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THE EFFECT OF PROBLEM-BASED LEARNING ACTIVITIES ON SECONDARY SCHOOL STUDENTS' AWARENESS OF BIODIVERSITY*

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Abstract

Nowadays, with the increase in local and global environmental problems, it is seen that human activities mainly cause environmental problems. Undoubtedly, the most effective way to solve these problems is environmental education, which aims to raise people's awareness. Within the scope of the study, the aim was to raise students' awareness about biodiversity by using the PBL method. In the 7th grade "Human and Environmental Relations" unit, the case study design, one of the qualitative research designs, was used to determine the effect of problem-based learning activities on students' understanding of biodiversity and its importance. Ten 7th-grade students participated in the study. The data of the study were obtained from the answers given by the students to the semi-structured interview questions in the fourth and fifth sections of the Environmental Awareness Interview Form. Content analysis was used to analyze the research data. As a result of the research, it was observed that the students in the experimental group, in which problem-based learning activities were carried out, had a higher awareness of not only interspecies biodiversity but also intraspecies biodiversity compared to the control group. In addition, it was determined that the experimental group students could evaluate the effects of the decrease in species diversity from multiple perspectives. In contrast, the control group students' perspectives on the subject were more limited. According to these results, deeper learning occurred in the experimental group students than in the control group.

Keywords: Biodiversity, problem-based learning, environmental problems, environmental awareness.

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PROBLEME DAYALI ÖĞRENME AKTİVİTELERİNİN ORTAOKUL ÖĞRENCİLERİNİN BİYOÇEŞİTLİLİK KONUSUNDAKİ FARKINDALIKLARINA ETKİSİ

Özet

Yerel ve küresel çevre sorunlarının giderek arttığı günümüzde, çevre sorunlarının temelde insan faaliyetlerinden kaynaklandığı görülmektedir. Bu sorunların çözüme kavuşturulması için şüphesiz en etkili yol insanların bilinçlendirilmesinin hedeflendiği çevre eğitimidir. Çalışma kapsamında, probleme dayalı öğrenme yöntemi kullanılarak, öğrencilerin biyoçeşitlilik konusu ile ilgili farkındalık kazanmaları amaçlanmıştır. 7. sınıf "İnsan ve Çevre İlişkileri" ünitesinin öğretiminde probleme dayalı öğrenme etkinliklerinin; öğrencilerin biyoçeşitlilik konusundaki farkındalıkları üzerindeki etkisini belirlemek amacıyla, nitel araştırma desenlerinden durum çalışması deseni kullanılmıştır. Çalışmaya 7. sınıfa devam etmekte olan 10 öğrenci katılmıştır. Araştırmanın verileri Çevre Farkındalığı Görüşme Formu'nun 4. ve 5. bölümlerinde yer alan yarı yapılandırılmış görüşme sorularına öğrencilerin verdikleri cevaplardan elde edilmiştir. Araştırma verilerinin çözümlenmesinde içerik analizinden yararlanılmıştır. Araştırma sonucunda, probleme dayalı öğrenme etkinliklerinin gerçekleştirildiği deney grubu öğrencilerinin yalnızca türler arası biyoçeşitlilik değil aynı zamanda tür içi biyoçeşitlilik konusundaki farkındalıklarının kontrol grubuna göre daha fazla olduğu görülmüştür. Ayrıca, deney grubu öğrencileri tür çeşitliliğinin azalmasının etkilerini çoklu bir bakış açısıyla değerlendirebildikleri, buna karşılık kontrol grubu öğrencilerinin konu ile ilgili bakış açılarının daha sınırlı olduğu belirlenmiştir. Deney grubundaki öğrencilerin nesli tükenen ve tükenmekte olan canlılarla ilgili örnekleri sayı ve çeşitlilik bakımından kontrol grubuna göre daha fazladır. Bunu yanı sıra, deney grubu öğrencileri biyoçeşitliliğin önemine dair daha detaylı açıklamalar yapmışlardır. Bu sonuçlar doğrultusunda, deney grubu öğrencilerinde kontrol grubu öğrencilerine göre daha derin öğrenme gerçekleştiğini söylemek mümkündür.

Anahtar Kelimeler: Biyoçeşitlilik, probleme dayalı öğrenme, çevre problemleri, çevre farkındalığı.

INTRODUCTION

Nowadays, environmental problems are increasing rapidly. As the impact of environmental problems is felt more and more in daily life, social environmental awareness is becoming an increasingly important issue. Therefore, it is necessary to focus on educational activities focusing on environmental concepts (Yücel & Özkan, 2015). Individuals need to know the environment to develop environmental awareness. In this context, the importance of environmental education in schools has gradually increased. In the Tbilisi Declaration, the general purpose of environmental education was defined as "to develop a world society that is aware of and concerned about the environment and environmentally related problems, and who, with the knowledge, skills, attitudes, and motivation, works individually and collectively to solve existing problems and to prevent new problems that may arise" (UNESCO-UNEP, 1976; Cited in Darner, 2007).

One of the most critical issues within the scope of environmental education is the issue of biodiversity. Biodiversity is the variability among living organisms from all sources (Lindemann-Matthies, 2009). Many of humanity's needs are met by biodiversity. Today, the world faces a severe biodiversity crisis. Every day, the number of beings from many species are decreasing to critical levels, and many species are becoming extinct (Hooper et al., 2005; Trombulak et al., 2004; Vié et al., 2008). The rapid increase in human population, urbanization and industrialization, and non-ecological agricultural applications rapidly reduce biodiversity (Çepel, 2008; Dobson, 2005; Görmez, 2007). Understanding biodiversity and the relationship between living things and realizing how vital each living species is in the ecosystem is essential in preventing many environmental problems. Therefore, teaching the concept of biodiversity is important. When the literature is examined, it is seen that various methods are used in teaching biodiversity-related subjects. For example, Gas and her friends (2021) stated that Bioblitz events, which provide students with experiential learning experience, increased students' learning and provided a learning opportunity outside of the traditional classroom. Okur-Berberoğlu, Yalçın-Özdilek & Sönmez (2014) aimed to determine the effect of the theatre method on students' learning about sea turtles. The results showed that the theatre method is effective for learning about sea turtles and is more successful than the traditional lecturing model. Paula et al. (2018) conducted a qualitative survey to investigate what kind of teaching methods have been used to promote biodiversity education and how the methods support student learning. Their survey displayed that the most effective methods in biodiversity education are the ones in which students actively participate.

One of the methods that can be used to study biodiversity is problem-based learning (PBL). Heard (2016) stated that PBL is an effective method to help students explore fundamental concepts, collect data, and synthesize this data. The goal of PBL was to develop students' professional practice skills by encountering real problems (Pease & Kuhn, 2010). Researchers (Dochy et al., 2003; Hmelo-Silver, 2004; Jones et al., 2013) state that PBL positively affects students' motivation and increases their permanent learning. PBL supports active learning and helps students develop life-long learning skills (Tessier, 2004). PBL helps develop skills that are very important in daily life. Anwar & Rahmayanti (2021), who studied the effect of problem-based learning, stated that it positively affects students' scientific argumentation abilities. Their findings displayed that problem-based learning significantly influences the ability of scientific argumentation. Similarly, Ismail et al. (2018) displayed that problem-based learning develops students' critical thinking skills.

Although there are differences in how the PBL is applied, it starts from the same point. In this method, the starting point of the learning process is scenarios related to real life (Dahlgren & Öberg, 2001). In the literature, expressions such as “problem” and “case” are also used instead of the word “scenario.” In the PBL, students reveal the problem in the scenario given to them and do research to solve it. At the end of the problem-solving process, students are expected to achieve their learning goals regarding the subject. Students working collaboratively to solve the problem are expected to analyze the problem and develop creative solutions to the problem. Although there are minor differences in practice, the student is at the center of PBL, and there are many stimuli during the learning process (Gorghiu et al., 2014). The problems used in the learning process are directly related to real life (Dahlgren & Öberg, 2001). Therefore, the learning process motivates the student and helps to achieve effective learning.

The study's goal was to use PBL to place students at the center of the learning process. This approach could facilitate effective learning. The complex structures of ecological problems necessitate not only knowledge about the subject but also various cognitive skills (Lewinsohn et al., 2015). Due to the multidimensional nature of the biodiversity issue, research and establishment of cause-effect relationships during the learning process are necessary. PBL is a method in which students use these skills, including research-questioning and analytical thinking skills. Given this, it was hypothesized that the PBL method would be effective in the context of teaching biodiversity. The study aimed to examine the effect of PBL activities on students' awareness of biodiversity and

its importance. The problem scenarios were designed to be relevant to both the subject and daily life.

The Aim of the Study

The study aims to examine the effect of PBL activities on students' awareness of biodiversity and its importance.

METHOD

The research model

This research used PBL activities to teach the 7th grade "Human and Environmental Relations" unit. The case study design, one of the qualitative research designs, was used to determine the effect on students' understanding of biodiversity and its importance.

Samples

The study group research consists of 10 students from two 7th-grade classes studying at a public secondary school in the Türkoğlu district of Kahramanmaraş province in the 2015-2016 academic year. In line with the purpose of the study, two classes whose levels were closest to each other were determined to carry out the applications, taking into account the class achievement averages and the opinions of the course teachers. The classroom experimental group, where PBL activities were implemented, was determined by impartial assignment as the classroom control group, where the activities in the textbook were followed. There are 30 students in each classroom where the applications are carried out. In this study's qualitative data collection process, the criterion sampling method, one of the purposeful sampling methods, was used to determine the sample (Creswell & Plano Clark, 2020). The students' academic achievement levels were considered a criterion in the selection of the students. In the application part of the study, five students from each of the experimental group and control group with similar academic achievement levels were selected by the researchers as participants in the collection of qualitative data.

Data Collection Tool

The data regarding the study were obtained from the short answers given by the students to the semi-structured interview questions in two sections of the Environmental Awareness Interview Form (EAIF). Some changes were made to the interview questions in the EAIF developed by Solmaz (2010) to be compatible with the environmental conditions of the region where the study was conducted. New questions were added considering that changing local and

global problems are a factor affecting the environment. EAIF includes 6 research topics that serve the learning gains of the 7th Grade "Human and Environment" unit and a total of 28 interview questions related to this research topic. For the purpose of this study, sections 4 and 5 of the edited version of EAIF were used as the data collection tool. Section 4 of EAIF consists of 5 questions related to the importance of biodiversity for natural life and section 5 consists of 6 questions related to the examples of plants and animals that are extinct or in danger of extinction in our country and in the world.

Preparation of Activities and Materials Used in the Research

In the research, scenarios were prepared for problem-based learning activities that address real-life issues and problems related to the achievements of the 7th Grade "Human and Environmental Relations" unit of the Science Curriculum. Textbooks, auxiliary resources, scientific publications, current events, and reference people were used to create scenario texts. In this process, the necessary corrections were made by benefiting from the opinions of two science teachers who are experts in their fields and two academicians, one of whom is an associate professor and the other a professor, and the original problem scenarios were given their final shape.

In line with the purposes of the research, four problem scenarios related to biodiversity and its importance were prepared. The prepared problems are related to biodiversity and its importance. The scenarios were prepared based on the learning gains in the human and environmental relations unit according to the Science Class Curriculum (MEB, 2013). Scenarios include situations that students are familiar with from daily life that attract their attention and interest, as well as problems involving social problems. The selected problem situations are expressed using clear and straightforward language so students can easily understand them. Below the scenarios, there were a few questions to help students find the problem, and with the help of these questions, the students could find the details for the detection and solution of the problem themselves. Problem scenarios and related topics/concepts are given in Table 1.

Table 1. Problem scenarios and related topics and concepts

Scenario title	Related topics/concepts
sahlep	biodiversity, local and global environmental problems, endangered species, unconscious hunting, species conservation
museum trip	biodiversity, local and global environmental problems, endangered creatures, species protection

which choice is good for us?	biodiversity, local and global environmental problems, species protection
nature massacre: look at what comes out of the stomachs of dead albatrosses!	biodiversity, local and global environmental problems, endangered creatures, species protection

Application process

The applications were carried out for four weeks, four lesson hours per week. The first week is "Sahlep", the second week is "Museum trip", the third week is "Which choice is good for us?" and week four "Nature massacre: Look at what comes out of the stomachs of dead albatrosses!" PBL applications were made with the scenarios titled. After the application, the students in the experimental and control groups were asked the questions in the fourth and fifth parts of the EAIF.

The application process in the control group

In the control group, the lessons were taught with the traditional lecture method according to the current curriculum. The applications were carried out for 4 weeks, 4 lesson hours per week. The applications in the control group were based on the science curriculum. For this purpose, the student textbook was used. The activities suggested in the specified source have been carried out, and the evaluation questions and exercises have been solved. Lessons in the control group, where the traditional lecture method was applied, were held in classroom and laboratory environments.

The application process in the experimental group

To familiarize the experimental group students with the PBL method, PBL applications were carried out as a pilot study in the previous unit before the main application. Students were divided into five groups of 5-6 people. While forming the groups, students' course achievements were taken into account, as was the case during the pilot study, to ensure that the groups were heterogeneous within themselves and homogeneous among the groups. Each group was asked to choose its president, scribe, and spokesperson and to find a group name. A sample scenario was worked on with the groups, and information was given about how the lessons would be conducted. Detailed information was given to the students on topics such as the steps of solving the current problem in the given scenario, choosing the source to benefit from, researching, preparing a report, and doing group work. In the experimental group, the steps of the PBL method were followed. The steps are given below:

- A separate problem scenario was prepared for each session, and the students read the scenarios at the beginning. In addition, a few questions were included under the scenarios to help students find the problem. These questions were intended to help the students find the details and sub-problems to detect and solve the problem themselves.
- In the first hour, student groups were given time to discuss and exchange ideas within the group to determine the problem or problems in the scenarios.
- At the end of the given time, the groups explained their ideas, and as a result of discussions within and between the groups, the problems in the scenarios were identified. Then, the students sought answers to the following questions about the problem:

  What do I know?
  What are my predictions?
  What should I research?
  What did I learn?
- To determine the students' existing knowledge, they are asked, "What do I know?" about the problem in the scenario. In addition, students listed their predictions under "What are my predictions." In the following lesson, the students were asked what information they needed to solve the problem, and they were expected to create sub-problems related to the problem they determined. In other words, students asked themselves, "What should I research?" Students were asked to research with their group friends on the problems, sub-problems, and topics they had determined. In this process, students benefited from different resources. At this stage, students were able to bring resources to the classroom and benefit from them, as well as to conduct research on the internet with the interactive whiteboard.
- Students were asked to find a solution to the problem based on the information they acquired through their research on the sub-problems and topics they created by discussing them as a group.
- Students accessed the materials they needed until the next lesson, shared the information they gathered before the lesson, and then prepared a report and product to solve the problem. They presented the report and product they prepared to their classmates. Students were allowed to discuss among themselves in the classroom environment, and the solution suggestions they obtained to solve the problem in groups were shared among the groups.

- In order to ensure permanent learning and to complete the missing information, if any, the auxiliary questions in the scenarios were asked to the students one last time, and all students answered the questions through discussion. Any incorrect or missing parts of the prepared report were corrected. In other words, the subject was summarized, and the problem was solved under the guidance of the researcher.
- Depending on the researcher's application plan, worksheets were distributed to the students in the middle and at the end of the application in order to reinforce their academic knowledge and review what they had learned.

An example of the scenarios and worksheets used in the PBL application is included in the appendix. In the PBL, students take responsibility for their learning as they reach knowledge by researching, questioning, and discussing among themselves. In this process, the teacher's guidance for the students helps them access information and realize learning. For this reason, the researcher guided the students throughout the application by asking questions, tried to prevent the students from deviating from the topic by making the necessary interventions, and provided supportive guidance in eliminating the deficiencies.

Validity and Reliability

In order to ensure the internal validity of the study, the opinions of one science education faculty member and one expert science teacher were received before the application of the interview form prepared by the researchers. Two science teachers not involved in the study were asked to read the form and evaluate the questions regarding readability and understandability. In line with the feedback from expert opinions, the researchers re-examined the form and made the necessary corrections. Before the interviews, participants were given explanations about how the interview would take place. During the interviews with the participants, the answers given by the participants to each question were repeated, the participants were expected to confirm, and any misunderstood parts were corrected immediately. The interviews lasted approximately 15-20 minutes. Considering the interviews were conducted with secondary school students, this period is suitable for long-term interaction. The answers from the participants are given verbatim as quotes in the findings section.

To ensure external validity, the research model, study group, data collection tools, data collection, data analysis, and how the findings were organized are

explained in detail. The study participants were determined by purposeful sampling and consisted of suitable individuals who would contribute to the purpose of the study.

For internal reliability, all research findings were presented without comment, and all data were transcribed to prevent data loss. In addition, the data were read separately by two researchers, and codes were created independently of each other. The researchers reached a consensus in creating themes based on the codes.

For external reliability, the data are appropriately discussed in the results section. In addition, the researchers evaluated the consistency of the results and findings sections, and a consensus was reached.

Analysis of data

The students' answers to the questions in the 4th and 5th sections of the EAIF in the experimental and control groups were transcribed and analyzed using content analysis. In determining the categories used for evaluation during the analysis, in addition to scientific sources, the analyses made by Solmaz (2010), who prepared the EAIF, were also used. Also, the created codes were examined by a science education associate professor, a science education professor and a science teacher who is an expert in her field. In calculating the reliability of the determined codes, Miles & Huberman's (1994) reliability formula (Reliability = [Agreement/ (Agreement 4 Disagreement)] x 100) was used and inter-rater agreement level was calculated as 86 %. Reliability calculations above 70 % are considered reliable for the research (Miles & Huberman, 1994). While questions 4a and 4b in section 4 of EAIF were evaluated separately, questions 4c, 4d, and 4e were evaluated together because they question the roles of living things in the ecosystem. Interview questions 5a, 5b, 5c, and 5d, which question the creatures that are extinct or under threat of extinction in the world and our country, were evaluated together in the 5th section of EAIF. Interview questions 5e and 5f of the fifth section, which question the reasons for the extinction of living things, were evaluated together.

FINDINGS

To examine the effect of the PBL on the students' awareness of biodiversity and its importance, five students from both the experimental and control groups were asked semi-structured interview questions in the EAIF Sections 4 and 5 after the application. The experimental group students are S1, S2, S3, S4, S5; the control group students were coded and named S6, S7, S8, S9, S10. The short

answers given by the students were analyzed using the content analysis method.

Findings from the answers to the questions in EAIF Section 4

Questions 4a, 4b, 4c, 4d, and 4e in Section 4 of the data collection tool are related to biodiversity and its importance. Below is the analysis of the answers given by the experimental and control group students to these questions.

Answers to the interview question 4a: "What comes to your mind when you think of biodiversity? Please explain this concept."

The students' answers to interview question 4a, which asked them to reveal their knowledge about the concept of "biodiversity," were examined in two separate categories, and their answers are presented in Table 2.

Table 2. Answers given by experimental and control group students to the question 4a

Category	Codes	Experimental group students		Control group students	
		n	%	n	%
species diversity	-various animals -various plants -multiple living species -living diversity	5	100	5	100
intraspecific diversity	-diversity of organisms of the same species	5	100	4	80

When the answers given by the experimental group students regarding the concept of "biodiversity" are examined, it is seen that all of the students (100%) answered in both the species diversity category and the intra-species diversity category. An example of student responses is given below:

S3: *" Bio is a separate word; diversity is another word. Bio means living like animals and plants. Biodiversity means the diversity of living things. "There is also diversity within its species, such as the brown bear and the polar bear*."

When the answers given by the control group students regarding the concept of "biodiversity" were examined, 80 % of the students gave answers in both the species diversity and the intra-species diversity categories. S10 answered,

"What is biodiversity?" by referring to "various animals." This answer only fits the category of species diversity. An example of student responses is given below:

S6: "Living *diversity. I mean living things. Plants and animals are coming to my mind. Desert foxes, arctic foxes, various creatures living in rainforests, for example."*

Answers to the interview question 4b: "While there are 25 species in a marine ecosystem, if the number of species decreases to 10, what consequences will this cause in that ecosystem?"

The students' answers to interview question 4b were examined in three separate categories, and their answers are presented in Table 3.

Tablo 3. Answers given by experimental and control group students to the question 4b

Category	**Codes**	**Experimental group students**		**Control group students**	
		n	%	n	%
level 1 it evaluates the decline in an ecosystem only in terms of species disappearing.	(no answer)	0	0	0	0
level 2 it also evaluates the decrease in species diversity in an ecosystem in terms of creatures that feed on extinct species.	-creatures that feed on endangered fish are negatively affected -those who feed on extinct creatures from outside are negatively affected -they become extinct	5	100	5	100
level 3 it evaluates the decrease in species diversity in an ecosystem in terms of all living things in that ecosystem.	-all living things begin to become extinct. -the balance of the ecosystem is disrupted	5	100	3	60

When the answers of the experimental group students regarding the importance of biodiversity were examined, it was seen that 100 % of them gave answers at the second and third levels. Examples of student responses are given below:

S3: *"The creatures that feed on them, as we have just given an example, if a mouse eats a grasshopper, it is affected by the mouse, just like if some eat that fish and feed on these creatures, like a bird, they cannot eat those creatures, they turn to other things and eat traps just like albatross birds. It may end up happening to them. There will be a decrease in their numbers, and the balance of that ecosystem will be disrupted."*

S5: "For *example, if they become extinct, the creatures that feed on them will also be in danger of extinction. Creatures that feed on it are affected, as they become extinct because there is no breeding, and other creatures are affected by this because nutrition decreases. The ecosystem is negatively affected."*

When the answers given by the control group students regarding the importance of biodiversity were examined, 100 % of them gave level 2 answers, and 60 % of them gave answers at the 3rd level. Examples of student responses are given below:

S6: *"The food chain is broken, and they feed on each other. They are negatively affected."*

S7: *"The number of fish decreases. If the species of fish it eats are extinct, the fish there may starve. They, too, may become extinct, disrupting the order in this ecosystem."*

Interview questions 4c, 4d, and 4e of the fourth section, which are related to the roles of living things in the ecosystem, were evaluated together.

Answers to the interview question 4c "In your opinion, is there any living thing in nature that has no role or benefit? If so, which creature is this? Why?, 4d "What is the role of the worms that live in our garden and scare some of our friends? Do they have any benefits for nature?", 4e "What might happen if we think they disappear from their environment?":

The students' answers to interview question 4c, 4d, and 4e were examined in three separate categories, and their answers are presented in Table 4.

Table 4. Answers given by experimental and control group students to questions 4c, 4d, and 4e

Category	Codes	Experimental group students		Control group students	
		n	%	n	%
level 1 he thinks that there are living things that do not benefit nature or have any function in nature. he believes that creatures that are disliked and seen as harmful by humans are also harmful to nature.	(no answer)	0	0	0	0
level 2 he knows that all living things benefit nature and have a duty in nature. but he cannot explain this with scientific reasons.	- every living being has a mission	5	100	5	100
level 3 he knows that all living things are beneficial to nature and have a function in nature, and he bases this on scientific grounds.	-its extinction will negatively affect other living things -other creatures may starve -its duty in nature remains incomplete -natural balance is disrupted	5	100	5	100

When the answers given by the experimental group students to the questions related to the roles of living things in the ecosystem were examined, it was seen that 100 % of the students gave answers at the second and third levels. They expressed the opinion that all living things in nature have a function. Examples of student responses are given below:

S2: "No, *sir, every living thing in nature was created for a reason." (4c)*

"Yes, there are. Their role is to aerate the soil, so plants grow better, and water can easily go to the bottom of the plant." (4d)
"The consequences of airless soil can be severe, leading to a decrease in productivity and negatively impacting other living organisms." (4e)

S5: *"Every living thing has a role in nature… every living thing impacts nature." (4c)*
-"Worms aerate the soil. They are connected to the environment and the soil, and they help plants grow by aerating the soil." (4d)
-"So, his task remains incomplete. Natural balance is disrupted." (4e)

When the answers given by the control group students to the questions about the roles of living things in the ecosystem were examined, it was seen that 100 % of the students gave answers at the second and third levels. They expressed the opinion that all living things in nature have a function. Examples of student responses are given below:

S6: *"No. "Every living thing has a duty." (4c)*
"They mix the soil so that the plant can take root more easily." (4d)
"Plants may have a harder time taking root. Therefore, it may have a negative impact." (4e)

S7*: "No. They all have benefits." (4c)*
"They open the air by piercing the soil, and water can easily enter the roots of the crops through the holes they make. I think it is beneficial." (4d)
"When crops cannot grow well, they are deprived of air, and their water fails to reach the bottom, to their roots." (4e)

Findings from the answers to the questions in EAIF Section 5
The first four questions of the fifth section, 5a, 5b, 5c, and 5d, related to the creatures that are extinct or under threat of extinction in the world and our country, were evaluated together.

Answers to the interview questions 5a "Are there any endangered creatures in our country? Can you give an example?", 5b "Are there any extinct creatures in the world? Can you give an example?", 5c "Are there any creatures in danger of extinction in our country? Can you give an example?", 5d "Are there any creatures in danger of extinction in the world? Can you give an example?":

Table 5 shows the answers of the experimental group students to the interview questions related to the creatures that are extinct or under threat of extinction.

Table 5. Answers given by experimental group students to the questions 5a, 5b, 5c, and 5d

Questions	Codes	n	%
are there any extinct creatures in our country?	-anatolian lion	3	60
	-caspian tiger	5	100
	-asian tiger	3	60
	-anatolian cheetah	2	40
	-anatolian leopard	1	20
	-asian elephant	2	40
	-forest rooster	1	20
are there any extinct creatures in the world?	-dodo bird	5	100
	-dinosaur	5	100
	-mammoth	5	100
	-moa	4	80
	-tasmanian devil	1	20
	-snake neck	1	20
	-caucasian bison	1	20
are there any creatures in danger of extinction in our country?	- bald ibis	4	80
	-grey mullet	1	20
	-grizzly bear	1	20
	-lynx	2	40
	-lycian orchid	5	100
	-snow flower	1	20
	-crocus	3	60
	-iris	2	40
	-daffodil	3	60
	-roe	1	20
	-swamp owl	1	20
	-mediterranean monk	1	20
	-red deer	1	20
	-sea turtle	1	20
are there any creatures in danger of extinction in the world?	-glass frog	3	60
	-polar bear	5	100
	-jade flower	1	20
	-raflesia flower	1	20
	-venus flower trap	1	20
	-panda	4	80
	-penguin	3	60
	-tiger of the bengal	1	20
	-white whales	1	20
	-sturge catfish	2	40
	-koala	1	20
	-javan rhino	1	20

When the answers in Table 5 were examined, it was seen that all of the students in the experimental group were aware of the existence of extinct creatures in

our country and could give at least three examples of these creatures. All students responded by using species names instead of the more general genus names when providing examples of these creatures. Some students responded using specific species names instead of common general names known in daily life. Students in the experimental group gave at least three examples each, knowing extinct creatures worldwide and using their species names. In addition, the experimental group students, aware of the existence of creatures in danger of extinction in our country, gave at least four examples of the names of these creatures and expressed these creatures with the names of their species. For the creatures in danger of extinction worldwide, all of the students in the experimental group gave at least three examples and expressed the mentioned creatures using their species names.

Table 6 shows the answers of the control group students to the interview questions related to the creatures that are extinct or under threat of extinction.

Table 6. Answers given by control group students to the questions 5a, 5b, 5c, and 5d

Questions	Codes	n	%
are there any extinct creatures in our country?	-there is none	3	60
	-there is but I don't	1	20
are there any extinct creatures in the world?	-asian elephant	1	20
	-asian lion	1	20
	-asian tiger	2	40
	-taurus frog	1	20
	-Dodo bird	4	80
	-dinosaur	5	100
	-mammoth	2	40
	-moa	1	20
are there any creatures in danger of extinction in our country?	there is but i don't know	1	20
	-lycian orchid	2	40
	-bald ibis	2	40
	-grizzly bear	1	20
	-cyclanum	1	20
	-red deer	1	20
	-sea turtle	1	20
are there any creatures in danger of extinction in the world?	-panda	4	80
	-penguin	1	20
	-short beaked dolphin	1	20
	-tiger of the bengal	1	20
	-polar bear	1	20

When the answers in Table 6 are examined, it is seen that after the application, 60 % of the control group students stated that there are no endangered

creatures in our country. A student stated that there are extinct creatures but could not give an example. Two students were able to give two examples each. All the students in the control group were aware of the existence of extinct creatures worldwide and gave two examples of each of the mentioned creatures. 80 % of the control group students were aware of the endangered creatures in our country and could give examples of these creatures using their species names.

Interview questions 5e and 5f of the fifth section, related to the reasons for the extinction of living things, were evaluated together.

Answers to the interview questions 5e "What could have contributed to endangered creatures reaching this state?", 5f "Do humans have a role in endangered creatures reaching this state? Please explain."

The students' answers to questions related to the reasons for the extinction of living things were examined at two levels, and the answers of the students in the experimental group are given in Table 7.

Table 7. Answers given by experimental group students to questions 5e and 5f

Category	**Codes**		**n**	**%**
level 1 recognizes the direct effects humans have on endangered species.	(no answer)		0	0
level 2 he/she recognizes the direct effects that humans cause, as well as the indirect effects that humans cause, in causing creatures that are in danger of extinction to reach this state.	direct effect -killing for fashion and accessories -hunting sport -urbanization -population growth -killing for trade -highway accidents -scientific experiments -zoos -deforestation -narrowing the living spaces of living things -using violence -unconscious hunting	indirect effect along with direct effects: -environmental pollution -global warming -climate change -depletion of the ozone layer	5	100

When the answers in Table 7 are examined, 100 % of the students in the experimental group gave answers at the 2nd level, considering the direct and indirect factors caused by humans in bringing the creatures that are extinct and

in danger of extinction to this state. Examples of student responses are given below:

S1-*"Global warming, highway accidents, unplanned urbanization, population growth, use for fashion accessories." (5e)*
-"Yes. Highway accidents… Even though there are signs, people do not pay any attention. Creatures such as crocodiles, lions, and leopards are hunted for trade. Creatures are being killed for fashion accessories such as bags, necklaces and bracelets. Zoos are established by removing animals from their natural habitats for trade. "There is bad treatment in circuses." (5f)

S3: - "*Human influence and natural factors… More human influence, sir. "(5e)*
-"People narrow down the habitats of animals, and when they narrow them down, when animals no longer live there, for example, when pandas and bamboo areas decrease, those animals decrease. Forests are being cut down. There is much biodiversity in forests. When trees are cut down, the creatures that feed on them and the creatures that live there become fewer and fewer. Gases that pollute the air, such as gases coming out of factory chimneys. The climate is changing due to pollution; for example, while some birds migrate due to climate change, animals do not know where it is, hot or cold, and their balance is disrupted as if winter and summer have changed places. Due to global warming, the poles are melting, and concreting is effective. Trees and plants are damaged due to floods, earthquakes, storms, and avalanches." (5f)
"Unconscious hunting is taking place, as the number of zoos increases, animals are moving away from their natural habitats, creatures that have no food left go to cities and are killed by people there." (5f)

The answers of the control group students to questions 5e and 5f are given in Table 8.

Table 8. Answers given by control group students to questions 5e and 5f

Category	Codes		n	%
level 1 recognizes the direct effects humans have on endangered species.	-killing for fashion and accessories -hunting sport -urbanization -deforestation -narrowing the living spaces of living things -using violence -unconscious hunting		4	80
level 2 he/she recognizes the direct effects that humans cause, as well as the indirect effects that humans cause, in causing creatures that are in danger	direct effect -killing for skin and fur -hunting sport -industrialization -deforestation	indirect effect -environmental pollution -climate changes	1	20

of extinction to reach this state.	-narrowing the living spaces of living things

When Table 8 is examined, 80 % of the control group students gave level 1 answers after the application on "the reasons why extinct and endangered creatures are in this situation." In comparison, 20 % of the students gave level 2 answers, including direct and indirect effects. Most of the students in the control group think that direct human factors are more effective in bringing extinct and endangered creatures to this state. They did not think about the direct effects caused by humans, indirect effects, and natural factors together and gave answers in this direction. Examples of student responses are given below:

S6: - *"People hunt them for their meat, fur, oil, etc. They also sometimes throw garbage into the sea, which affects the fish." (5e)*
"I think it has a share in it; they destroy natural habitats. They cut down trees, destroy their food…" (5f)

S10: -*"The mammoth could not survive in the ice age. In other words, climate characteristics are effective (climate changes)." (5e)*
- *"Unconscious hunting, unconscious urbanization, deforestation."(5f)*

RESULTS AND DISCUSSION

Within the scope of the study, the effect of problem-based learning activities on students' awareness of biodiversity was examined. The answers given by the experimental and control group students to the questions were analyzed. When the students' answers regarding the concept of "biodiversity" were examined, it was seen that 100 % of the experimental group students and 80 % of the control group students gave answers that included both species diversity and intraspecific diversity. This reveals that all students in the experimental group can evaluate species diversity and intraspecific diversity together in the concept of biodiversity. But there are students in the control group who need help comprehending the issue of intraspecific diversity.

When the students' answers to question, which questions the consequences of the decrease in the number of species in an ecosystem regarding the importance of biodiversity, are examined, it can be seen that all of the students in the experimental group can give answers from a holistic perspective regarding the importance of biodiversity and that the decrease in biodiversity in an ecosystem can be seen both in terms of extinct species and in terms of extinction. It has

been observed that they can evaluate the species in terms of the species that feed on them and all living things in that ecosystem. While all control group students associated the decrease in species diversity with disappearing species, only 60 % of this group could evaluate it from a holistic perspective. The experimental group students thought more about the species' decrease in the ecosystem and evaluated more variables than the control group.

When the answers given by the students to the questions questioning the roles of living things in the ecosystem were examined, it was seen that all the students in both the experimental group and the control group gave answers at the second and third levels. All students know that all living things have a function in nature and can base this on scientific facts. Both the experimental and control group students answered that all living things in nature have a function and that other living things will be affected by the extinction of a living creature in nature. However, when the answers given by the experimental group students were compared with the answers given by the control group students, the subject of "the importance of biodiversity" was explained in a broader context in the answers of the experimental group students, and there were statements that all living things would be affected by the extinction of one living thing from nature and the natural balance would be disrupted.

When the answers given by the students regarding extinct or endangered creatures were examined, it was seen that there were differences between the students in the experimental and control groups. All of the experimental group students were aware of extinct creatures in our country and could give at least three examples of these creatures. On the other hand, 60 % of the control group students stated that there are no extinct creatures in our country, and one student said that there are extinct creatures but could not give an example. The number and variety of examples given by the experimental group students are greater than those given by the control group. The experimental group and the control group students could give examples of extinct creatures worldwide. However, the examples the experimental group students gave was considerably higher in both number and variety than the control group students. Both the experimental group and the control group students were aware of the creatures in danger of extinction in our country and could give examples of these creatures. However, while all of the students in the experimental group could give examples, one student in the control group could not give any examples. The number and variety of examples in the experimental group are much higher than in the control group. A similar situation also applies to examples of creatures in danger of extinction. While both the experimental and control group students can give examples of creatures that are in danger of extinction

in the world, the number and variety of examples of the experimental group students are much higher than the control group.

When the answers given by the students to the questions about what caused the extinction of living things were examined, it was seen that the students in the experimental group were able to evaluate the indirect effects together with the direct effects caused by humans. Experimental group students were able to give many examples of the direct and indirect effects of people. In contrast, 80 % of the control group students focused on the direct effects of people and gave examples based on this. Only one student could express direct and indirect effects and give examples for both groups.

As a result, it was observed that the students in the experimental group, where problem-based learning activities were carried out, were more aware of inter-species biodiversity and intra-species biodiversity than the control group. In addition, it was determined that the experimental group students could evaluate the effects of decreasing species diversity from multiple perspectives, whereas the control group students had more limited perspectives on the subject. The students in the experimental group had more examples of extinct and endangered creatures than the control group in terms of number and diversity. In addition, the experimental group students made more detailed explanations about the importance of biodiversity. Experimental group students carried out applications in four problem scenarios within the scope of the study. They did research to answer the questions in the problem scenarios and developed solution suggestions at the end of the research processes. Students took responsibility for their learning processes. The research process enables students to access more information and develop different perspectives. In the control group, the activities in the textbook were followed. It was observed that the PBL activities carried out in the experimental group not only increased the students' knowledge and awareness of the subject but also broadened their perspectives. As a result, problems created in daily life positively affect students' learning and various skills. Similarly, Souse (2014) searched for the effect of problem-based learning methods while teaching the origins of biodiversity and continents and oceans, and the results of the study revealed that problem-based learning is very effective. Additionally, in their study, Ramadoss & Poyya Moli (2011) aimed to develop biodiversity consciousness among students and developed an action-oriented biodiversity education program. In this program, they developed active classroom sections, hands-on training activities, and field exposure. Their results showed that their program increased the students' knowledge, interest, and skills to protect and conserve local natural resources and biodiversity.

In the literature, there are various studies in which PBL applications are carried out in environmental education (Mittelstaedt et al.,1999; Waliczek & Zajicek, 1999; Palmberg & Kuru, 2000; Kadji-Beltran et al., 2001; Bögeholz, 2002; Korhonen & Lappalainen, 2004; Kaplowitz & Levine, 2005; Bolin et al., 2005; DiEnno & Hilton, 2005; Uzun & Sağlam, 2007; Barbas et al., 2007; Akça & Ata, 2009; Carrier, 2009; Bektaş & Horzum, 2010; Ajiboye & Olatundun, 2010; Erdoğan, 2011; Güven, 2012; Kızıl, 2012; Koçyiğit & Zembat, 2013; Acaray, 2014; Erentay, 2013; Dursun et al.,2015), it is stated that the practices have a positive impact on students' environmental attitudes and awareness. The results of this study and the referenced research above also reveal that the PBL method effectively teaches more specific concepts, such as biodiversity and general concepts in environmental education.

SUGGESTIONS

The results of the study revealed that the problem-based learning method affected the students' awareness of biodiversity and its importance in a positive way. The students' answers to the questions showed that it supported them to think within a broader perspective on a multidimensional and complex issue such as biodiversity. The aim of environmental education is to raise individuals who are aware of environmental problems and can propose solutions to these problems. Considering the complexity of the problems, the importance of being able to look at problems from different perspectives cannot be denied. Students had to think multidimensionally in solving daily life problems in problem-based learning applications. Therefore, problem-based learning method can be utilized in teaching different subjects within the scope of environmental education. The results of the study show that problem-based learning enabled students to approach the interpretation of their knowledge with a broader perspective. The ability to use what is learned in daily life is an indicator of meaningful learning. It is seen that problem-based learning enables students to use what they have learned while solving problems. Therefore, it is an effective method that can be used to support meaningful learning and to use knowledge in daily life. In addition, in line with the aims of science education, it is important to raise individuals who can think, conduct research and apply the knowledge they have learned to daily life. Considering the positive contribution of problem-based learning to the awareness of biodiversity and its importance within the scope of the study, this method can be used in different subjects of the science course. To summarize, problem-based learning method can be utilized in many subjects in both environmental education and science education. Problem-based learning is a method that can be used at all levels of education. Therefore, the application of the method can be realized with

problem scenarios suitable for the developmental levels of students at different educational levels.

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Genişletilmiş Özet

Giriş

Günümüzde hızla artan çevre problemleri günlük yaşamı günden güne daha çok etkilemektedir. Bundan dolayı insanların çevre farkındalığı kazanmaları giderek daha önemli bir konu haline gelmektedir. Bireylerin çevre konusunda bilgi sahibi olması, çevre farkındalığı geliştirmede oldukça önemlidir. Çevre sorunlarının farklı disiplinleri ilgilendiren karmaşık yapısı nedeniyle, çevre eğitiminin konu kapsamı da oldukça geniştir. Canlıların birbiri ile ilişkisinin anlaşılması, her bir canlı türünün ekosistemde ne kadar önemli olduğunun fark edilmesini içeren biyoçeşitlilik konusu bunlardan biridir ve pek çok çevre sorununun önlenmesinde oldukça önemlidir. Bu nedenle, biyoçeşitlilik konusunun öğretiminde etkili öğretim yöntemlerinin kullanılması gerekmektedir. Biyoçeşitlililik konusunda kullanılabilecek yöntemlerden bir tanesi de probleme dayalı öğrenme yöntemidir. Çalışma kapsamında, probleme dayalı öğrenme yöntemi kullanılarak, öğrencilerin biyoçeşitlilik konusu ile ilgili farkındalık kazanmaları amaçlanmıştır. Bu bağlamda hazırlanan problem senaryoları da hem konu ile ilgili hem de günlük yaşam bağlamı düşünülerek hazırlanmıştır.

Yöntem

Bu çalışmada nitel araştırma desenlerinden durum çalışması deseni kullanılmıştır. Araştırma seviyeleri birbirine en yakın iki 7. sınıf ta uygulanmıştır. Sınıf "İnsan ve Çevre İlişkileri" ünitesinin öğretiminde PDÖ etkinliklerinin uygulandığı sınıf deney grubu, ders kitabındaki etkinliklerin takip edildiği sınıf kontrol grubu olarak tarafsız atama ile belirlenmiştir. Uygulamaların gerçekleştirildiği her bir sınıfta yaklaşık 30 öğrenci bulunmaktadır. Bu çalışmanın veri sürecinde örneklemin belirlenmesinde amaçlı örnekleme yöntemlerinden ölçüt örnekleme yöntemi ile akademik başarı düzeyleri bir ölçüt olarak kullanılarak deney ve kontrol grubundan düzeyleri benzer olan beşer öğrenci katılımcı olarak seçilmiştir. Yani araştırmanın çalışma grubu, bir devlet ortaokulunda 7. Sınıfta öğrenim gören 10 öğrenciden oluşmaktadır.

Araştırmaya ilişkin veriler, öğrencilerin "Çevresel Farkındalık Görüşme Formu" nun (ÇFGF) iki bölümünde yer alan yarı yapılandırılmış görüşme sorularına verdikleri kısa yanıtlardan elde edilmiştir. ÇFGF 'in 4. bölümü biyoçeşitliliğin doğal yaşam için önemine ilişkin 5 sorudan, 5. bölümü ise ülkemizde ve dünyada nesli tükenen veya yok olma tehlikesiyle karşı karşıya olan bitki ve hayvan örneklerine ilişkin 6 sorudan oluşmaktadır. Öğrencilerin verdikleri cevaplar yazıya geçirilmiş ve içerik analizi ile incelenmiştir.

Sonuçlar ve Tartışma

Öğrencilerin "biyoçeşitlilik" kavramı (soru 4a) ile ilgili cevapları incelendiğinde deney grubu öğrencilerinin %100' ü, kontrol grubu öğrencilerinin ise % 80'inin hem tür çeşitliliğini hem de tür içi çeşitliliği bir arada bulunduran cevaplar verdikleri görülmüştür. Bu durum deney grubu öğrencilerin tamamının biyoçeşitlilik kavramında tür çeşitliliği ve tür içi çeşitliliği bir arada değerlendirebildiğini, kontrol grubu öğrencilerinde ise tür içi çeşitlilik konusunu kavrayamayan öğrencilerin olduğunu ortaya koymaktadır.

Öğrencilerin, biyoçeşitliliğin önemine yönelik olarak, bir ekosistemde tür sayısının azalmasının sonuçlarını sorgulayan soruya (4b) verilen cevaplar incelendiğinde, deney grubu öğrencilerinin tamamının biyoçeşitliliğin önemi ile ilgili bütüncül bir bakış açısıyla cevaplar verebildiği ve bir ekosistemdeki biyoçeşitliliğin azalmasını hem yok olan türler açısından hem yok olan türlerle beslenen türler açısından, hem de o ekosistemdeki tüm canlılar açısından değerlendirebildikleri görülmüştür. Kontrol grubu öğrencilerinin ise tamamı tür çeşitliliğinin azalmasını yok olan türlerle ilişkilendirirken, bu gruptaki öğrencilerin sadece %60'ı bütüncül bir bakış açısıyla değerlendirebilmiştir. Deney grubu öğrencileri, ekosistemdeki tür sayısının azalması ile ilgili daha detaylı düşündükleri ve kontrol grubuna göre daha fazla değişkeni değerlendirdikleri söylenebilir.

Öğrencilerin, canlıların ekosistemdeki rollerini sorgulayan sorulara (4c, 4d, 4e) verdikleri cevaplar incelendiğinde hem deney grubundaki hem de kontrol grubundaki öğrencilerin tamamının ileri düzeyde cevaplar verdikleri görülmüştür. Öğrencilerin tamamı, tüm canlıların doğada bir görevi olduğunu bilmekte ve bunu bilimsel gerçeklere dayandırabilmektedirler. Doğada bulunan bütün canlıların bir görevinin olduğu ve bir canlının doğada yok olmasından başka canlıların etkileneceği yönünde cevaplar vermişlerdir. Ancak cevaplar karşılaştırıldığında deney grubu öğrencilerinin cevaplarında "Biyoçeşitliliğin önemi" konusu daha geniş çerçevede açıklanmış, bir canlının doğadan yok oluşundan bütün canlıların etkileneceği ve doğal dengenin bozulacağı yönünde ifadeler yer almıştır.

Öğrencilerin nesli tükenmiş veya tükenmekte olan canlılara ilişkin sorulara (5a, 5b, 5c, 5d) verdikleri cevaplar incelendiğinde, deney ve kontrol grubu öğrencileri arasında farklılıklar olduğu görülmüştür. Deney grubu öğrencilerinin tamamı ülkemizde nesli tükenen canlıların varlığından haberdar olarak bu canlılara en az 3' er örnek verebilmiştir. Buna karşılık kontrol grubu öğrencilerinin %60'ı ülkemizde nesli tükenen canlıların olmadığını ifade etmiş ve bir öğrenci de nesli tükenen canlıların var olduğunu söylemiş ancak örnek

verememiştir. Deney grubu öğrencilerinin verdikleri örneklerin sadece sayısı değil, çeşidi de kontrol grubuna göre fazladır. Hem deney grubu hem de kontrol grubu öğrencileri dünyada nesli tükenen canlılara örnekler verebilmişlerdir. Ancak deney grubu öğrencilerinin verdikleri örneklerin sayısı kontrol grubu öğrencilerine göre hem sayıca hem de çeşit olarak oldukça fazladır. Hem deney grubu hem de kontrol grubu öğrencileri ülkemizde nesli tükenme tehlikesi altında olan canlıların farkındadırlar ve bu canlılara örnekler verebilmişlerdir. Ancak deney grubu öğrencilerinin tamamı örnek verebilirken, kontrol grubunda bir öğrenci herhangi bir örnek verememiştir. Deney grubunda verilen örneklerin sayısı ve çeşidi kontrol grubundakilerden çok daha fazladır.

Öğrencilerin canlıların nesillerinin tükenmesine nelerin sebep olduğuna ilişkin yöneltilen soruya (5e-5f) verdikleri cevaplar incelendiğinde, deney grubu öğrencilerinin insanların sebep olduğu doğrudan etkilerle beraber dolaylı etkileri bir arada değerlendirebildikleri görülmüştür. Deney grubu öğrencileri, insanların doğrudan ve dolaylı etkilerine çok sayıda örnek verebilmişlerdir. Buna karşılık, kontrol grubu öğrencilerinin %80'i insanların doğrudan etkileri üzerine odaklanarak, buna dayalı örnekler vermişlerdir. Sadece bir öğrenci, doğrudan ve dolaylı etkileri bir arada ifade ederek, her iki gruba da örnekler verebilmiştir.

Literatürde çevre eğitiminde probleme dayalı öğrenme uygulamalarının gerçekleştirildiği çeşitli çalışmalarda (Bögeholz, 2002; Korhonen ve Lappalainen, 2004; Şahin ve ark., 2004; Kaplowitz ve Levine, 2005; Ajiboye ve Olatundun, 2010; Özdemir, 2010; Erdoğan, 2011; Güven, 2012; Kızıl, 2012; Koçyiğit ve Zembat, 2013; Acaray,2014; Erentay, 2013; Dursun ve ark.,2015), yapılan uygulamaların öğrencilerin çevre tutum ve farkındalıklarını olumlu yönde etkilediği belirtilmektedir. Bu çalışmanın sonuçları ve refere edilen çalışmaların sonuçları da biyoçeşitlilik gibi daha spesifik kavramların öğretilmesinde, probleme dayalı öğrenme yönteminin etkili olduğunu ortaya koymaktadır.

Öneriler

Çevre eğitiminde farklı konuların öğretiminde hem de fen bilgisi eğitiminde pek çok konuda probleme dayalı öğrenme yönteminden yararlanılabilir. Farklı eğitim seviyelerinde, öğrencilerin gelişim düzeylerine uygun problem senaryoları ile yöntemin uygulaması gerçekleştirilebilir.