The impact of project-based learning environments on conceptual understanding: The "Recycling" concept

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Abstract

The aim of this study was to investigate the effect of project based learning environments on 4th class students' conceptual understanding of recycling. The case study method was used in this study. The effects of project-supported learning environments on students' conceptual understanding were investigated. The sample

group of the study consisted of 18 [10 girls and 8 boys, mean age: 10.78)] grade 4 students in a primary school in Trabzon, Turkey. One voluntary teacher from the same school participated in the research. A conceptual understanding test including 2 open ended questions and semi structured interviews was used in the data collection process. Interviews were conducted to investigate the effectiveness of project based learning environments on the conceptual understanding of students. Semi structured interviews including two questions were carried out. Students were divided into 4 groups at the beginning of the study. Each group developed its own project related to "recycling". The semi structured interview was conducted with 8 voluntary students. The students' conceptual understanding was presented in detail with semi structured interviews. It was seen that seven students' described "recycling" associating with the "papers' missing" in the pre-interview. At the end of the study; it was found that the project based learning environment had a positive effect on 4th grade students' conceptual understanding of recycling ($t= -8,695$, $p<0.05$).

Keywords: Recycling concept, conceptual understanding, case study

Introduction

How much plastic waste is released into the environment each day? How do these wastes dissolve in the environment? What is the impact of such rapid consumption of resources on nature? How many plastic or glass bottles etc. finds their way to the garbage on an average day? Will our planet be able to cope with such a careless level of consumption of energy resources? Will our resources run out some day? Questions of these sorts are products of the damage ever growing human population inflicts on the environment. Humanity's uninhibited use of natural resources is bound to cause problems for future generations. The countries all around the world are trying to come up with collaborative solutions to cope with this problem. One such solution is through the concept of "sustainable development". Sustainable development came to the forefront of the global agenda in response to the report by the World Commission on Environment and Development called the Brundtland Commission, published in 1987. Sustainable development refers to a program to ensure that natural resources are utilized to meet the requirements of future generations without actually destroying the resources (Brundtland Report, 1987; Littledyke & Manolas, 2010). In order to draw sufficient attention to sustainable development, the United Nations

proclaimed the period 2005-2014 as the "Decade of Education for Sustainable Development". The main vision of that decade-long plan is to build a world allowing all to learn the values, behavior, and life style required for a sustainable future and social transformation (UNESCO, 2007). Education constitutes the foundation of sustainable development. The basic vision of the curriculum in Turkey, updated in 2013, also emphasizes sustainable development. The programs underline the issues and concepts concerning environmental education with respect to the achievement of sustainable development. One such concept is recycling.

Recycling, in this context, constitutes a crucial part of sustainable development (Hopper & Nielsen, 1991; Oskamp, 1995; Valle, Reis, Menezes & Rebelo, 2004; Graedel, Allwood, Birat, Buchert, Hagelüken, Reck, Sibley & Sonnemann, 2011; Eser, Çelik, Çay & Akgümüş, 2016). The rapid growth of world population leads to a state of affairs where the collection and storage of waste poses a true problem. Every passing day necessitates new sites of waste storage. That is why from 80s on in particular, recycling became a part of our lives. Recycling refers to the physical or chemical processing of solid waste, enabling the use of the materials as raw materials for a second time (Çimen & Yılmaz, 2012). As the existing raw materials in nature become rarer and rarer, an awareness of gradual exhaustion of most resources arisesthe need to make optimal use of raw materials and resources clear (Yaptık & Aydın, 1991). The advent of recycling helped ease the strain on waste storage, as well as enabling savings on the use of raw materials and natural resources. Recycling is crucial in terms of sorting the waste at source, and hence reducing the volume of trash and the level of environmental impact (UNESCO, 1992). Recycling can help prevent pollution and ignorant destruction of natural resources (Spiegelman & Sheehan, 2004). Schools, in turn, play crucial roles in ensuring that students understand the concept of recycling (Connor, 1989). Thanks to their education, students would understand what recycling is, and which materials can be gained through recycling. Indeed Gamba & Oskamp (1994) note the ignorance of people with respect to the concept of recycling, as one of the obstacles to effective recycling. In this perspective, schools have very important duties in developing an awareness of the concept of recycling.

The concept of recycling appears first in 4th grade, under the titles "Living things and life" and "Human and environment relation". In this grade students design a project to protect and enhance the environment.Further grades also discuss this

concept with a view to helping contribute to the development of the awareness of recycling. Yet, the level of emphasis on the concept of recycling in Turkish education programs is deemed to be insufficient (Çelik, 2011). Çelik (2011) investigated the recycling practices at selected primary schools in a number of districts at various levels of socioeconomic development, through a detailed analysis of education activities regarding the recycling of packaging waste, as provided in primary school curricula. A total of 944 students from the 3rd, 4th and 5th grades in the Istanbul province took part in the study. That study reached the conclusion that the information regarding the recycling of packaging waste constituted only an insufficient part of the curriculum, and the information provided did not have the continuity required. The programs' shortcomings regarding information on recycling, and the limited nature of the information the students have on this issue, underlines once more the need for the present study. A glance at the studies on the concept of recycling reveals that such studies more often than not try to establish the prevailing attitudes (Harman, Aksan & Çelikler, 2015; Kışoğlu & Yıldırım, 2015; Kok & Siero, 1985; McCarthy & Shrum 1994; Oskamp, Harrington, Edwards, Sherwood, Okuda, & Swanson, 1991; Yaşar, İnal Kaya & Uyanık, 2012) views and the level of awareness (Cici, Şahin, Şeker, Görgen & Deniz, 2005; Çimen & Yılmaz, 2012; Karatekin, 2014; Kok & Siero, 1985; Yaşar, İnal, Kaya & Uyanık, 2012). An in-depth look into the studies carried out with respect to the concept of recycling (Yaşar et al. 2012; Çimen & Yılmaz 2012) reveals that the applied studies on the teaching of the concept of recycling at the primary school level were rare. In this context, the need for experimental studies to contribute to a better understanding of the concept of recycling on part of the students is certain. Şallı, Dağal, Küçükoğlu, Niran & Tezcan (2013) carried out a study with 60-72 months old children, to investigate the effectiveness of the recycling program implemented on the basis of the project-based learning perspective with family participation. The study had both experiment and control groups, and found that, in comparison to the control group, the students in the experiment group who were subjected to the project-based learning perspective with family participation had covered more ground in terms of student development.

There are also projects supported by the Ministry of Education, albeit in limited numbers, on the recycling of valuable waste. "Recycling for the Future Project", "Recycling Project for Books Provided Free of Charge", "Harmony with the Environment Project", "Small Things Help Replenish the Nature Environment

Education Project" are but a few of such projects (Çelik, 2011). The inclusion, of projects to help students perceive what the concept of recycling means in the learning environment, would help in increasing the level of awareness of the students.

Project-based learning is a method where the student is the active party in terms of helping students gain information, skills, attitudes, values and scientific concepts, and enabling them to seek solutions to real-life problems (Krajcik, Czerniak & Berger, 1999). The project-method provides the students with the opportunity to make applied use of their knowledge and skills (Korkmaz & Kaptan, 2001). Project activities allow students to establish the causal relationships between the knowledge gained in the classes and real life problems (Blumenfeld et al., 1991; Bransford, Brown & Cocking, 2000). Projects contribute to the development of a creative classroom environment for students (Shearer & Quinn, 1996). Projects developed in project-based learning environments enable students to learn through experience, and hence to achieve lasting learning by having fun at the same time (Winn, 1997). In project-based learning environments, the students achieve in-depth learning of the information presented, and have more success in adapting the knowledge to new cases they may come across later (Solomon, 2003). Project-based learning environments help reinforce the students' feelings of responsibility towards their physical and social environment (Dori & Tal, 2000). A glance at the existing literature reveals a number of studies to understand the impact of project-based learning environments on the learning levels of the students, through the process from primary school to university (Ayan, 2012; Barak & Dori, 2004; Bayram & Seloni, 2014; Çalıker & Balım, 2012; Krajcik, Blumenfeld, Marx & Soloway, 1994). The literature, however, lacks case studies supported by project-based learning environments at the primary school level, with respect to the concept of recycling, therefore underlining the need for such studies.

The Aim of the Study

The aim of the study is to investigate the impact of project-based learning environments on the conceptual understanding of 4th grade primary school students, regarding the concept of recycling. The following research questions guide this study:

1. What is the impact of project-based learning environments on the conceptual understanding of the 4th grade primary school students regarding the concept of recycling?
2. What is the opinion of the 4th grade primary school students on the concept of recycling?

Method

The case study method was used in this study. The case study method enables a researcher to closely examine the data within a specific context. The case study method investigate contemporary real-life phenomenon of a limited number of events or conditions, and their relationships (Yin, 1984). In this study, the effects of project-supported learning environments on students' conceptual understanding were investigated. Within the context of the case study method, the development of each student was examined individually.

Sample

The sample group for the research consists of 4th grade primary school students. A total of 18 students from a class with 18 students [10 girls and 8 boys, mean age: 10.78)] participated in the research. One voluntary teacher from the same school participated in the research. The teacher graduated as a primary school teacher from university. The teacher had eleven years' experience. The teacher was provided with information by the researchers with the aid of the intervention process, before the intervention.

Data Collection

A concept test and an interview consisting of semi-structured questions have been used in this research. The concept test included two open-ended questions. These questions are; "How would you describe recycling? Please explain." and "What do you understand by the concept of recycling? Please show by drawing." Drawing is a technique which ensure the discovery of dimensions which cannot be discovered with open-ended and other understanding research techniques (White & Gunstone, 1992). Drawings are very valuable as they provide more detailed information beyond words (Bahar, Ozel, Prokop & Uşak, 2008).

The interviews were conducted to investigate the effectiveness of project based learning environments on the conceptual understanding of students. The semi structured interviews included two questions. These questions are; "How would you describe recycling? Please explain." and " Which substances may be recycled? Please explain." Individual interviews were used in this study and the interviews were conducted by the researchers. Two students selected from each project group participated in the interview. There were 4 different groups in the study.Preliminary and final interviews were conducted with 8 of the students ((S1, S2, S4, S5, S6, S15, S16, and S18). Voluntary students were selected in the interview process.

Validity and Reliability

The concepts test were administered one week before the intervention. The same tests were employed after the intervention. To enhance content and face validity the tests were evaluated by two science teachers. To measure the reliability of the concept and drawing tests, they were implemented on 10 5th grade students, who learned these concepts in 4th grade. The first version of the concept test consists of 3 questions. Students were asked "Which substances may be recycled? Please explain." in the concept test. When students' answers to the first and second questions were examined, the second question was excluded from the test. The last version of the concept test consisted of two questions.

Data Analysis

Marek's (1986) categorization has been used in the analysis of the concept test and interviews.

Table I. Categorization Used in the Analysis of the Concept Test and Interviews

Categories	Code	Point
Complete Understanding	A	3
Partial Understanding	B	2
Alternative Concept	C	1
No response or Irrelevant Responses	D	0

Content analysis was used in the second interview questions. The students answers were examined in detail, then codes were composed. Tables including frequency

values related to each code have been presented in the result. In addition the first question of the conceptual tests was analyzed with a dependent t-test. The data obtained from the drawings has been presented with tables including frequency values. The students' drawings were examined in detail. Codes were composed according to the students' drawings. For example; student drawings related to the concept of heat were examined with these codes; "bottle and the recycle bin", "paper and recycle bin", "battery and recycle bin", "various recyclable materials", "others" and "no drawing". Also samples from student drawings related to each code have been shown in the tables. The students were coded in line with research ethics. For instance, student number 1 from the experiment group has been coded correspondingly, as S1PT in the pre-test and as S1LT in the post test. The students conceptual understanding related to the "recycling concept" is shown with graphics. Each graphic showed the students individual conceptual understanding before and after the intervention. This study was conducted as a case study, therefore; each students' conceptual understanding was investigated in depth with graphics and tables.

Intervention Process

Within the framework of the study, the students in the classroom were divided into 4 groups. The first two groups were assigned 5 students each, and the third and fourth groups were assigned 4 students. Care was taken to ensure the heterogeneity of group elements. The teacher of the class made a presentation of 1 class (40 minutes) to the students, discussing how they would proceed. Then, the teacher took the students to the material storage room of the school. In the material storage room, the students worked with their group-mates and exchanged their views on what could be done with waste materials. The teacher gave the students a duration of 1 week. The teacher then asked the students to use that week to decide on what they could do with waste materials. The waste materials from the material storage room were chosen in line with the ideas provided by the students. Each week, the teacher reviewed the students' projects and provided feedback. In project-based learning, the students discovered the knowledge themselves, and structured the research on their own. In the following section, the projects implemented within the framework of the study are presented in detail.

The first group developed a model of the circulatory system. The students obtained cables from various unused electrical equipment, cardboards, fabric and fiber pieces from the material storage room. They made use of blue and red tapes to show the veins in the circulatory system. The blood shown in the system was made by the students in the group, using waste fabric and fibers. The members of the group had some form of labor division. 2 students drew the human body on the cardboard, while the remaining three placed the model of the heart and the tapes representing the blood vessels on the model. Figure 1 presented below is a compilation of the photos of the activities of the group members.

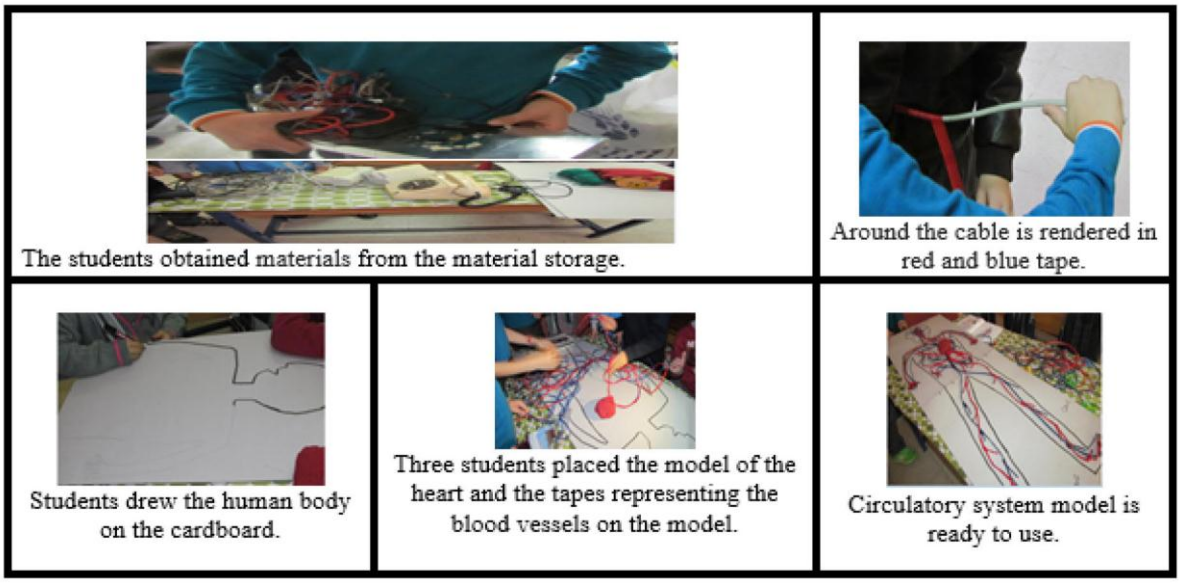

Figure I. Some Photos of the Activities of the First Group Members

The second group developed a lampshade. The students obtained a broken sphere, a light bulb and batteries from the storage room. They voiced their intent to build a lampshade using these materials. One of the students set an electric circuit using materials such as the cable, light bulb, and battery, and came up with a working lamp. To adorn the chandelier, the students used paper in various colors. The students installed their light bulbs in the chandelier they built, only to realize that it did not produce sufficient light. Through further deliberation, they decided that they needed to increase the number of batteries in order to increase the amount of light produced. The students in the group thought about how to increase the amount of illumination, and reached the conclusion that using a larger bulb would help. The students brought

a larger light, but failed to find a socket to install the larger bulb. Realizing also that they would not be able to operate it with batteries only, they thought of using a cable and a plug. The teacher brought a broken floor lamp from home, after securing the potentially hazardous sections and the plug and the cable using a tape. After attaching this cable to the chandelier, they connected it to the mains, and came up with a working means of lighting in the end. Figure 2 presented below is a compilation of the photos of the activities of the group members.

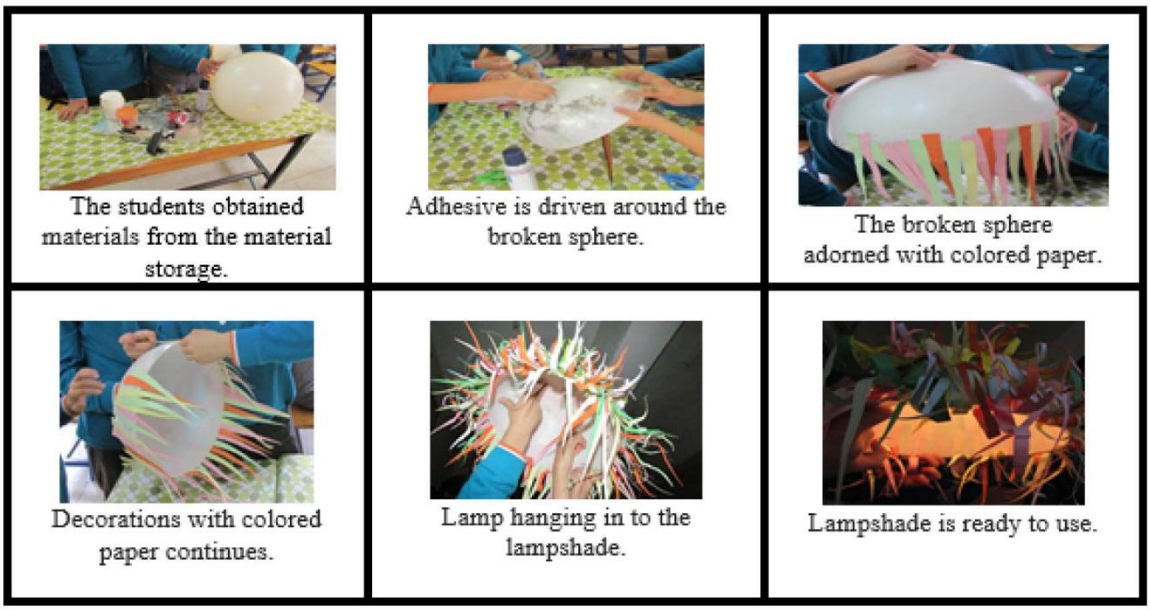

Figure II. Some Photos of the Activities of the Second Group Members

The third group developed an illuminated frame model. The students obtained a blank puzzle from the storage room. They said that they would build an illuminated frame using the puzzle. The teacher provided the necessary assistance with the sections to be removed from the puzzle using an adze. The students adorned the puzzle using sea shells, but soon realized that the glue they used failed to completely secure the sea shells. Seeing that, the teacher supplied the students with silicone. The students then adorned the puzzle board using tinsel, flakes, and sea shells. To illuminate the circumference of the board, they procured a battery-powered led lamp. Once the necessary arrangements were made for the led lamp, they placed it around the frame, and concluded the project. Figure 3 presented below is a compilation of the photos of the activities of the group members.

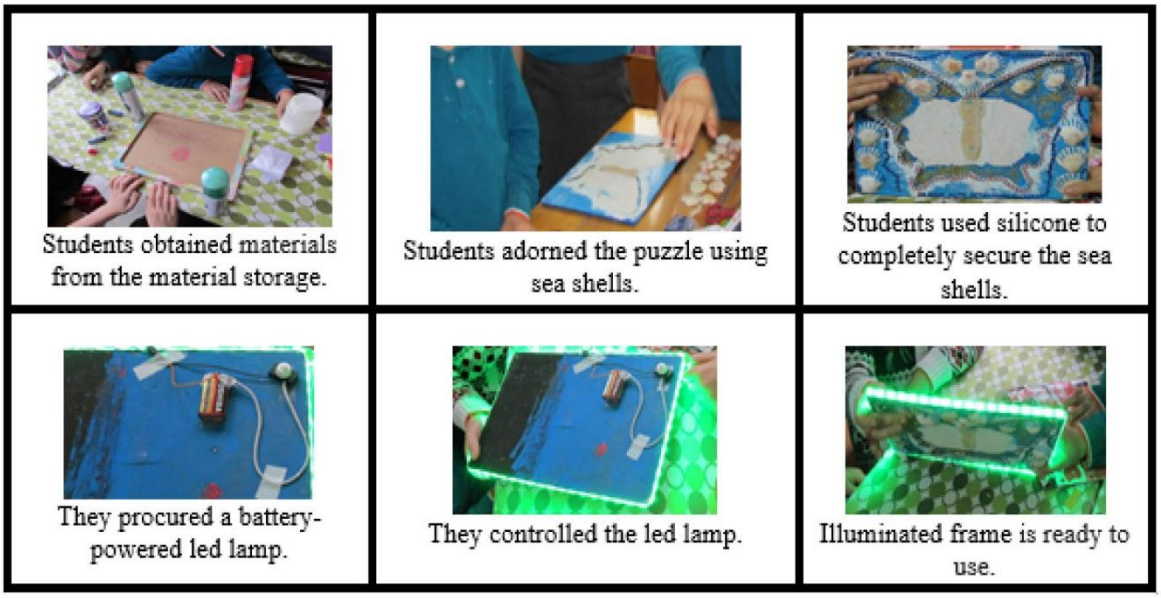

Figure III. Some Photos of the Activities of the Third Group Members

The fourth group, in turn, came up with a new armchair project. The students saw a very old and abandoned armchair in the material storage room, and stated their intention to render it reusable through recycling. The students obtained some fabric and fibers abandoned in the material storage room. The students realized that the bottom section of the armchair lacked support. They covered the bottom section of the armchair using pieces of planks obtained from abandoned bookshelves. They then decided to go for a patchy fabric to drape the armchair. Each one of the group members brought some waste fabric from their homes, to add to the pieces found in the material storage room, to produce a patchy fabric. They then saw that the pieces of iron comprising the frame of the armchair were rusty, and proceeded to paint the iron sections using the paints available in the material storage room. After waiting for the paint to dry for two days, they removed the old fabric and cushion from the armchair. They then put the fibers they obtained from the material storage room instead, and covered it with the fabric produced by the students. Then, the plank obtained from the bookshelf was placed under the armchair, and secured with nails. The whole arrangement was then placed on the recently painted iron legs. Figure 4 presented below is a compilation of the photos of the activities of the group members.

Figure IV. Some Photos of the Activities of the Fourth Group Members.

Results

Each students' conceptual understanding related to the 1st question in the concept test can be seen in figure 5.

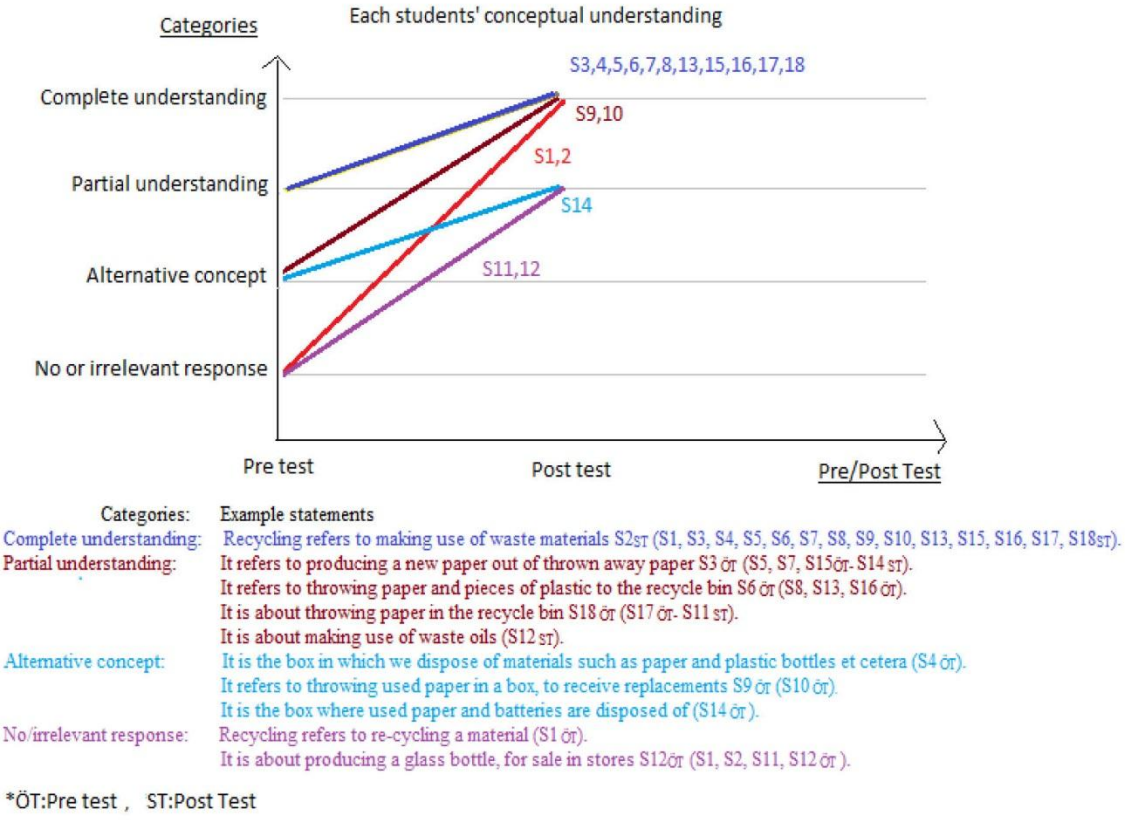

Figure V. Each Students' Conceptual Understanding

When Figure 5 is examined, it is observed that S3,4,5,6,7,8,13,15,16,17,18 students were in the partial understanding category in the pretest. The students' conceptual understanding increased to the complete understanding category in the post test. The review of the responses provided by the students to the first question of the test revealed that the large majority of the students failed to provide a thorough definition of the concept of recycling. As Figure 5 reveals, the overwhelming majority of the students referred to the production of recycled paper out of waste paper. Furthermore, the pre-test revealed that 4 students provided unrelated definitions. The drawings provided by the students in response to the 2nd question in the concept test have been presented in Figure 6. Some students drew more than one code.

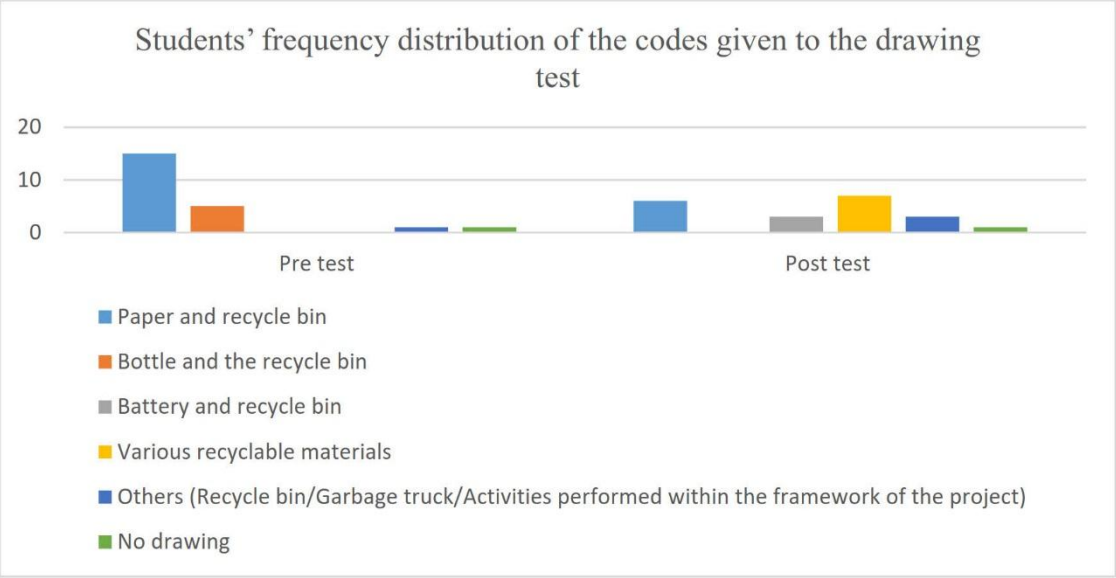

Figure VI. Students' Frequency Distribution of the Codes Given to the Drawing Test

A glance at Figure 6 reveals that the drawings by the students can be categorized under the groups "bottle and the recycle bin", "paper and recycle bin", "battery and recycle bin", "various recyclable materials", "others" and "no drawing". Figure 6 shows that the vast majority of the students provided drawings in the paper and the recycle bin category in the pre-test concerning the recycling concept. The post-test, on the other hand, saw 6 of the students reflect various recyclable materials in their drawings. The examples of the drawings provided by the students in each category, with respect to the concept of recycling, are provided in Figure 7.

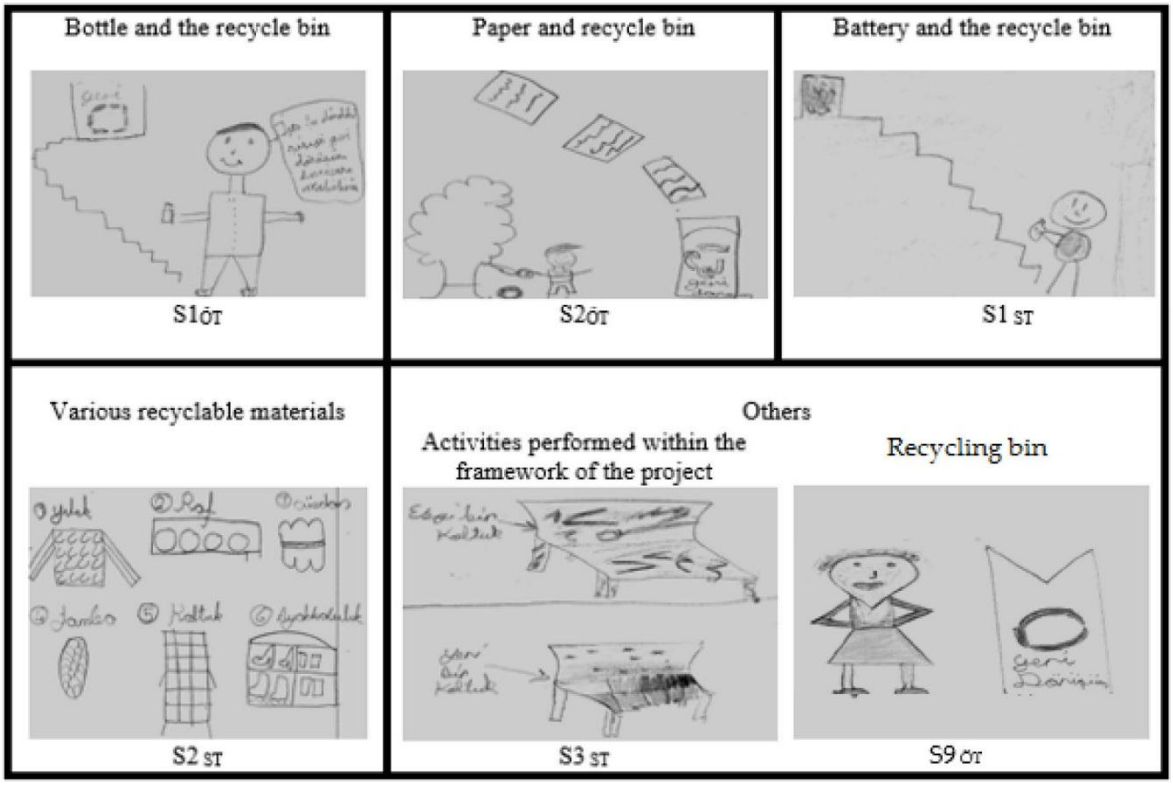

Figure VII. Samples of the Students' Drawings

When Figure 7 is examined, it is observed that students have different drawings. Students S3ST drew his/her project named "a new armchair project". The findings regarding the concept of recycling, reached through the interviews, are presented in Figure 8.

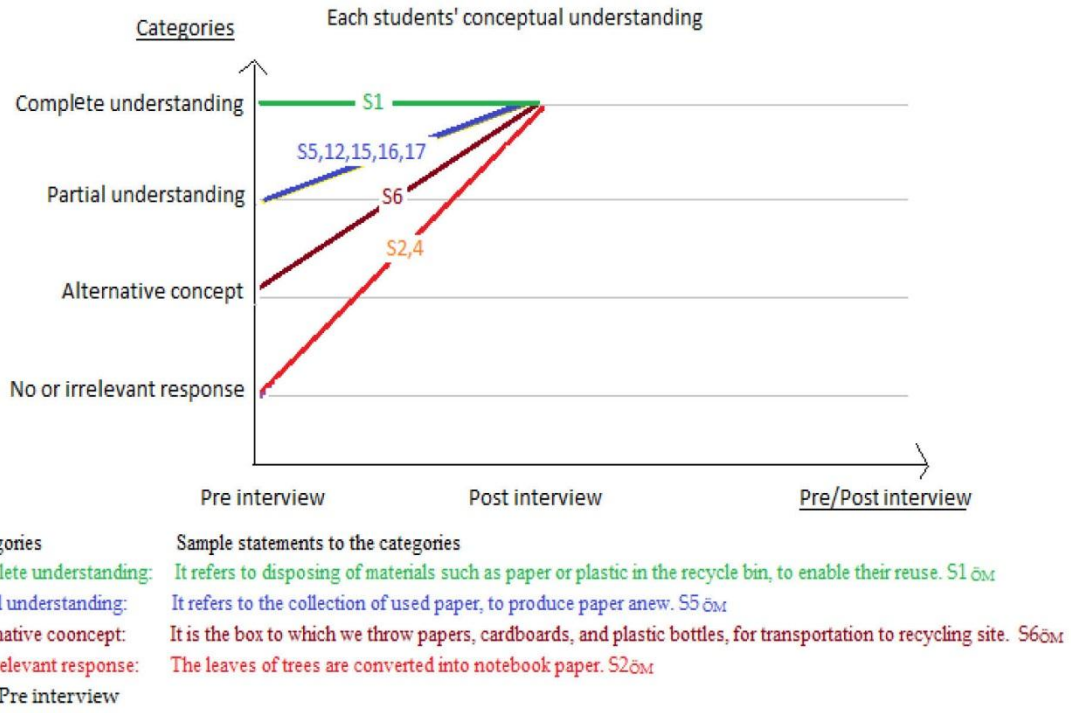

Figure VIII. Categorization of the Responses to the Interview Question, and Selected Statements

The review of the responses provided by the students to the interview questions reveals that the vast majority of the students provided responses which can be categorized under the partial understanding category. In the post-application interview, on the other hand, all the students provided responses suggesting complete understanding. No alternative conceptualizations were observed among the students during the post-application interview. The findings regarding the "Which substances may be recycled? Please explain." Question have been presented in table II.

Table II. Students' Responses and Codes

	Paper	**Garbage**	**Waste materials**
Pre interview	S2, S17, S4, S5, S6, S12, S15	S16	S1
Post interview	-	-	S2, S17, S4, S6, S12, S15, S16

As seen in Table II, the students stated paper, garbage and waste materials may be recycled. Most of the students stated that paper may be recycled in the pre-

test. Dependent t-test results of the concept test pre-post test scores have been presented in Table III.

Table III. Results of the Dependent t-Test

	Mean Rank	N	Std. Deviation	Sd.	t	p
Pre test	1,3889	18	,84984	17	-8,695	,000
Post test	2,8333	18	,38348			

As seen in Table III, there was a significant difference in favour of the post test (t= -8,695, p<0.05).

Discussion

Prior to the application, the vast majority of the students were observed to fail in providing a complete definition of the concept of recycling, and had instead defined recycling as the process of producing paper out of waste paper (see Figure 5). The drawings by the students and the results of the interviews point at a similar direction. Out of the 18 students who took part in the pre-test, 15 described the concept of recycling exclusively by drawing paper and a recycling bin (see Figure 6). In the pre interview, 5 of the students who took the interview defined the concept of recycling through a link of producing new paper out of collected waste paper. The statement "It refers to the collection of used paper, to produce new paper" provided by the student coded S5 supports this finding. The direct link the students harbor between the concept of recycling and the recycling of paper may be a result of the fact that the overwhelming majority of the recycling activities which take place around the students are about the recycling of paper. It is clear that the more responsibility the students are given in terms of the environment, the more responsive and responsible the students will be to the environment (Harness & Drossman, 2011). There are also projects supported by the Ministry of Education, albeit in limited numbers, on the recycling of valuable waste. One such project is the "Recycling Project for Books Provided Free of Charge" project implemented at schools (Çelik, 2011). The implementation of such projects at schools may have contributed to increasing the students' level of knowledge about the recycling of paper. Çimen and Yılmaz (2012) found, through their study aiming to assess the level of knowledge 6th, 7th, and 8th

grade students in primary education have with respect to recycling, as well as their recycling behaviors, that the most frequently used recyclable product the students use is paper. The participation of the students in their daily routine, in activities aiming to ensure recycling of paper may have contributed to providing them a sufficient level of information on this aspect of the concept. This finding, in turn, suggests that applied learning which finds its way into behaviors produces more lasting results. In the pre-test, just 5 of the students provided drawings suggesting that not only paper but also bottles were recyclable materials. It is well known that recycling refers to the physical or chemical processing of solid waste, enabling the use of the materials as raw materials for a second time (Çimen & Yılmaz, 2012). Many solid waste materials other than paper and bottles can be recycled. The lack of representation of other types of solid waste in the students' drawings, as well as the lack of mention of such materials in the interviews may have something to do with the students lacking adequate knowledge about the matter. In a detailed study on the recycling of packaging waste as part of the primary education curriculum, Çelik (2011) found that the curriculum did not provide adequate information, and the students had only limited knowledge about the matter. This leads to the hypothesis that even though various projects for the recycling of paper take place at schools, to be witnessed by 4th grade students, the curriculum fails to provide sufficient knowledge, and lacks applied projects regarding the utilization of different types of solid waste. In a similar vein, in the pre-test some of the students exhibited confusion of the concept of recycling and the recycling bin itself. The statement provided by student S14 in the pre-test "It is the box where used paper and batteries are disposed of" and the drawing provided by student S9 (see Figure 7) support this argument. The confusion the students have between the concept of recycling and the recycling bin itself may be due to the lack of sufficient emphasis on the concept of recycling as part of the curricula. Pike, Shannon, Lawrimore, Mcgee, Taylor & Lamoreaux (2003) conducted a case study with some students at the Francis Marion University related to recycling. At the end of the study; it was found that when students were trained related to recycling boxes and recycling, students living in campus apartments had significantly reduced the waste stream. Also it was found that the project based learning environment had a positive effect to teach sustainability to the students. It is clear that the education given to schools on the concept of recycling will positively affect not only the students but also the households in student houses. Maddox, Doran, Williams & Kus (2011) conducted a study to summarize and

evaluate how school-level waste education promotes action at the household level. The project was conducted with 6705 elementary school children in 39 schools. Working together with the students in the research, the message of "Reduce, Reuse and Recycle" was taken to their families and sustainable waste management practices were provided. The results of the study showed domestic recycling behaviors will be positively affected by intergenerational influences with school-based waste education model. In this case, the recycling of waste should be given more place in the program, and students should contribute to their learning by carrying out projects that require active participation in the process.

While S2 student was in the preliminary interview unrelated description category, the final interview responded to the complete understanding category. Likewise, S2 coded student responded to the conceptual understanding test in the preliminary test, and the final test in the complete understanding category. In the last drawing, it is seen that the student puts the recycled paper only in the front drawing, but the recycled paper shows the material which can be recycled in addition to paper (Figure 7). The activities carried out through the project led to a new state of affairs whereby 15 of the students (See Figure 5) were able to associate recycling with waste materials, and provide accurate definitions. In the project-based learning environment the class was divided into 4 groups, each composed of 4 to 5 students working together towards the development of their own projects regarding the concept of recycling. In the initial stage to come up with the project, the students visited the school's material storage room with their teacher and decided on what they could do in terms of recycling. The students did some research on the issue first, to obtain in-depth knowledge about the concept of recycling. Making use of the waste materials available at the school's material storage room, the students designed new products and completed their projects. The projects carried out by the students aimed to provide them with information on what could be done in terms of the recycling of materials other than paper. Such new insights, in turn, found their way to the final interviews and drawings. A glance at the drawings provided by the students after the application of the project reveals that 7 out of 18 students drew a number of distinct types of solid waste together (see Figure 6). Furthermore, 2 students were found to refer to their projects in their drawings. For instance, student S3 took part in the "a new armchair" project along with her group mates. The drawing by the student described how they produced a new armchair out of an old one which had been out

of use, by drawing the armchair before and after the project (see Figure 3). The conclusion is that the projects where students work actively through direct participation in their learning environments had a positive effect on their conceptual development levels (see Table III) Indeed, numerous studies note that projects serve useful purposes in terms of establishing links between the knowledge learned in the classes and used in daily life (Blumenfeld et al., 1991; Bransford, Brown & Cocking, 2000), developing a creative classroom environment for the students (Shearer & Quinn, 1996), rendering learning an enjoyable process through actually doing and experiencing (Winn, 1997) and contributing to in-depth learning of concepts (Solomon, 2003).

Conclusions and Recommendations

The present study, in turn, found that the students engaging in their own research activities as a group, followed by actually doing some work and developing projects regarding the concept of recycling is an effective means of furthering conceptual development. Ayan, (2012); Barak & Dori, (2004); Bayram & Seloni, (2014); Deniş Çeliker & Balım, (2012); Krajcik, Blumenfeld, Marx & Soloway, (1994), Pike et all, (2013) which also suggest that project-based learning environments have a positive impact on learning on part of the students, from the primary school to the university level.

The study reached the conclusion that projects developed with respect to the concept of recycling had a positive impact on the conceptual development of students. Further research may investigate the role the development of project-based learning environments regarding the concepts associated with environment education, with a view to raising "awareness about sustainable development" among the students, plays in terms of the conceptual development of students.

As the students had mostly been involved in programs to ensure the recycling of paper in their daily lives, they had mostly referred to such programs when trying to describe what recycling means. Against this background, projects regarding the recycling of a number of solid waste types can be implemented. For instance, projects regarding the recycling of waste such as glass, batteries, or plastics can be implemented at every school, enabling the students to take part in such programs.

The students can develop an awareness of sustainable development only through involvement in projects regarding the recycling of different types of solid waste in their daily lives as part of applied education programs. The knowledge thus gained should not be confined to basic theoretical learning, but also be integrated into behaviors through applied education.

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