

Teachers' and students' views about the applicability of the project-based learning approach in science courses in Turkey

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The aim with this study was to examine how, from the teachers' and students' perspectives, the project-based learning approach was applied in science and technology lessons. The research was conducted through a case study with qualitative research methods. The data of the study were obtained from semi-structured interviews with 38 students and 11 science and technology teachers. This data were analysed by descriptive analysis which is a qualitative data analysis method. The results of this study show that the teachers described the project-based learning approach as an inapplicable approach in schools. Teachers advised a reduction of curriculum content and a reduction in class sizes. We understood that the other phases of the project processes that started with the selection of project topics at school were done with the help of the students' families at home. It also became clear that during the evaluation process, the teachers took the students' own efforts into consideration. We determined that most of the students who participated in the projects in the science and technology course were free to choose their project subjects. It also became clear that students preferred to do projects in the science and technology course. At the end of the research report, suggestions based on the results of the research are made.

Keywords: project-based learning (PBL); qualitative analysis; science education; secondary school teachers; students' opinions

Introduction

Project-based learning (PBL) is a learning approach that supports the creativity of students, improvement of their critical thinking skills, the implementation of learning strategies such as metacognitive learning strategies like monitoring and evaluating, cognitive learning strategies like problem-solving, and socio-affective learning strategies by group or individual studies (Işman, Baytekin, Kıyıcı & Horzum 2002; Özel, 2013). PBL enables the active use of the main strategies in O'Malley and Chamot's (1990) cognitive approach-based learning strategies classification. Therefore, PBL has great importance in science lessons and is actively applied in the science lessons of secondary education schools in Turkey. Science lessons and the approaches used in these lessons are of great importance for finding creative solutions to the problems that individuals face in their lives (Keser, 2008). Considering the effect of PBL on the students' learning experience in general, implementation of PBL in science courses is emerging as one of the most appropriate approaches (Kurnaz, Sünbül, Sulak & Alan, 2005). Considering its effect, it is important to understand the applicability of the PBL in real-life settings.

Literature Review

Project-based learning (PBL) is an innovative and educational method in which students mainly work cooperatively to solve real-life problems. PBL is an inquiry-based learner-centred approach that enables students to create high-quality, unique products in response to complex questions, problems or challenges. Project-based learning (PBL) is an innovative and educational method in which students mainly work collaboratively to solve real-life problems (Havenga & De Beer, 2016; Rivet & Krajcik, 2004). In the preparation phase of a project, students learn how to access information, how to use resources, how to combine what they find and how to be critical about their findings. In the PBL approach, while students deal with individual learning experiences, teachers support or guide students while they do their projects. While students are the ones to deliver the projects, the teachers work in the background to facilitate the students' work (Demirhan, 2002). Through this, PBL both makes it possible to focus on the product and allows the teachers to re-teach the subjects that students failed to understand (Demirel, Başbay, Uyangör & Bıyıklı, 2001; Havenga, 2015; Kiliç & Özel, 2022).

A number of quantitative studies relating to the implementation of the project-based learning approach in science education have been done. From the literature we observed that there are fewer qualitative studies than quantitative studies that combine teachers' and students' views. Qualitative and quantitative research methods have an important place in education (Kılıç & Özel, 2014, 2015). While researchers use quantitative research to reach generalised and numerically supported results on the various problems they deal with, researchers use qualitative research to explain the depth of a phenomenon and its environment and limitations. Although quantitative research results provide some general information, it is, due to the general level of information, inadequate to provide practical information and suggestions to teachers and administrators in practitioner positions. The limited explanatory properties of such studies and their insufficiency in giving meaning to the results lead educational researchers to carry out new explorations (Yıldırım & Şimşek, 2011).

Theoretical/Conceptual Framework

Multiple theories inform project-based learning (PBL) of which the main theories are Piaget's Constructivism and Vygotsky's Social Constructivism. John Dewey's Pedagogical approach also played a major role in the development of PBL (McLeod, 2018).

According to Piaget, individuals are born with schemas in the brain. These schemas allow them to go through the processes of accommodation and assimilation. Through assimilation, new information is added and adapted to the existing schemas. Therefore, unless schemas are being reshaped or new ones formed, the student will only understand the information as the existing schema allows (Scholnik, Kol & Abernethy, 2006). Piaget's theory has been adjusted and adapted by many constructivist theorists. However, one thing remains constant: students construct their knowledge by building up existing knowledge through experience. Although Piaget never directly associated his theories with education, it is easy to see where it can be applied. One way to apply constructivism to education is through discovery learning. Discovery learning is the idea that children learn best by actively exploring and physically doing (McLeod, 2018). The practice of constructivist theories allows the creation of an environment that is conducive for project-based learning.

One thing that Piaget's theory does not account for is the social aspect of the learning environment. The addition of the social aspect would lead to Vygotsky expanding constructivism into social constructivism. Vygotsky believed in learning by experience and doing through social and interpersonal interaction (Scholnik et al., 2006). Vygotsky led the development of the Zone of Proximal Development (ZPD), which is described as the learner's current or actual level of development and the next level attainable through the use of mediating semiotic and environmental tools and facilitation by capable adults or peers (Shabani, Khatib & Ebadi, 2010).

It is often said that John Dewey is the father of project-based learning. He believed that students should have opportunities to participate in their own learning. He believed that students would succeed in environments where they could have interaction, both socially and with the curriculum, and are able to learn through experience. Dewey's Pedagogical approach presents two sides to the educational processes – psychological and sociological. While the psychological side is the basis, neither side is more important than the other. Dewey argues that the educational process would be arbitrary and superficial without understanding the psychological and sociological perspective of the individual which channels and shapes individuals' activities. This side of the educational process is, therefore, in preparation of future life. A student is trained to be

able to have the full and ready use of all his capacities (Dewey, 1925).

Purpose of the Study

From the literature it is clear that the application of the project-based learning approach in science education is based on academic achievement, attitudes towards science and technology lessons, scientific process skills, creative thinking as well as quantitative studies examining teachers' and students' views. However, very few qualitative studies that included the views of teachers and students were found in literature in Turkey. This study was carried out with the aim of both eliminating the gap in the literature and understanding how Project-Based Learning approach used in the science and technology course affected students and teachers, and to possibly contribute to the studies done on the teaching of science and technology.

Statement of the Problem

The research problem was composed by questioning what teachers' and students' opinions were about the process of applying project-based learning in the science and technology. To answer the main question, the following sub-questions were investigated:

- 1) What do teachers and students understand under project-based learning?
- 2) How do teachers and students explain the project preparation process?
- 3) How are the project topics chosen by students and teachers?
- 4) From whom and in what way do students receive support while doing their project homework?
- 5) How do teachers see the guidance they provide in their project work?
- 6) How do teachers evaluate project work?

Methodology

In this qualitative research project, semi-structured interviews were used to collect data as such interviews allow researchers the freedom to change the number and order of questions, help uncover complex personal and emotional problems, obtain the desired information in depth and in full, provide instant feedback to the answers received, have the flexibility to suit different conditions (Büyüköztürk, Kılıç-Çakmak, Akgün, Karadeniz & Demirel, 2012; Çepni, 2010). In our study we used the case study method. Case studies are used in research to identify and determine the details that make up an event, develop possible explanations for an event, and evaluate an event (Gall, Borg & Gall, 1996).

Participants

The research participants in this study were 11 science teachers and 38 students from five state schools in Turkey. The student participants were randomly selected from the students who were preparing projects and studying in the 6th and 7th

grades. The teacher participants, on the other hand, were the teachers who taught the student participants.

Measurements and Tools

In this study semi-structured interview forms were used as data collection tools. These forms were used because they provided opportunities for rapid coding and analysis of the data and enabled comparison of the similarities and differences between the data provided by the participants (Büyüköztürk et al., 2012; Çepni, 2010). A preliminary study was conducted to improve the validity, reliability and usefulness of the developed interview forms. The questions on this interview forms were determined by considering the purpose of the research. In order to ensure the content and construct validity of the prepared forms, a research group was formed. The forms were applied to two students and two science teachers who were not randomly selected from the research group. The results of the preliminary experiment were reviewed and the interview forms were finalized. The target questions in these forms were used to guide the interviews.

Data Collection

In order to facilitate the qualitative data analysis and increase the reliability of the research, the participants' answers to the interview questions were audio-recorded. Before the interviews, permission was obtained from the participants for appointments and audio recordings. The interviews were done face to face. Interviews with teachers were on average 30 to 35 minutes long and the interviews with the students lasted around 15 minutes – depending on their age and level of attention. The interviews were held in meeting rooms at the schools, science and technology laboratories and conference halls. Care was taken to ensure that the interview environments were quiet and free from distractions.

Analysis

A descriptive analysis method, one of the data analysis methods used in qualitative research, was applied for the analysis of the data obtained from the interviews. In descriptive analysis, the aim is to present the data obtained from interviews and observations to the reader in an organised and interpreted way. The data were classified, summarised and interpreted according to the predefined themes. A causal relationship was established between the findings and a comparison of cases was made (Yıldırım & Şimşek, 2011). According to Altunışık, Coşkun, Bayraktaroğlu and Yıldırım (2010), descriptive analysis consists of

four stages: creating a framework for the study, processing the data, interpreting and writing up of the findings.

To adhere to ethical requirements, no personal details of the participants were included in the interview forms. Participants were referred to using codes. For example, the teacher and students were referred to as T and S respectively. A number was added to these codes to indicate the different participants, e.g. T1 and S1. Miles and Huberman's (1984) summarisation and transformation principles, which enables the coding of qualitative data were used to collect data on the main and sub-problems. The similarities and differences were determined by examining the relations between the codes. Encoding consistency of individually composed categories were examined. Then, the researcher's and the two experts' evaluations were examined individually. In light of those evaluations they were grouped as "Opinion Union" and "Opinion Separation" based on the answers given by the teacher and student questions. The reliability of the research was calculated by using the recipient percentage calculation formula. Per cent compliance is the ratio of the total number of assessments or observations to the number of items that observers or evaluators agree upon (Türnüklü, 2000). The calculations indicate that the percentage of agreement between the researchers and the two experts on the data collected from the students was 81.81% and from the teachers, 87.50%. Şencan (2005) emphasises that the percentage of consent must be above 70% in order for it to be credible. Therefore, considering the results obtained, it is possible to say that this research was credible.

Results/Findings

Some of the interview questions put to the teachers and students are given below.

Questions Put to the Teachers

Question 1: What do you think about the feasibility of the project-based learning approach in schools?

Table 1 Frequency (*f*) and percentage (%) values of the teachers' answers to Question 1

Coding	<i>f</i>	%
Not applicable	9	81.8
Applicable	2	18.2

The majority of the teachers (81.8%) believed that project-based learning as approach could not be implemented in schools (cf. Table 1). According to the teachers, the reason why project-based learning could not be implemented were crowded classrooms, very intense curriculum, short lessons and a lack of project habits by students.

Question 2: What do you think is needed to implement this approach in schools? Please explain.

Table 2 Frequency (*f*) values of the teachers' answers to Question 2

Coding	<i>f</i>	%
Course duration should be increased	5	45.4
Curriculum content should be reduced	5	45.4
Class size should be reduced	5	45.4
The teachers, students and parents should be encouraged to do projects	2	18.18
Projects should be executed starting from kindergarten to promote forming of habits	3	27.27

Note. *Since more than one theme was specified at the same time, only frequency values are shown.

In Table 2 the suggestions that teachers made regarding the Project-Based Learning approach are presented in five categories. A few of the teachers' answers to Questions 1 and 2 are given below.

T1: *I cannot implement this approach although it is very useful to the students. Reduction of the content of the curriculum and the class size is needed if we want to implement the project-based learning approach. We can apply this approach easily if the Ministry of Education reduces class sizes. Of course, the content reduction of the curriculum is also needed. The content should be concise; there are many subjects that are not needed.*

T2: *I think it is not an applicable approach. The class size should be at least 20 students or fewer to apply this. I strongly disagree that it can be applied to the classes with students more than 20. To illustrate from my school, we have classes with 47 or 49 students. As a result, implementation of this approach is not very possible; the implementation of the curriculum will not be done properly in such large classes.*

T7: *Not applicable. Like I said, there has to be a*

project-based course. A 3-hour course apart from the curriculum is required. A 3-hour course should be added for the projects, and their evaluation. It is necessary to be efficient. Students should improve and express themselves. Maybe they will regard simple things as complex ones. They will solve things they see as problems.

T11: *It is feasible, but would everyone be eager to use it? It is a very laborious job both for the teacher and for the student. There are problems in the construction of the project. This approach is not preferred because it brings some financial burden to the families, it is avoided. Some students do not want to spend time. However, it can be applied in terms of applicability.*

From Table 1 and Table 2 it is clear that most of the teachers said that project-based learning could not be applied in schools. In addition, teachers advocated for smaller classes and a reduction of the curriculum content apart from the fact that this approach should be implemented in the early years of education.

Question 3: How do the students prepare the homework related to projects, what do you think?

Table 3 Frequency (*f*) and percentage (%) values of the teachers' answers to Question 3

Coding	<i>f</i>	%
The students and parents do it together	8	72.2
The students do it by themselves	2	18.1
There is the support from close relatives and siblings	1	9.7

From Table 3 we see that the teachers were of the opinion that students did their assignments in collaboration with their parents. The teachers thought that very few assignments were done by the students themselves or with only some support from relatives. This was an unexpected outcome. Examples from the teachers' answers are given below.

T6: *With the concerned families it is the father who helps. If there is a big sister or brother, they also help. If they ask for help from their teachers, we also help them.*

T7: *They do it by themselves if it is a simple project. The parents also help with more complex projects if it is detailed. Students do not have enough information about subjects like electricity. Parental support is needed. About the projects I conduct: students do not need help from others because I don't give any projects exceeding their abilities. The students need only limited help from their parents.*

However, parents do 60 to 70% of more complex projects. The students come up with the ideas and do some of the work (about 30%) while the parents develop the project.

T10: *Students are absolutely getting help. They get help with both ideas and implementation. My most optimistic guess is that they probably get help with 50% of the project. However, that is also normal considering their ages because there are things that require handicraft skills.*

T11: *Generally, the students do it with the parents. After getting approval about how to do the project the student tries to do it with the help of the parents at home. They do it together if the parents are good at handicrafting. If there is no parental support, we do it together at the laboratory.*

A large number of teachers indicated that their students received assistance from their parents while doing projects. The findings also show that teachers thought that the parental support was extremely

rewarding in terms of sharing information and the positive psychological effect that it has on students.

Question 4: How do you evaluate projects prepared by students?

Table 4 Frequency (*f*) values of the teachers' answers to Question 4

Coding	<i>f</i>
Effort	10
Usefulness, functionality	8
Authenticity	4
Layout, aesthetics	3
Literature review	3

From Table 4 it is clear that teachers took effort and usefulness/functionality of the projects into account. In addition, the teachers valued the layout,

Questions Addressed to the Students

Question 5: Have you prepared a project for the science course before? If yes, how would you describe your preparation?

Table 5 Frequency (*f*) and percentage (%) values of the students' answers to Question 5

Codes	<i>f</i>	%
Yes		
Find the topic, research it, test the hypothesis at home/school and present it to the class	19	50
The teacher gives a topic, research is done, equipment is provided, the hypothesis is tested at home/school and a presentation is made	13	34.2
No	6	15.8

Students were divided into two groups – those who have done projects before and those who have not. It was determined that 32 students had done projects before and six students had not. From the interviews conducted with the students who had conducted projects before, there were similarities between the construction processes, but the choice of the topics for the projects differed among students. From Table 5 it seems as though most of the students were free to choose the topics for the projects. Some of the students' comments on the preparation process for the projects are given below.

S10: I did. Last year we did group work. These researches were about our body. We studied, researched and wrote about some parts of our body and then presented it to our friends. Our teacher had already given us the subject. We researched and prepared with our friends. Everyone had worked on a different section, and then we presented it in turn with the class. I thought of ideas that would make life easier and how we could be more beneficial for the environment. I told these ideas. I said let's put a brush under the toy car to vacuum the carpets. I had another idea, but my teacher said my first idea would be better. It was easier for me this idea. I tried

aesthetics and originality of the projects and took the literature reviews into account during the evaluation process. Teachers' views on how the projects were evaluated are presented below.

T1: I pay attention to its authenticity and usefulness. I have my own assessment form, and I have several criteria assigned in it such as the layout of the project and the effort spent. I evaluate them according to these criteria.

T6: The students effort with the project and the authenticity thereof are important to me. I evaluate according to these Criteria. I also have my own assessment form that I use.

T9: Has he done the necessary research? Who did he get help from and how much help did he get? I care about these things. Is the project original, does it have a function? These are usually my criteria.

working at home. I set up a remote-controlled toy car with detergent and water and used it to clean the house. I took two candy boxes from the cafeteria and put water in one and detergent in the other. I grabbed one of the brushes of the carpet broom and put it under the car. Then I showed it to my friends.
S11: Yes I did. I designed to build a house by the sea for my project. There will be a pool in front of the house. The water coming from the sea will fill this pool, this water will evaporate in the pool over time, the oxygen in the evaporating water will mix into the air and prevent the ozone layer from being pierced. Also, I thought of installing solar panels in the house. After conceiving this idea in my mind, I did some research and then I built the house and showed it to my classmates.

One can conclude that the students' freedom to select a topic can contribute to the development of students' creativity, their environmental awareness and their personal development. Students who had the freedom of choosing their own topics wanted to do things to make their lives easier. On the other hand, some of the students whose projects were chosen by their teachers said that they could not find ideas for their project, therefore, the teachers chose the topics for them.

Question 6: If you could execute a project at school, for which course would you choose to do that?

Table 6 Frequency (*f*) and percentage (%) values of the students' answers to Question 6

Codes	<i>f</i>	%
Science and technology	19	50.0
Mathematics	8	21.0
Turkish	4	10.5
Social Studies	3	8.0
*Others	4	10.5

Note. *It is not included because the frequency of courses such as music and sports education and computer technology was fewer than two.

When students were asked in which courses they preferred to do projects, 50% of the students stated that they would choose the science and technology. From Table 6 we see that mathematics, Turkish, social sciences and others were chosen as possible subjects in which to do projects. Some of the students' responses are given below.

S25: *It is science because there are more projects to choose. Also, I like science courses very much. The science course teachers is also our classroom teacher and she helps a lot with the projects.*

S33: *Science course, again. There are various topics to choose from. Also, it contains important information about the life such as magnets and atoms.*

While choosing courses for the projects, the students preferred courses that they liked and those that they were interested in. It may be thought that they chose these courses based on their individual skills, abilities and career development.

Discussion

The discussion of the result in this section is done according to the different secondary research questions.

What do Teachers and Students Understand Under the Concept of Project-Based Learning?

From the results it is clear that most of the teachers regarded projects as new product design and production. Teachers described the PBL approach as one of the approaches that should be applied in science education. It was understood that teachers regarded this approach as a tool for students to create new products, solve problems, learn by doing and prepare them for life. The students participating in the study regarded projects as creative ideas and the things scientists do, the design of a new product, the development thereof, conducting research about it and revealing their ideas. It seems as though the teacher's views on project-based learning are in line with Baki and Büttner's (2009) research.

How do Teachers and Students Explain the Project Preparation Process?

All teacher participants in the study used the PBL approach in their lessons. However, it was seen that real-life practice also occurred with some flaws. In addition, it has been determined that the majority of these teachers considered the PBL approach to be an approach that cannot be used in schools. Teachers

stated that the course curriculum and class sizes should be reduced in order to make it possible to apply the approach. These findings are similar to those of Çakan (2005), Kaymakçı and Öztürk (2011) and Şahin (2007) that indicate that large class sizes make it difficult to apply this approach and that the current class sizes should be reduced.

The students stated that they were confident about the preparation of their projects and that they were aware of their responsibilities and were actively involved in their projects. This result is in similar to the findings in studies by Ayaz and Söylemez (2016), Başbay (2006), Çakallıoğlu (2008), Çakan (2005), Gültekin (2007), Kurak (2009), Özdener and Özçoban (2004), Serttürk (2008), Uzun (2007), Yavuz (2006) and Yılmaz (2006) who indicate that taking responsibility for their own learning in the project process helped students to be active in their learning process.

How are the Project Topics Chosen by Students and Teachers?

The result show that the teachers prepared a list of topics from which the students could choose for their projects. The results also show that some students preferred to choose their own topics for their projects. In cases where students could not come up with topics for their projects, topics were chosen for them by the teacher. This finding is the same as that of Kütükte (2010) who argues that teachers preferred to give projects on the topics that they determined.

From Whom and in What Way do Students Receive Support while Doing their Project Homework?

While we observed that the students received assistance with their projects from their families, teachers and friends, it was understood that this support was in the form of giving ideas at the beginning of the projects and by supporting the production of the product during the development phase. Most of the teachers participating in the study, on the other hand, thought that the project assignments were completed through cooperation among students and parents.

How do Teachers See the Guidance they Provide in their Project Work?

The results show that the teachers provided guidance by giving ideas, giving resources, and support for the projects. It was understood that while guiding the

students in the counselling process, they mostly tried to get the students to freely produce their ideas. However, it was understood that the teachers could not provide effective guidance as the projects were not completed in school, but at the students' homes.

How do Teachers Evaluate the Project Work?

From our study we observed that teachers mostly valued the students' efforts and the usefulness of the projects during the evaluation of the projects. Furthermore, teachers tried to develop students' sensitivity towards the environment as well as their development of problem-solving and psychomotor skills. This again is in line with the results of Kütükte's study (2010) who determined that teachers paid attention to the students' efforts in their project work. Esen and Güneş (2012), on the other hand, found that teachers assessed project work based on the students' written and oral grades in school lessons. The results from our study seem to support these findings.

In conclusion, although the PBL approach is thought to be very beneficial for students in theory, we found that teachers regarded this approach as inappropriate for use in schools. The reasons cited for this were large class sizes and the intensive curriculum content. From the results of our study it seems as though the participating teachers were only involved in the projects during the evaluation phase. The results show that students and parents worked together on completing the students' project. From the results it is clear that the parents' contributions were far greater than those of the students. It seemed from our study as though projects given by the teachers did not contribute to students' learning, as most of the project work was done by parents or other family members and not solely by the students. In this case, project work did not achieve its purpose of contributing to students' learning. Efforts should be made to guide parents on how and to what extent they should support the children in project work.

Project work should be assigned to students according to their developmental levels so that they can gain knowledge and awareness on and about their choice of topics. Furthermore, schools could embark on training teachers about project-based learning, the purpose thereof and how it should be implemented in their classes.

Authors' Contributions

This study constitutes a part of Mehtap ÖZEL's master's thesis completed under supervision of İsmail KILIÇ. All statistical analyses in the study were conducted by both researchers. The corresponding author prepared the manuscript. All data used in the study were quoted from the master's thesis.

Notes

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