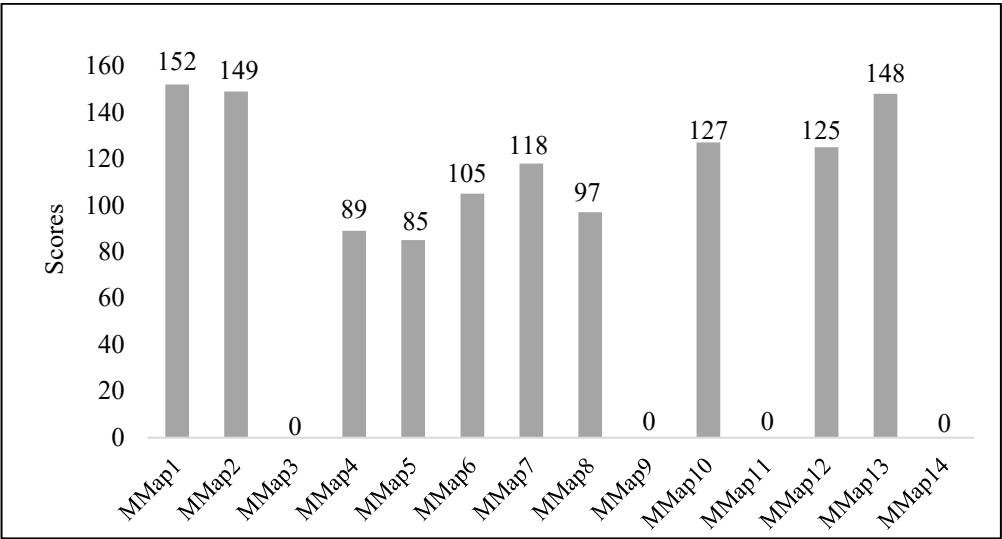
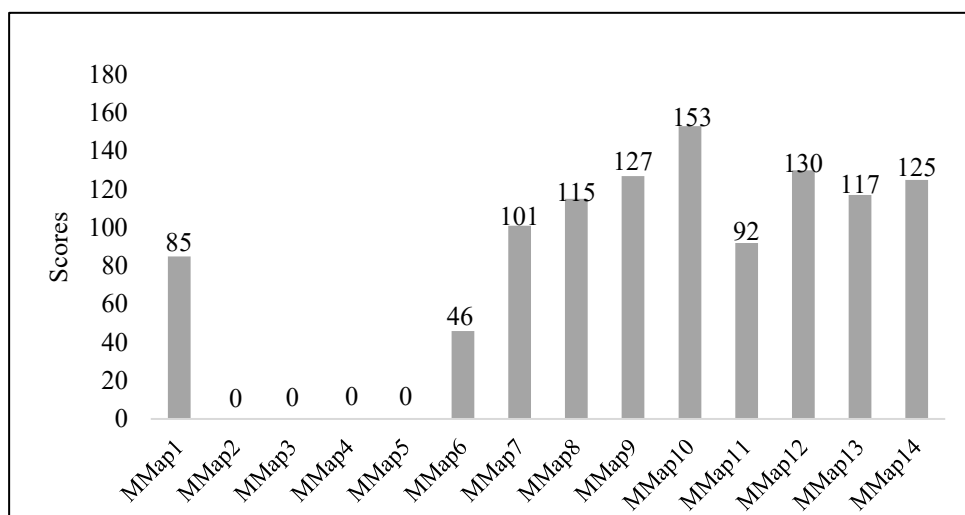


Table 4*Relationship Levels, Concepts and Examples in Mind Maps Related to Soil Pollution*

Relationship Levels	Concepts	Samples
1st Level	The environmental factors	Stubble burning
	Agriculture	Toxic gases
	Wastes	Fertilizer
	Industry	Nitrogen
	Education	Pesticides
2nd Level	Urban waste	Heavy metals
	Erosion	Packaged products
	Mechanization	Lead
	Fallow	Paper
	Nuclear waste	Glass
	Industrial waste	Plastic
	Acid rains	Battery

With regard to the concepts related to soil pollution (Table 4) in the first level relationships, the students organized concepts such as environmental factors, agriculture, wastes, industry and education; in the second level, they used concepts such as waste types, fallow and erosion. Examples of soil pollution problem in mind maps were analysed to be burning of stubble; toxic gases; fertilizer; nitrogen; heavy metals; images of glass, paper, battery and plastic.

Figure 7*Mind Map Scores of Global Warming*

The examination of the students' mind maps scores on global warming showed that their scores were not particularly high. When the level of the established relationship was considered, they remained at the 2nd level (Figure 7). Moreover, some students drew mind maps that were not valid regarding global warming. As a result,

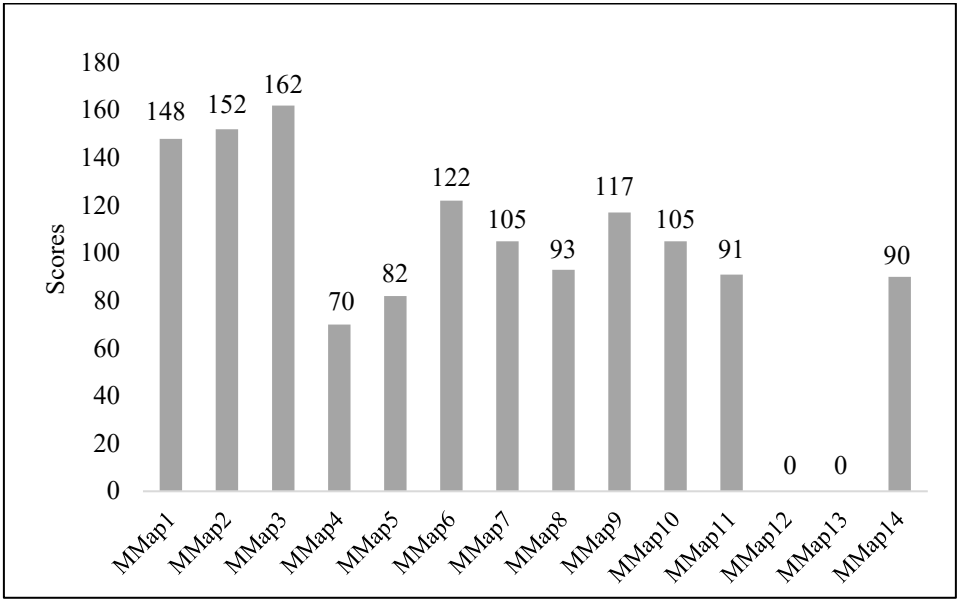
scoring was not possible in these mind maps-MMap2, MMap3, MMap4 and MMap5. The average score obtained by the students from their mind maps on global warming was 77.92.

Upon the analysis of findings in Table 5, it was discovered that the 1st Level students' conceptions incorporated the influencing and affected factors; organizations; fossil fuels and extinct animals. The fact that they added concepts such as drought, temperature, the ozone layer, energy usage and carbon footprint at the relationships in 2nd Level made it more remarkable.

Table 5
Relationship Levels, Concepts and Examples in Mind Maps Related to Global Warming

Relationship Levels	Concepts	Samples
1st Level	Influencing factors	Greenhouse gases
	Affected factors	Fire
	Organizations	Power plants
	Fossil fuels	Green roof
	Extinct animals	Climate network
2nd Level	Carbon footprint	Glaciers
	Carbon emissions	
	Energy consumption	
	Climate change	
	Ozone layer	
	Drought	
	Heat	

Figure 8
Mind Map Scores of Population Pollution



One of the environmental problems addressed within the scope of the Environmental Education course was the increase in the population. In this respect, the students got high scores from their mind maps and the average score was determined as 95.50 (Figure 8); owing to the students' likelihood to use the 2nd Level relationship as well as the 1st Level relationship in most mind maps.

In relation to the population pollution, the students' concept maps at the 1st and 2nd levels respectively illustrated concepts such as the measures; failed systems; effects and causes of the population pollution; purchasing awareness; consumerism; migration; waste; lack of services for education and health; restrictions on the number of vehicles; the ecological footprint; birth and death rates (Table 6).

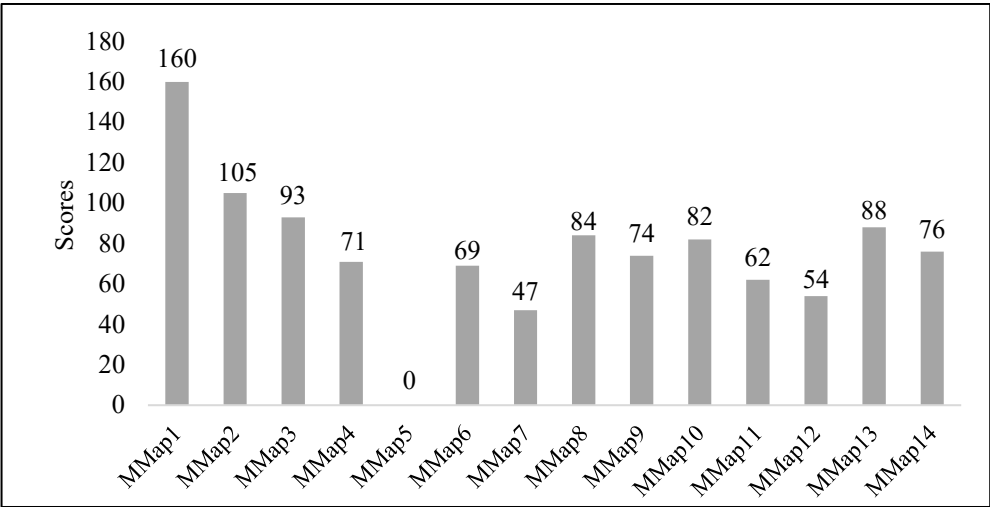
Table 6

Relationship Levels, Concepts and Examples in Mind Maps Related to Population Pollution

Relationship Levels	Concepts	Samples
1st Level	The measures	Chinese
	Failed systems	Nigeria
	Effects	India
	Causes	Turkey
2nd Level	Population policies	USA
	Restrictions on the number of vehicles	
	Purchasing awareness	
	Consumerism	
	Ecological footprint	
	Lack of education service	
	Lack of health service	
	Migration	
	Waste	
	Birth rate	
	Death rate	

This section relays on the environmental approaches aimed at eliminating the use and production of chemical substances harmful to the environment and human health; methods to prevent the formation of such substances (green chemistry and its applications in environmental pollution. Upon examination of mind maps about an alternative method to prevent environmental pollution, green chemistry and applications; the students did not get high scores (Figure 9). The average score of all the mind maps related to this subject was 76.07. At this point, it can be said that students use concepts more in the 1st Level relationship, and rarely establish 2nd Level relationships.

Figure 9
Mind Map Scores of Green Chemistry and Its Applications in Environmental Pollution



The concepts that students included at the 1st level were the measures, principles, causes and effects: at the 2nd level they were the green product, recycling, pharmaceutical industry, atomic economy and reduction of by-products (Table 7). The students' examples based on the relationships included products for alternative solutions such as water-based paint; organic solvent; water-based adhesive and treatment facilities.

Table 7
Relationship Levels, Concepts and Examples in Mind Maps Related to Green Chemistry and Its Applications in Environmental Pollution

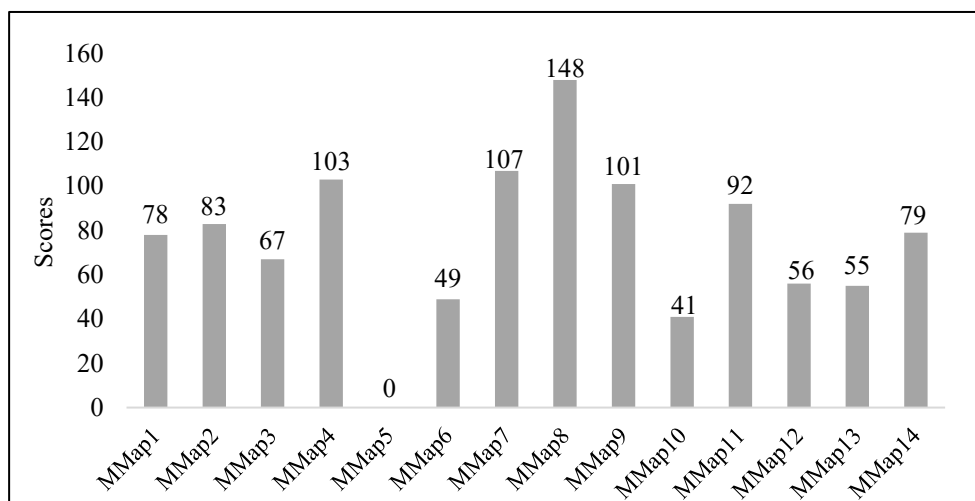
Relationship Levels	Concepts	Samples
1st Level	The measures	Water-based adhesive
	The principles	Water-based paint
	Causes	Organic solvent
	Effects	Treatment plant
2nd Level	Green product	Oil pipeline
	Recycling	Oil refinery
	Chemical reactions	
	Pharmaceutical industry	
	Atomic economy	
	Energy-saving	
	Design of degradation	
	Prevention of accidents	
	Reduction of by-products	

Artificial intelligence applications are one of the alternative strategies used to find answers to environmental issues in terms of energy conservation. The average score of

the students' mind maps, which indicated how to construct the relationship between technologically based artificial intelligence applications and the environment was 75.64. Also, it was clear that the students' scores were not very high (Figure 10).

Figure 10

Mind Map Scores of Artificial Intelligence and Its Applications in Environmental Pollution



When the students' mind maps about artificial intelligence and its applications in environmental pollution were examined, it was revealed that they established concept relationships at both levels. At 1st Level, they mostly included concepts such as energy saving, nuclear accident, climate change and extinct animals; whereas their mind maps contained concepts such as robots, autonomous weapons, natural resources and organizations (Table 8) at the 2nd Level. Additionally, they commonly described hybrid cars, sensor lights, robot Sophia and recycling robot Clarke in their drawings that they provided as means of examples.

Table 8

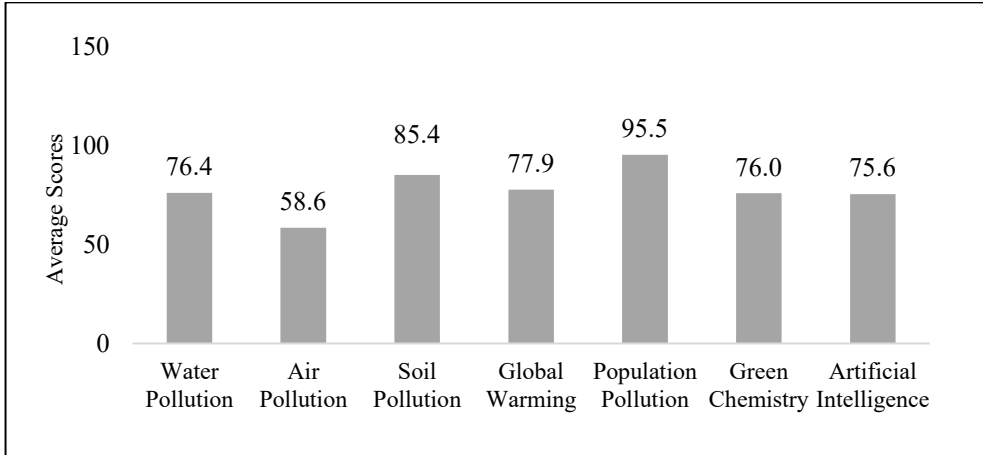
Relationship Levels, Concepts and Examples in Mind Maps Related to Artificial Intelligence and Its Applications in Environmental Pollution

Relationship Levels	Concepts	Samples
1st Level	Energy-saving	Hybrid car
	Nuclear accident	Sensor lights
	Malicious deeds	Sensor faucet
	Climate change	Electric motor
	Extinct animals	Media Lab
2nd Level	Robots	Robot Sophia
	Autonomous weapons	Recycling robot Clarke
	Natural resources	Elephant listening project
	Organizations	

Considering the average scores for the 7 environmental issues in general, it was seen that population pollution and soil pollution had the highest scores (Figure 11). This is because the students were able to relate many concepts at the 2nd level and write a wide variety of examples.

Figure 11

Average Scores of Mind Maps for the 7 Environmental Issues



On the other hand, it was evident that the score obtained from the mind maps prepared on air pollution was the lowest. The explanation for this is that the students showed more relationships established with the main topic at the 1st level in their mind maps. They had difficulty at the 2nd level and could not establish a relationship with any concept related to the 3rd level; thus provided few examples.

Findings from the Interviews

The aim of the first question posed to the university students in the interviews was to determine their thoughts about the educational radio program activities carried out within the scope of this environmental education course. According to the responses stated, we found that the students' experiences with group research projects and creating group presentations for educational radio programs varied. In these instances, the students said that emphasizing scientific debates in their group research and presentations increased the course's significance, usefulness and effectiveness. The following are some illustrative quotes:

"The fact that the method of teaching was different from other courses and that our friends who prepared educational radio programs organized informative and entertaining events helped us to focus on the subject. Through scientific discussions, I was exposed to my friends' various viewpoints. I had the chance to critically express my own thoughts, comments, and opinions. I found the course to be beneficial. (GN-8, S.46)"

"I think that the environmental education course process was efficient and effective on me and my friends. It was quite appropriate to deal with these environmental issues, which were social, in a different way and to express them with various schemes. What caught my attention the most was that most of the students were

able to participate in it in an interested and attentive way. Besides, it was instructive to discuss the ideas in the presentations as thesis-antithesis. (GN-3, S.15)"

"Educational radio programs based on knowledge-based scientific discussions helped us gain useful information about environmental issues during the environmental education course. We have increased our awareness of these issues by revealing the under-covered environmental issues. (GN-12, S.73)"

In the second question of the interviews, the university students were asked to explain the group that they found most remarkable among the educational radio program activities carried out during the environmental education course and justify their choice. When the answers were examined, we determined that the group subjects that the students found most striking were "artificial intelligence and its applications", "global warming", "air pollution", "green chemistry and its applications". The students cited the instructive nature of these group activities with discussions; the inclusion of participant-activating actions such as quiz competitions; the performance of dramas and the presentation of real-life instances in these dramas as the most significant aspects of these group activities. Below are illustrative quotes from the respondent' statements as well.

"The group project on artificial intelligence and its uses, in my opinion, was impressive. It was a very nice touch to cast Stephen Hawking and the group members as robots in the program flow, which had grown monotonous due to the lectures. In addition, the organization of a knowledge contest in which all our friends could participate at the end of the activities was also effective. Even though everyone found artificial intelligence to be an interesting subject, a lot of foreign terminology were used. (GN-5, S.29)"

"I found the activities on air pollution most interesting. In addition to being informative, they also reflected the details that should be in a radio program in their presentations. For instance, it was impressive that a group member who participated in the program as a representative of the World Health Organization (WHO) and spoke the program in a foreign language also provided the SMS number of an institution related to environmental problem and control and offered an idea to send an SMS on the subject. (GN-4, S.20)"

"I was impressed by the green chemistry and its applications group's efficacy. Because they showed how important the issue was among the people. I had never heard of the principles of green chemistry. I got an idea that the principles can contribute to the development of environmental awareness in students and thus to the creation of an environmentally conscious society. In addition, the presenting group reflected the difficulty of convincing the public about environmental awareness in the most transparent way to all my friends. (GN-1, S.3)"

The thoughts of the university students about the circumstances they focused on when creating mind map activities were obtained in the third interview question. "Placing concepts appropriately," "using all concepts," "supporting with visuals," and "drawing attention" were the most prevalent themes in these views. The students claimed that they made an effort to reflect their subjects in explanatory ways and to maintain the subject's integrity in their mind maps. The responses to this question are shown in typical samples.

"By grouping the concepts, we tried to gather those with similar expressions into the same group. We tried to choose the basic concept related to the subject and placed this concept in the middle of the map. We supported these concepts with cartoon-style drawings. Because similar concepts should be in the same place on the mind map so

that the essence of the subject can be better understood. (GN-10, S.58)"

"We tried to keep the possible issues in mind by paying attention to the components of our main topic. Adhering to the integrity of the subject, we tried to indicate the side problems related to our subject. We paid attention to its appeal to the eye and to reveal its scientific side. Because we should be able to tell people a lot at a glance. (GN-7, S.40)"

"We tried to use more images, keeping in mind that children will be the group we target the most. Because the more we draw attention to environmental awareness in younger age groups, the more sensitive and aware a generation will be raised in the future. (GN-3, S.16)"

We examined university students' responses to a question regarding creating mind maps in which we asked them about challenges they had encountered. These conclusions demonstrate that the students have difficulty when using images and connecting concepts in their mind maps. There are quotes provided that express the students' opinions on this issue.

"...we had problems grouping the concepts. We sometimes had trouble separating concepts based on their similarities and establishing relationships between concepts. Even though we performed educational radio program activity on the subject, I believe we have these issues because we cannot comprehend all the concepts. Even though we did some research on the issue of the week as homework and then listened to the radio presentation of our friends, it was quite difficult to relate the concepts that emerged and to give examples, we tired our minds a lot, but I think we created very good mind maps, especially on some issues. (GN-2, S.9)"

"The time after the event was insufficient because creating the mind map took a lot of effort. Because of this, we were unable to finish painting. Apart from that, it was challenging to design the mind map and draw the images on it. On a few issues, it was difficult for us to locate suitable images to draw. This was because the issues were scientific, making it challenging to create suitable illustrations. (GN-5, S.31)"

"We had a hard time grouping the concepts. There were many concepts. Although our friends presented these issues with educational radio programs, we had difficulties in some issues that we were not familiar with. For example, the issue "Green chemistry and its applications". We discussed it with our friends before mapping each concept. In this way, I think we create better mind maps. (GN-11, S.65)"

Conclusions

University students' opinions regarding environmental issues and potential solutions have been gathered for the study through mind maps and radio program activities during the environmental education course. According to results from the mind maps, the students did not receive good scores. The reason for this could be that the students' concepts related to the subjects were mostly at the 1st and 2nd level; therefore, they were insufficient in these relationship levels. According to Buzan (2013), the branches in mind maps should be connected dynamically, and the concepts utilized should be routinely and suitably related to the central idea. Otherwise, it becomes difficult to organize thoughts that have a complex structure and give the scattered structure in a hierarchical way. However, one of the main purposes of mind maps is to present in-depth analysis on the subject in a clear, accurate and understandable way. Regarding the subject of population pollution, we can conclude that students were relatively able to develop relationships at the 2nd level based on their high average

score. In addition, another remarkable finding is that their scores related to soil pollution were slightly higher than others. This is because the university students included most examples and visual drawings in this subject than in other mind maps. In general, the images they used on their mind maps related to examples and concepts at the 2nd level. This situation indicates that university students used their creativity. Şen and Çoban (2018) argue that the shapes and symbols drawn about the subject next to words support creativity.

When we examined the concepts included in the mind maps, at the 1st level, the causes and consequences of environmental problems and the measures that can be taken stand out in the subject of "Green chemistry and its applications", along, the principles of "Green chemistry and its applications" were included. Similarly, in the subject of "Artificial intelligence and its applications", concepts such as science, technology and energy were used. This situation shows that university students used many concepts and examples related to environmental problems and alternative solutions in their mind maps. In their study that examined how students evaluate environmental problems by mind maps, Erduran Avcı et al. (2013) used the students' environmental problems, such as air, water and soil pollution. They revealed that the students reflected on their mind maps with more themes and concepts than written statements related to these subjects. In addition, these results coincide with the results obtained from the studies of Pe'er et al. (2007) and Tal (2010). Their results reveal that the students stated that the mind maps were useful in order to determine their knowledge and deficiencies on environmental issues included the concepts such as ecosystem and biodiversity; greenhouse effect; climate change; global warming; sustainable development-sustainable agriculture; air pollution; water pollution; acid rains and recycling. Therefore, mind maps are suggested as an open strategy for incorporating them into classroom activities because they offer a visual record of students' thoughts and the growth of their thoughts (Balım, 2013; Goodnough & Woods, 2002).

Another striking result of the research is the effectiveness of radio program activities. Considering the results obtained from the interview findings on this issue, it was revealed that the educational radio program activities made the issues covered in the environmental education course more memorable. The issues covered within the framework of radio program activities were entertaining and informative as well as attention-grabbing and provided an efficient learning environment. This could be the result that the radio texts (scenarios) prepared by the students were interesting and provided opportunities for group discussions. Bazin and Saintis (2021) state that radio programs significantly increase understanding of issues such as climate change; educating both the officially and non-formally educated. Literature claims that educational radio is most successful when it is accompanied by skilled facilitators, group learning, group discussion, feedback and the use of multimedia approaches (Acido et al., 2013; Nwaerandu & Thompson, 1987; Sanusi et al., 2021). By extension, it was important for students to acquire solutions-oriented, comprehensive and scientifically based knowledge through entertaining and attention-grabbing radio program activities on these issues; along with their awareness of environmental problems. Studies show that radio programs can provide messages that contribute to the relaxation of listeners and educate them at the same time, and these features are referred to by scholars as Entertainment-Education (Anele et al., 2019; Khalid & Ahmed, 2014). Khalid and Ahmed (2014) emphasize that radio programs that combine entertainment and education can influence audience awareness, attitudes and

behaviors towards a socially desirable goal. They also pointed out that when educational content is laced with entertainment, the message is comparatively easily understood, and the new attitude conveyed in the message has a better chance of being accepted. Furthermore, the results of the interviews revealed that the students were able to comprehend the relationship between these issues and the environment; particularly when undertaking study on lesser-known issues. For example, students learned, that green chemistry and its principles and applications; artificial intelligence and its applications are alternate answers to environmental challenges. Koulougliotis et al. (2021) states that teaching green chemistry to students through education is important for environmental awareness. Similarly, Akkuzu Güven and Uyulgan (2021b) emphasize that various strategies that enable active learning (e.g., activities of multiple intelligence) should be used to increase awareness and sensitivity about environmental issues.

To sum up, the implementation of educational radio activities blending with mind maps enabled university students to think about the most emphasized environmental education issues and their alternative solutions, and created an awareness in students about how lesser-known issues are related to the environment. Students focused on a cognitive and affective process within the framework of these two activities and learned to look at environmental issues multidimensionally from different perspectives by adding new concepts to the concepts they already knew. At the same time, students were able to assess quality of their own knowledge and skills in relation to the environmental issues addressed.

Limitations and Recommendations

Human beings should be able to adapt to their environment as a part of the ecosystem and continue their lives in accordance with their needs. Otherwise, there would be ecological imbalance. In their study, Sasa et al. (2023) bring forth the positive impact of in relation to university education; that, students who received environmental development courses at university were more knowledgeable about the impact, causes and evidence of environmental issues compared to other students. The activities carried out in this study are limited to two different data collection tools that complement each other. As in this study, lecturers can blend various activities and students can increase knowledge about issues pertaining to the environment in the desired direction through these activities. Mind maps can be used in various research in active learning environments to raise students' awareness about environmental issues and alternative solutions, and to improve their understanding of the sustainable environment. A powerful tool such as a mind map can help improve thinking, a skill developed through applications and training. This enables students to gain different perspectives on environmental issues. In addition, the environmental issues examined in this study were limited to 7 different topics. The scope of the research can be expanded with studies addressing different environmental issues other than these issues.

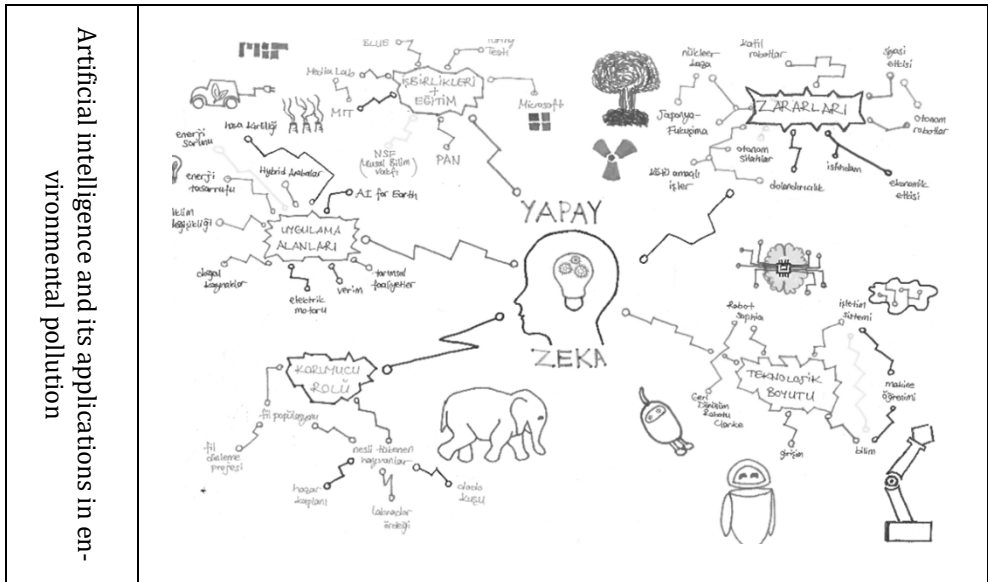
Future studies could conduct similar activities with students enrolled in different programs, and they may determine how they perceive environmental issues and potential solutions by using mind maps. Additionally, this study that was conducted by organizing student groups, comparisons can be made by having mind maps created individually.

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