The Effect of Problem-based Learning on 7th-grade Students' Environmental Knowledge, Attitudes, and Reflective Thinking Skills in Environmental Education

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The Effect of Problem-based Learning on 7th-grade Students' Environmental Knowledge, Attitudes, and Reflective Thinking Skills in Environmental Education

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Article Info	Abstract
	The study aimed to investigate the effect of authentic problem-based learning (PBL) activities in the unit of "Human and Environment" on 7th graders' environmental information, their reflective thinking skills and their environmental attitudes. The sample of the study consisted of 53 7th grade students from two different classes attending Science and Technology Course at a government school in Turkey. One of the groups was attended as control group the other one was attended as experimental groups. Reflective Thinking Skills Scale, Environmental Knowledge Test, and Environmental Attitude Scale were used as data collection tools. The research design of the study was quasi experimental pre-test post-test control group design. The experimental group was taught by PBL and the control group was taught by didactic teaching method. The results of the study displayed that PBL had significant effect on 7th graders' environmental knowledge; environmental attitudes but it had no significant effect on students' reflective thinking skills.

Introduction

The number and variety of environmental problems are increasing day by day. Urgent environmental problems such as global warming, food scarcity, and destruction of biodiversity are very complex problems, and they concern both science and society (Wals, Brody, Dillon, & Stevenson, 2014).Although the existence of these problems is noticeable, individuals continue to behave environmentally unfriendly at the individual, governmental, and societal levels. The rapid growth of environmental problems leads to the extinction of many species, and this leads to the deterioration of the ecological balance. Although a human being is not independent of its environment and the ecosystem, individuals continue to pollute the environment as if they were living out of this system. The increase of ecological problems threats not only other living bodies they also threat humans' wellbeing. As stated by UNESCO-UNEP (1991), Environmental education aims to make students environmentally literate individuals who play an active role in protecting the environment by making decisions and behaving environmentally-friendly (Makki, Abd-El-Khalick, &Boujaoude, 2003). Environmental awareness, knowledge, and attitude play an important role while protecting the environment (Lahiri, 2011). When individuals increase their knowledge related to environmental issues, they will be more aware of environmental problems and increases their environmental responsibility (Aminrad, Zakariya, Hadi, &Sakari, 2013; Palmberg& Kuru, 2000). Chapman and Sharma (2001), Salequzzman and Stocker (2001), Bradley, Waliczek, and Zajicek (1999) stated that environmental education fosters environmental awareness, environmental understanding, and environmental skills through increasing environmental knowledge. Through environmental education, individuals can understand environmental issues and become a part of the solution to environmental problems. Environmental education helps people to understand the relationship between environmental and their lives (Hafezi, Shobiri, Sarmadi, &Abass, 2013). Lieflander, Föhlich, Bogner, and Schultz (2013) stated that individuals should have a positive relationship with their environments to cope with environmental problems.Makki et al. (2003) stated that environmental knowledge and attitudes affect individuals' environmental decisions and behaviors. Today, in environmental education, the focus is on the development of students' critical thinking and problem-solving skills through working on environmental issues and problems (Kwan & So, 2008).

In line with the goals of environmental education, students need to work on real-life problems to develop their critical thinking, problem-solving, and decision-making skills (Stevenson, 2007). In this context, problem-based learning (PBL) is appropriate for environmental education since it encourages students to express ideas, develop their cognitive and affective skills, direct their learning through analyzing real-life problems (Said, Yahaya,

&Ahmadun, 2007). Vasconcelos (2012) evaluated the success of a PBL intervention program in environmental education and stated that it had positive effects on students' learning of environmental subjects.Meaningful learning occurs when students learn through concrete experiences such as real-life experiences. Therefore, students need to participate in the activities in which they gain first-hand experience, work on real-life and real issues (Chang, Chen, & Hsu, 2011). PBL connects real-world and classroom requirements. PBL focuses on knowledge construction and interaction with real-life problems (Reynolds & Hancock, 2010).In various studies, the researchers stated the positive effects of PBL on students' learning and some effective factors (such as attitude, motivation.9. For example, Etherington (2011) stated that PBL had positive contributions on pre-service teachers' motivation to teach science. Similarly Gorghiu, Draghicescu, Critea, Petrescu and Gorghiu (2015), Jansson, Söderström, Andersson, and Nording (2015), Senocak, Taskesenligil, and Sözbilir (2007) expressed that PBL increased students' understanding of some science concepts.

Albanese and Mitchell (1993) stated that PBL has similar views with Plato and Socrates who want students to think, ask questions, produce new ideas and discuss different ideas. PBL is also similar to the ideas of John Dewey's and Jerome Bruner's about the learning environment (Schmidt, 1993). In PBL students discover and construct their knowledge. In PBL, a loosely constructed real-life problem stands in the center (Reynolds & Hancock, 2010). The teacher encourages the students to participate in the learning process to try to develop solutions for loosely structured problems. In this method, students reach the necessary information while trying to solve the problem. PBL has been applied in various ways, but Reynold and Hancock (2010) summarized the PBL process by reviewing the literature as below:

- A real-world problem is presented to the students. The students work in groups and analyzed the problem by using their previously acquired knowledge;
- The students determine the issues related to the problem and define the sub-problems.
- The students determine the priority of the issues, organize the issue, and prepare a working plan.
- The students try to solve the problem, explore the previous learning, try to put new ideas to solve the problem
- Students discuss their ideas, solutions, and decide which one is the best solution for the problem.
- Following the PBL process, the students evaluate themselves, their group mates, and the process.

Individuals must learn the basic concepts related to ecology and be aware of ecological problems at an early stage in their lives. Within the scope of this study, the effect of the authentic problem-based learning method which will be used in the 7th grade "Human and Environment Relationships" unit on the students' reflective thinking skill based on problem-solving, environmental knowledge (academic success) and attitude towards the environment. Students need to develop reflection skills for deep and meaningful learning (Xie, Ke, & Sharma, 2008). Reflection is a process of inquiry in which students try to find a solution to a problem. Therefore, it was considered that the process of problem-based learning would develop the students' reflective thinking skills.

In this study, dealing with authentic learning and problem-based learning methods together and also working on environmental subjects displays the difference and importance of this study compared to other studies. In reflective thinking, since the student is allowed to learn through his/her own experiences, he/she is given a chance to be aware of what he/she is doing, think about his/her activities, correct mistakes if there are any, do critical thinking about himself/herself, solve problems and do research to solve problems. Due to these characteristics, it is considered that analyzing the skill of reflective thinking will contribute to the science lessons' learning-teaching process.

The aim of the Study

The study aimed to investigate the effect of authentic PBL activities in the unit of "Human and Environment" on 7th graders' environmental information, their reflective thinking skills, and their environmental attitudes. By this aim, the following research questions were prepared:

- Do authentic problem-based learning activities make significant differences in students' environmental information?
- Do authentic problem-based learning activities make significant differences in students' reflective thinking skills?
- Do authentic problem-based learning activities make significant differences in students' environmental attitudes?

Method

In the study, the effect of authentic PBL activities on 7th-grade students' reflective thinking skills, environmental knowledge, and environmental attitudes was investigated in the context of the "Human and environmental relations" unit in science class.

Samples

The sample of the study consisted of 53 7th grade students from two different classes (Number of students in experimental group 26, number of students in control group is 27) attending Science and Technology Course at a government school in Turkey. The sample was selected by incidental sampling method. The first unit related to the environment in the middle-school science program is the "Human and environmental relations" unit. Therefore, this sample group was used in line with the goals of the study. The study was conducted in the 2015-2016 Academic Year.

Research design

The quasi-experimental research design, which is one of the quantitative research designs, was used in the content of the study. The information about the experimental and control groups, teaching approach and data collection tools are given in Table 1.

Table 1. Research model

Groups	Pre-tests	Method	Post-tests	App. period
Control Group	EKT	Didactic teaching	EKT	6 Weeks
N=27	EAS		EAS	
	RTSS		RTSS	
Experimental	EKT	Authentic PBL	EKT	6 Weeks
Group	EAS		EAS	
N=26	RTSS		RTSS	

Data collection tools were administered as pre-test in the previous week of the application process, and data collection tools were administered as post-test in the following week of the application process. PBL activities continued for four weeks. The process was completed in 6 weeks, included with the pre and posttest applications. In the control group, the teacher followed the activities in the coursebook and used didactic teaching method, in the experimental group, the teacher taught with the PBL method. The application was carried out in the Human and Environmental Relations Unit in the 7th Grade science class curriculum.

Data collection tools

Reflective thinking skills scale

Reflective Thinking Skills Scale was used to identify students' reflective thinking skills level. The scale was developed by Kızılkaya and Aşkar (2009).The items in the scale are related to how the students manage the problem solving process. In the problem solving process, there are items which are related to whether the students are aware of the steps they follow. It was considered that the scale was suitable for observing reflective thinking skills in the problem solving process.The scale was composed of 14 items, and it is a 5 point Likert type scale. The statements in the scale were coded as "Always=5", "Usually=4", "Sometimes=3", "Seldom=2", "Never=1". Kızılkaya and Aşkar (2009) calculated the Cronbach Alpha reliability coefficient of the scale as (Kızılkaya&Aşkar, 2009). The examples of the items are given below:

> When I can't solve a problem, I ask myself questions to understand why I can't solve the problem.

> When I'm solving a problem, I think about the stages I follow and think about why I follow these stages.

Environmental knowledge test

Environmental Knowledge Test (EKT) developed by Bildik (2009) was used to evaluate students' environmental knowledge level. The test was developed by considering the learning gains in the "Human and environmental relations" unit. It consisted of 24 items. Bildik (2009) calculated the Cronbach Alpha Reliability Coefficient of the scale as 0,762; the KR-20 coefficient as 0,761 and the difficulty index of the test as 0,60. The examples of the items are given below:

1. In an ecosystem, when we kill all predators like lion, fox, and eagle, which one of the following results occurs?
      a. People get rid of these predators, wild animals, and feel comfortable.
      b. Other animals living in the ecosystem are not affected by this situation.
      c. No change in the food chain
      d. Deterioration of natural balance in the ecosystem and increase in the number of some animal species

2. If all plant species in the world are destroyed as a result of an environmental disaster, which of the following is not expected?
      a. The increase in the amount of oxygen in the atmosphere
      b. Damage in all ecosystems
      c. The destruction of animals that eat plants
      d. Degradation of ecological balance

Environmental attitude scale

Environmental Attitude Scale (EAS) developed by Bildik (2009) was used to evaluate students' attitudes towards the environment.The items in the scale aim at identifying the students' attitudes towards environmental problems. The scale was chosen with the view that it is suitable for the purpose of the study. The scale consisted of 20 items, 10 of which are positive, and ten are negative. It was a 3-point Likert type scale, and the positive statements were coded as "Agree=3", "undecided=2," and "disagree=1". Negative statements were coded in reverse. The Cronbach Alpha reliability of the scale was 0,718. The examples of the items were given below:

      1) I feel safe when our country signs agreements to protect the environment.
      11) The balance of nature is very sensitive and can be easily broken, so I need to take various precautions to protect the environment.

The process

Before the application, data collection tools (RTSS, EKT, and EAS) were administered to the students as pre-test. The students who participated in the study were attending two different classes. One of the classes was attended as experimental group, and the other one was attended as control group randomly. The same teacher taught both of the groups to prevent the possible effect of the teacher on the groups.The teacher has 5 years of experience.

The teaching process in the control group

The teacher taught through the didactic teaching method considering the activities given in the textbook. The applications were carried out within four weeks as 4 lesson hours per week. In the applications carried out in the control group, the science education program was taken as the basis. Therefore, the students used only the textbook. The activities in the mentioned source and suggested activities were carried out and the evaluation questions and exercises were completed. The teacher started each lesson by giving a summary of the previous lesson. The teacher asked the students to take notes when it was necessary. The teacher explained the subjects in the textbook and did the exercises at the end of the subjects together with the students. In this process, the teacher played a more active role and taught the lesson using question-answer and discussion techniques.

The teaching process in the experimental group

Preparing authentic problem scenarios

The PBL activities were carried out in the Human and Environmental Relations Unit in the 7th Grade science class curriculum. In the unit mentioned, it was targeted for the students to explain the ecosystem and the related concepts, question the reasons and consequences of environmental problems, acquire knowledge and skills about bio-diversity, extinct beings, and beings under the threat of extinction and what needs to be done to protect these species. A total of 5 authentic problem scenarios were prepared related to the "Human and Environmental Relations" unit to be used in PBL. In this respect, it was aimed to reach the subjects and concepts given in Table 2 in the study.

Table 2.Authentic problem scenarios and related concepts

The title of the scenario	Related concepts
Report Card Gift (Pilot study)	Ecosystem, Habitat, Population, Species
Salep (Anatolian Orchid)	Biodiversity, Local and global environmental problems, Endangered species, Overhunting, Conservation of species
Museum visit	Biodiversity, Local and global environmental problems, Extinct species, Conservation of species
Which decision is better for us?	Biodiversity, Local and global environmental problems, Conservation of species
The Massacre of Nature: Look at the garbage in the stomachs of the dying albatrosses!	Biodiversity, Local and global environmental problems, Endangered species, Conservation of species

When Table 2 was analyzed, it was seen that each scenario is related to more than one concept. Each scenario is related to more than one subject and the concept is due to these problems being authentic. Because in authentic learning, learning must take place through problems that mostly display correlations and are in complex contexts. The information which will be acq1uired through an authentic problem must be able to carry real-life complexity. In the preparation of the scenario texts, the researchers used the textbook, supplementary sources, scientific publications, and current events. In this process, the views of two science teachers, one science education associate professor and a chemistry education professor were made use of, the necessary corrections were made and the final version was achieved for the authentic problem scenarios. The scenarios consist of problems that the students are familiar with in daily life, situations that attract their interest and attention and related to social problems. In the preparation of the selected problem situations, a path towards pieces to the whole was followed and these were expressed in an open and simple language that the students can easily understand. Under the scenarios, a few questions which helped the students find the problem were included and it was aimed for the students to find the details about the identification and solution of the problems on their own.

One of these scenarios titled "Salep (Anatolian Orchid)" is given below. The city of Kahramanmaraş, where the study was carried out, is famous for its ice-cream. This type of ice-cream produced in Kahramanmaraş is called Maraş ice-cream in Turkey. In the production of Maraş ice-cream, the root of the salep plant which is a type of orchid, is used. After the roots of the salep plant whose pictures are given below are processed, they are used to give taste and consistency to the ice-cream. The salep plant grew naturally in the mountains and picked up in the mountains. It is a plant the students are familiar with and ice-cream production is important for the city's economy. Also, salep is a plant species whose numbers are decreasing due to not being grown in culture environments and the increasing ice-cream production. This plant is authentic and directly related to the daily lives of the students, the subject being interesting and the extinction of various orchid types were the reasons why it was selected as the subject of the scenario. The example scenario titled "Salep" and the learning gains related to the scenario are given in Appendix 1.

PBL activity

After the pre-tests were done, a pre-study consisting of 4 lesson hours was carried out to give information about the method to be used with the experiment group students. In this study, five groups consisting of 5-6 students and have different characteristics in terms of learning levels were formed which were heterogeneous within themselves and homogeneous between the groups. An example scenario was studied with the groups and the students were given information about how the lessons were to be taught. Information related to the steps of solving the current problem, selection of sources to be made use of, doing research, preparing reports, teamwork, etc. were given through the scenario. The sitting places of the groups in the experiment group were determined and each group was asked to select a president, clerk and speaker and to find a name for the group. In the experiment group, the lessons were taught in the following manner using the authentic PBL method:

- For each séance, a different authentic problem scenario was prepared, and the students were asked to read these at the beginning of each séance. Also, a few questions were added under the scenarios to help the students find the problem and it was aimed for the students to find the details about the identification and solution of the problem and the sub-problems themselves through these questions.
- The students who were separated into small groups consisting of 5-6 people in the first lesson hour were given some time to identify the problem or problems in the scenarios, to discuss these in their groups and to exchange ideas.
- After the given time was over, the groups announced their ideas, and as a result of the discussions both within the groups and between the groups, the problems in the scenarios were identified. Then, the students seeking for the answers to the following questions:
  What do I know about the problems?
  What are my guesses about the problems?
  What do I need to research on?
  What have I learned?
- To identify the current knowledge of the students, they were asked to find the answer to the question "What do I know?" related to the problem and the situation indicated in the scenario. Thus, the students listed their guesses under the "What are my guesses?" title.
- In the following lesson hour, the students were asked what information they need to solve the problem and they were expected to form sub-problems about the problem they identified. Therefore, the students tried to find the answer to the question, "What do I need to research on?" They were asked to research with their group members on the problem, sub-problem and the subjects. In this process, the students made use of different supplementary sources. In this step, the students were able to bring supplementary sources to class and they were allowed to research on the Internet through the interactive board as well.
- The students were asked to find solutions to the problem in the light of the research they carried out on the sub-problem and subjects which they identified through group discussion.
- The students obtained the materials they needed until the next lesson, shared the information they prepared by getting together before the lesson and then wrote reports or created a product related to the solution to the problem. They presented their reports and products to their classmates for 5 minutes each. They were asked to have discussions with each other within the class environments and it was made possible for them to share suggestions for a solution which they identified for the solution of the problem among the groups.
- The assisting questions in the scenarios were asked a final time to the students and each question was answered through the discussion of the whole class. The erroneous or incomplete parts in the reports were observed during the presentations and corrected. Therefore, the subject was summarized and the problem was solved under the guidance of the researcher.
- At the end of the lesson, the students filled out the "peer evaluation form" and "self-evaluation form" to evaluate themselves, the method, their friends and teamwork. Also, in the 2nd and 4th weeks of the application, student exercise pages were given to consolidating their knowledge and for the students to review what they have learned. A sample of the exercise pages is given in Appendix 1. The authentic problem scenario which included the gains of the following weeks were distributed to the students in a written form and the necessary explanations were given. In the application, the same method was followed for the other problem situations.

In the PBL method, since the students reach information by doing research, questioning, and having discussions among themselves, they take responsibility for their own learning. In this process, the guidance of the teacher for the students is helpful in terms of having students reach information and learning to take place. Therefore, the researcher guided the students by asking questions during the experimental activity, tried to prevent students from getting off the track by interfering when necessary and guided them to make up their deficiencies. The lesson plan used in the experiment group is given below. A few photos from the PBL activity are given in Appendix 3.

Findings

The data, obtained from the pre-post test results of the experimental and control group were analyzed, and the following findings were obtained. The quantitative data obtained within the scope of the study showed normal distribution, and the required statistical analyses were made accordingly. The students who participated in the study were attending two different classes. One of the classes called Group 1 and the other one was called Group 2 at the beginning of the study. The data collection tools (EKT, EAS, and RTSS) were administered to

the students of Group 1 and Group 2 as pre-test before the application. The pre-test scores of Group 1 and Group 2 students were compared with the help of independent samples t-test to determine whether there was a difference between pre-test scores of the groups. The findings of the independent samples t-test were displayed in Table 3.

Table 3. Comparison of the pre-test scores of the groups with independent samples t-test

Tool	Groups	N	$\bar{X}$	SD	df	t	p
EKT Pre-test	Group 1	26	12,08	3,38	51	0,223	0,824
	Group 2	27	11,85	3,91			
EAS Pre-test	Group 1	26	50,85	3,90	51	1,913	0,061
	Group 2	27	48,52	4,87			
RTSS Pre-test	Group 1	26	54,38	9,03	51	1,540	0,130
	Group 2	27	50,56	9,06			

The findings displayed that there was no significant difference between the pre-test EKT scores of Group 1 and Group 2 students (t=0,223; p=0,824>0,05); there was no significant difference between the pre-test EAS scores of Group 1 and Group 2 students (t=1,913; p=0,061>0,05); there was no significant difference between the pre-test RTSS scores of Group 1 and Group 2 students (t=1,540; p=0,130>0,05). The comparison of the pre-test scores displayed that the groups displayed similar characteristics, and Group 1 was attended as experimental group, and the Group 2 was attended as control group randomly. Paired samples t-test was carried out to identify whether there were significant differences among EKT, EAS, and RTSS pre and post-test scores of the experimental group and the findings are presented in Table 4.

Table 4.Comparison of the pre and post-test scores of the experimental group

Tool	N	$\bar{X}$	SD	df	t	p
EKT Pre-test	26	12,08	0,66	25	-8,728	0,000
EKT Post-test	26	17,27	0,89			
EAS Pre-test	26	50,85	0,76	25	-2,560	0,017
EAS Post-test	26	53,23	0,71			
RTSS Pre-test	26	54,38	1,77	25	-,293	0,772
RTSS Post-test	26	54,69	2,01			

Table 4 displays that there is a significant difference between the EKT pre-test and post-test mean scores of the experiment group in favor of the post-test (t(25)= -8,728,p= 0,000 < 0,05). This result reveals that in the experimental group, authentic PBL had a significant effect on students' academic achievement. Paired sample t-test results displayed that there is a significant difference between the EAS pre-test and post-test mean scores of the experimental group in favor of the post-test (t(25)= -2,560, p= 0,017 < 0,05). This result reveals that in the experimental group, authentic PBL had a significant effect on students' environmental attitudes. The results displayed that there is no significant difference between the RTSS pre-test and post-test mean scores of the experimental group following the PBL (t(25)= -0,293, p= 0,772 > 0,05). This result displays that in the experimental group, the authentic PBL activities had no significant effect on students' reflective thinking skills. Paired samples t-test was carried out to identify whether there were significant differences among EKT, EAS, and RTSS pre and post-test scores of the control group and the findings are presented in Table 5.

Table 5. Comparison of the pre and post-test scores of the control group

Tool	N	$\bar{X}$	SD	df	t	p
EKT Pre-test	27	11,85	0,75	26	-3,228	0,003
EKT Post-test	27	14,07	0,89			
EAS Pre-test	27	48,52	0,94	26	-1,599	0,122
EAS Post-test	27	50,11	1,26			
RTSS Pre-test	27	50,56	1,74	26	-1,354	0,187
RTSS Post-test	27	52,00	1,68			

Table 5 displays that there is a significant difference between the EKT pre-test and post-test mean scores of the control group in favor of the post-test (t(26)= -3,228, p= 0,003 < 0,05). This finding displays that the didactic teaching method had a significant effect on students' learning in the control group. Paired sample t-test results displayed that there is no significant difference between the EAS pre-test and post-test mean scores of the control group (t (26) = -1,599, p= 0,122 > 0, 05). This result reveals that the didactic teaching method had no significant effect on students' environmental attitudes in the control group.

The results displayed that there is no significant difference between the RTSS pre-test and post-test mean scores of the control group following the PBL (t(26)= -1,354, p= 0,187 > 0,05). This result reveals that the didactic teaching method had no significant effect on students' reflective thinking skills in the control group. EKT, EAS, and RTSS post-test scores of the experimental and control group students were compared by using independent samples t-test, and the findings are displayed in Table 6.

Table 6. Comparison of the post-test scores of the experimental and control group

Tool	Groups	N	$\bar{X}$	SD	df	t	p
EKT Post-test	Experiment Group	26	17,27	4,52	51	2,545	0,014
	Control Group	27	14,07	4,62			
EAS Post-test	Experiment Group	26	53,23	3,61	51	2,156	0,037
	Control Group	27	50,11	6,55			
RTSS Post-test	Experiment Group	26	54,69	10,24	51	1,029	0,309
	Control Group	27	52,00	8,72			

Independent samples t-test results displayed that post-test EKT scores of the experimental group (M=17,27) was higher than those of the control group (M=14,07) and the difference was significant (t(51)= 2,545, p= 0,014 < 0,05). This result reveals that authentic PBL activities were more effective on students' academic achievement than traditional teaching. Similarly, post-test EAS scores of the experimental group (M=53,23) were higher than those of the control group (M=50,11) and the difference is significant (t(51)= 2,156, p= 0,037 < 0,05). This result revealed that authentic PBL activities were more effective on students' environmental attitudes than traditional teaching. No meaningful differences were detected between post-test RTSS scores of the experimental group (M=54,69) and the post-test RTSS scores of the control group (M=52,00) (t(51)= 1,029, p= 0,309 > 0,05).This result displays that the authentic PBL and the didactic teaching method had similar effects on students' reflective thinking skills. Covariance analysis (ANCOVA) was implemented on data to determine whether statistically meaningful differences existed between experimental and control groups' post-test EKT scores when pre-test EKT, EAS, and RTSS scores were controlled. The findings are presented in Table 7.

Table 7. ANCOVA analysis results when pre-test scores are controlled*

Source of Data	$\bar{X}$	df	F	p
Model	186,107	3	14,207	0,000
EKTpretest**	341,510	1	32,280	0,000
EASpretest**	42,670	1	4,033	0,050
RTSSpretest**	2,783	1	0,263	0,610
group	75,050	1	7,094	0,010
ERROR	10,580	48		
Total	14167,000	53		

*R^2= 0,577; **Controlled variables

According to Table 7, the implemented model is meaningful (for the model p= 0,000 < 0, 05). The model explains 58 % of the academic achievement in the "Human and Environmental relations Unit (R^2= 0,577). The results of the ANCOVA analysis display that the PBL had a meaningful effect on the experimental group students' academic achievement when pre-test scores were controlled.

Results and Discussion

In the content of the study, data collection tools (EKT, EAS, and RTSS) were administered to the student groups as pre-test before the study. The pre-test scores of the groups were compared by using independent samples t-test. When the pre-test scores of the groups were analyzed, it was seen that the EAS pre-test average of group 1 was 50,85, while the EAS pre-test average of group 2 was 48,52. In addition, the RTSS pre-test average of the experimental group was 54,58, while RTSS pre-test average of group 2 was 50,56. When the averages were analyzed, although it was seen that the averages of both tests were higher in group 1, the results of the independent samples t-test showed that the difference is not statistically significant.The findings displayed that there was no significant difference between the pre-test scores of the EKT, EAS, and RTSS. The comparison of the pre-test scores displayed that the groups displayed similar characteristics and one of the groups was attended as experimental group, and the other one was attended as control group randomly. The experimental group was taught through the PBL, and the control group was taught through didactic teaching method.

Following the application, data collection tools were administered to the groups as post-test. The pre-test and post-test scores of each group were compared by implementing paired samples t-test. The paired sample t-test results displayed that there was a significant difference between the EKT post-test scores of the experimental group in favor of the post-test. Similarly, the paired samples t-test results displayed that there was a significant difference between the EKT post-test scores of the control group in favor of the post-test. Independent samples t-test was carried out to determine whether there was a significant difference between post-test scores of the experimental and control group. The results displayed that there was a significant difference between EKT post-test scores of the experimental and control group in favor of the experimental group. This finding revealed that authentic PBL activities had a significant effect on students' academic achievement when compared with the didactic teaching method.

Additionally, the results of the ANCOVA analysis display that the PBL had a meaningful effect on the experimental group students' academic achievement when pre-test scores were controlled and explained 58 % of the students' achievement in the "Human and Environmental relations Unit. Findings showed that PBL activities using authentic problems were more effective in increasing students' environmental knowledge compared to the traditional method. When the studies in the literature are analyzed, it can be seen that the findings in both studies which make use of the problem-based learning method and authentic learning support the finding that PBL increases the academic success of the students (McParland, Noble, & Livingston, 2004; Kelly & Finlayson, 2009; Wong & Day,2009; Reynolds & Hancock, 2010; Dochy, Segers, Van Der Bossche, &Gijbel, 2003; Albanese & Mitchell, 1993; Vernon & Blake, 1993).

In PBL, students deal with real-life problems. The real-life problems are worthy of solving and interesting and the students' attendance and learning increase in the activity. In PBL, a scenario that is related to a real-life situation is one of the most important components of the method. This scenario provides a meaningful context for the concepts (Dahlgren &Öberg, 2001). Since the scenarios make students focus on their learning process, designing the scenarios is very important (Boudand&Feletti, 1991). The problem scenarios are considered to be effective in the increase of students' learning about the subject.

Similarly, McGibbon and Van Belle (2015) stated that real-life problems enhance students' awareness and increase their participation. In PBL, students try to find solutions for a real-world problem, need collaboration and work in teams (Brundiers&Wiek, 2015). The problems are complex, systemic and cannot be solved easily (Wiek, Ness, Schweizer-Ries, Brand, &Farioli, 2012). In a PBL environment, students direct their learning while trying to solve the problems (Smith, 1995; Hungerford & Volk, 2003). Directing their learning supports the development of students' abilities and provides meaningful learning. Since the real-world problems in PBL are complex and multidimensional, students need to work in teams collaboratively (Stauffacher, Walter, Lang, Wiek, &Scholz, 2006). This situation supports not only the learning of students but also the development of various social skills.

Therefore, the researchers paid attention; that the scenarios used in the study carried a local quality. The events in the scenarios were directly related to the daily lives of the students, and they increased their interest in the problems and their willingness to find solutions. The use of authentic problem scenarios that reflect real-life or taken from real life, the problems in these scenarios having sub-problems and increasingly becoming interesting increased the interest of the students on the subject as well. Also, the students working together and sharing tasks and information in the PBL activities carried out in cooperative activities and being responsible for their learning and their friends' learning is another reason which positively affects the increase in their academic success. The students doing individual research and acquiring wide-scale information by interacting with more than one source to solve the authentic problems can be shown as a reason for the increase in their academic success.

The studies in the literature, in particular, show the efficiency of PBL in education related to environmental issues. For example, Haney, Wang, Keil, and Zoffel (2007) examined teachers' beliefs and practices in a problem-based learning curriculum that focuses on environmental health issues. The results displayed that PBL was an effective method in environmental education. Haney et al. (2007) stated that an integrated EE curriculum increased students' achievement compared with a traditional curriculum. In another study, Keil, Haney, and Zoffel (2009) stated that the proficiency and performance scores increased through using an integrative problem-based environmental health science curriculum. Kwan and So (2008) investigated the environmental learning of students through a PBL program, and the findings revealed that students acquired more in-depth knowledge and developed their critical thinking and problem-solving skills. Due to the complex and multidimensional nature of environmental problems, traditional didactic teaching methods are not sufficient

while teaching these issues (Ashford, 2004). Therefore, as the findings of this study displayed, PBL is one of the effective methods that can be used in environmental education.

Following the application, EAS pre-test and post-test scores of the experimental group were compared by implementing paired samples t-test. The results displayed that there was a significant difference in favor of the post-test. EAS pre-test and post-test scores of the control group were compared by implementing paired samples t-test. The results displayed that there was no significant difference between the pre-test and post-test scores. When the EAS post-test scores of the experimental group and the control group by implementing independent samples t-test, the results displayed that there was a significant difference in favor of the post-test scores of the experimental group. This finding shows that authentic PBL activities had a significant effect on students' environmental attitudes. Similar findings were stated in various studies (Mittelstaedt, Sanker, &VanderVeer, 1999; Waliczek&Zajicek, 1999;Palmberg& Kuru, 2000; Kadji-Beltran, Barker, &Rager, 2001; Bögeholz, 2002; Korhonen&Lappalainen, 2004;Kaplowitz& Levine,2005; Bolin,Khramtsova, &Saarnio, 2005; DiEnno& Hilton, 2005; Carrier, 2009;Ajiboye&Olatundun, 2010; Zembat, 2013; Reynolds & Hancock, 2010).The efficiency of authentic PBL activities in terms of increasing their attitude and awareness towards the environments can be explained by reasons such as the students being busy with authentic problems related to the environment, researching groups in the stage related to solving the authentic problems and their interest and sensitivity increasing due to the increase in their knowledge about the environment as a result of these researches. The problem scenarios being directly related to the lives of the students (for example, Salep-Anatolian Orchid) resulted in students realizing that the current problems might directly affect their own lives. In this respect, environmental problems have become a phenomenon that is not outside of their environment and lives but a phenomenon that directly and negatively affects their lives. It is considered that this increases the students' attitude towards the environment. In the present time, environmental problems have reached a dimensions which cannot be ignored and have gradually become complex. There is no single solution method for these problems. To solve the mentioned problems, individuals need to think, question and do research. Individuals who are faced with numerous news and information each day on the media need to have certain skills to be able to understand this news and distinguish right information from the erroneous ones. The purpose of environmental education is to help students acquire knowledge about the environment and develop their awareness of the environment. The findings of this study and the findings of the other studies indicated above showed that PBL application is an effective method in terms of increasing students' knowledge and awareness about the environment. Therefore, PBL is a method which can be used in environmental education.

Paired sample t-test was carried out to identify whether there was a significant difference between RTSS pre-test and post-test scores of the experimental group. The results displayed that there was no significant difference between RTSS pre and post-test scores of the experimental group. Similarly, when the RTSS pre-test and post-test scores of the control group were compared, the results displayed that there was no significant difference between the pre and post-test scores. When the RTSS post-test scores of the experimental and control group were compared, the results displayed that there was no significant difference between the post-test scores of the groups. However, Preus (2012) in his study, showed that authentic learning activities increase the skills of reflective thinking. This study was carried out in a total of 6 weeks in which pre and posttest applications were done. The PBL application lasted for four weeks. This period may not be sufficient for the development of the students' reflective thinking skills for problem-solving. Another reason is considered to be the young age of the students. Also, since the students met the authentic problem-based learning method for the first time, they may need more time to get used to the method. It is considered that with the process of getting used to the method, the students' giving their interest and attention to the applied method gets ahead of their reflective thinking and therefore, the method is not effective on the skill of reflective thinking.

Conclusion and suggestions

The findings of the study showed that authentic PBL application is an effective method in increasing the students' knowledge of the environment and developing positive attitudes towards the environment. Certain suggestions can be made to make the application more effective. The most important material of learning activities based on authentic problems is the problem scenarios prepared concerning the subject. The problem scenarios should be prepared taking the gains of the unit into consideration, be interesting and taken from real life or be possible to associate them with real life. A pre-study can be carried out and visual materials can be used in the presentation of the scenarios to make them more interesting. When PBL science education subjects are taken into consideration, it can be used in teaching all kinds of subjects, because all science related subjects have a place in daily life. However, the preparation of problem scenarios suitable for each subject can be compelling for teachers. While the teacher prepares problem scenarios suitable for a given subject, he/she can

use news on the media for inspiration, as well as his/her own creativity. Therefore, the preparation stage can be time consuming and difficult for the teachers compared to the traditional method.

One of the most important problems which can be faced with during PBL application is time limitation. The application of learning activities based on authentic problems is a method that requires more time compared to the traditional method. Since the application requires research to be done both in and out of the classroom, time management is extremely important. The teacher needs to plan and manage the process in a very good manner. In this process, problems can be solved with the teacher being familiar with the method and being experienced in the application of the method. The teachers who will be applying the method for the first time can face these mentioned problems in the beginning. In limited class lessons, the planning before the application needs to the done in a very careful manner to use the method productively. Therefore, pilot applications will be beneficial in terms of the identification of the application time and considering possible problems that may take place. Arranging the class in which the learning activities based on authentic problems suitable for group work, the materials to be used in the experiments and activities being easily accessible will make the method more productive. Continuous control and giving feedback during teaching through learning activities based on authentic problems is important for the process to continue productively. Therefore, it is suitable to work in only a few and small groups to increase interest and participation. In this sense, classes that are not too crowded will be more suitable for the use of this method. In teaching applications through learning activities based on authentic problems, the teacher should be competent in using the method. The teacher should create a democratic atmosphere in the class and should give importance to the views of the students on the method, encourage them and keep their motivation high and should guide the students as an expert when necessary. Learning activities based on authentic problems is an approach that aims at learning the subjects in-depth. Therefore, teachers can carry out these applications on subjects and concepts for which students are expected to learn in-depth, can come face to face within real life and wished to create awareness. Therefore, the use of the learning method based on problems in environmental subjects will be extremely suitable.

The habits of students as much as the habits of teachers can make the PBL process difficult. It can be difficult for the students who get used to the learning environmentsin which they are passive,to get used to PBL applications which require them to be active. Therefore, the teacher needs to inform students about the process and their expectations from them. When students know about the application steps and what is expected of them, it will be easier to carry out the PBL application. As a result, the possible problems to be faced during the PBL application can be overcome with the motivation of teachers. It is the teacher who will make the process easier and interesting for students. During the application process, students will become familiar with the process by time, and the problems which can be faced in the application will be reduced to the minimum.

Notes

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Appendix 1: Problem Scenario

Learning gains
1. Questions the importance of bio-diversity for natural life.
2. Discusses the factors which threaten bio-diversity based on research data and produces suggestions for solution.
3. Does research on plant and animal species which are extinct or under the threat of extinction in our country and in the world and gives examples.

Scenario

You graduated from the university as a food engineer. You hear that a food engineer will be hired by a new ice-cream factory in Kahramanmaraş. When you go there to apply for the job, the person in charge tells you that there are many applications for the position and that you need to write a report in which certain criteria should be given place to in order to be able to hire the best food engineer for the factory. He indicates that the food engineer who prepares the best report will be hired. The following criteria are needed:
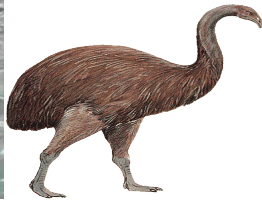1) How is salep which is used in ice-cream production obtained?
2) Where should salep be obtained from for the ice-cream not to lose its Maraş ice-cream quality?
3) What needs to be done to find large amounts of salep every time it is required?

Appendix 2: Student worksheet
1. Below, photos of some species are presented. Decide whether the photo belongs to a species which is under the danger of extinction or became extinct.

MediterraneansealMoaLykia Orchid   Dinosaur

…………………………………. …………………………………. ………………………………….
………………………………….

    Bald Ibis   CarettaCarettaMammothGalanthus

…………………………………. …………………………………. ………………………………….
………………………………….

2. Consider the following sentences as true (T) or false (F).
   ( ) The diversity and number of living species in a region express the biodiversity in that region.
   ( ) The biodiversity of our country is very poor.
   ( ) Biodiversity is used in the field of agriculture, medicine, pharmacy, forestry, fishing, breeding, and industry.
   ( ) The biodiversity of the desert ecosystem is richer than the biodiversity of the marine ecosystem.
   ( ) Deterioration of ecosystems does not affect biodiversity.
   ( ) The richness of a country's biodiversity supports the economic and cultural development of that country.
   ( ) Both human-induced factors and natural factors are effective in the deterioration of ecosystems.
3. Please match the statements given below.

Environmental problem	Related Event
( )Air pollution	a. Polluting the environment by radioactive substances.
( )Snow slide	b. Increasing toxic gases in the air.
( )Forest destruction	c. Combining toxic gases with rain.
( )Nuclear pollution	d. The sliding of a large mass of snow down the side of a mountain or cliff.
( )Soil pollution	e. Increasing waste in the soil.
( )Acid rain	f. Air polluting gases cause the world to overheat.
( )Ozone layer depletion	g. Increasing waste in the water.
( )Greenhouse effect	h. Exposure to the harmful effects of the sun.
( )Water pollution	ı. Reducing the number of plants and animals.

4. Please give five examples for the species which threatened with extinction in our country and the world (Plants/animals).
5. To prevent environmental problems, please write down your suggestions.

Appendix 3: Students'photos in PBL activities