Effects of a Technology Supported Project Based Learning (TS-PBL) Approach on the Success of a Mobile Application Development Course and the Students' Opinions

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Abstract – **Similar to traditional desktop software development processes, teamwork is a necessity in the mobile application development process. Thus, the aim of this study is to examine the effects of the technology supported project-based learning approach in mobile application development courses on the academic achievement of students and to clarify the engineering students' opinions. A total of 130 engineering students from the Department taking mobile application development courses were the participants of this study. The lessons progressed in one group in the form of technology supported project-based learning steps, while in the other group, they were conducted using traditional methods. Based on the results, the practical implementation of a mobile application with a TS-PBL approach in engineering students' education will be discussed.**

Keywords **– Mobile application development, project-based learning, students.**

1. Introduction

The rapid advance in technology, particularly witnessed in the development of inexpensive mobile and wireless technologies along with the progress of applied engineering science, has resulted in the more emergence of ICT as a key factor in society [1]. Kose (2010) indicated that it is possible to shape the structure of every society through education and technology [2]. Many researchers have emphasised that learners take an active role in student-centred settings, thus facilitating learning [2;3]. In order to achieve this, it is essential to use technology efficiently in educational activities [4]. The field of computer programming has also been affected by technological developments. While companies previously exhibited preferences for desktop applications, they have now started to use web-based automation systems. The increasing availability of low-cost mobile and wireless devices and infrastructure has heralded opportunities and challenges for both teachers and students [5]. Additionally, mobile applications that function on mobile phones are being developed in modern society [6]. People who want to learn a programming language or who are required to learn programming language for their areas of expertise, can be educated in this field at different levels. Jumaat and Tasir indicated that mobile applications that encourage learning in the current market are particularly beneficial for students [7]. Similar to traditional desktop software development processes, teamwork is needed in the mobile application development process [8]. Kalayci (2008) stated that students described project-based learning as a learning approach based on imaging, planning, imaging and developing drafts. PBL is a student-centred approach that enables students to combine multiple disciplines when studying on projects by providing real life experiences and situations. Project-based learning paves the way for interdisciplinary collaboration and teamwork. Interdisciplinary projects encourage students to work with communication and cooperation by requiring different abilities [9]. With well-designed projects, students comprehend theoretical subjects better by combining theory with practice; therefore, information that has been learned becomes more permanent. In particular, group projects prepare students for their future careers, because project development processes are similar to

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projects they will face in their working lives [10]. Developments in information technology have changed the viewpoints of researchers about the project-based learning approach. With this approach, technology-assisted and technology-based projects have become more widespread [11].

In the light of this information, it is inevitable that the benefits from collaboration and permanent learning that can be obtained from project-based learning can be used to train mobile software developer experts in the field. Thus, it is important to implement and evaluate the project-based learning approach in the syllabi of mobile application courses. Hence, the aim of this study is to examine the effects of the technology-supported project-based learning approach in mobile application development courses on the academic achievement of students and to clarify the engineering students' opinions.

2. Method

A combination of qualitative and quantitative methods were used in this study. A semi-structured interview form was used in the qualitative section and an achievement test was used in the quantitative section. Quantitative research can be generalised on the various problems it covers, while quantitative studies try to determine results supported by numbers. Furthermore, qualitative research is used in an effort to explain the depth of the phenomenon and within the framework of its own environment and limitations. Both forms of research have significant advantages for the field of education and these methods cannot be used interchangeably. However, both forms of research can be used together in a supportive manner. For this reason, quantitative and qualitative methods have been used together in this study [12]. Mujs indicated that using mixed methods through combining quantitative and qualitative research methods is one of the most effective methods in research [13].

Mobile Application Development Course: This course aims to develop students' knowledge by providing practical experience in mobile application development. The Android operating system was chosen as the mobile application development platform. The Android operating system is an open source mobile operating system that is constantly being developed. The main reason for choosing Android is that it is more affordable in terms of materiality and more flexible in the implementation of the recurring design phases. Additionally, when considering the global operating system usage rates, it is seen that 66% of mobile users are Android, 19% are IOS and 15% are users of other platforms.

Participants

A total of 130 engineering students (65 control, 65 experimental) in their third year at the Computer Engineering Department taking mobile application development courses were the participants of this study. Student ID numbers were observed in order to organize the empirical group and control group; odd numbers were included in the empirical group, even numbers were included in the control group. The average age was 21 years.

Research Design

In this study, pre-test and post-test designs with the experimental and control groups and a mixed design that consisted of qualitative data were used. Before commencing the experiment, only the "programming achievement test" was applied. In the control group, the courses were conducted with a traditional method and, in the experimental group, courses were conducted with a project-based learning approach in a blended learning environment. At the end of the experimental application, the "programming achievement" test was applied as a post test. Moreover, at the end of the experimental processes, semi-structured interviews were conducted with the experimental group students.

The mobile application development course achievement test was used as a pre-test applied before beginning the course in order to identify the levels of both the experimental and control groups. Academic achievement is expected to be homogeneous among the groups. The independent t-test results of the pre-tests applied to the students are shown in Table 1.

Table 1: Pre-test scores of experiment and control groups

Groups	N	X	S	sd	T	p
Experiment	65	39.04	17.3	70	.641	.563
Control	65	39.42	11.02			

As can be seen in the table above, the achievement test grades of students in the mobile applications, obtained to evaluate background knowledge, are similar and do not show a significant difference ($t=.641$, $p>0.05$). According to the results, it can be said that both groups of students had the same level of mobile application development skills and knowledge prior to the courses. Therefore, it can be said that the distribution of the groups is homogeneous.

Procedure

The experimental research was conducted over a 12-week period in the 2016-2017 fall semester. “Mobile application development”, “Adobe Flash Professional” “ActionScript 3.0” topics were taught to both groups of learners. This course was given to both groups by the researcher. Before commencing, the Project-Based Learning group was informed about the PBL process. All materials were prepared before the application. Videos were captured using Camtasia Studio 7 software. As mentioned in Bergmann and Sams's study, video lessons were prepared with lengths of 10 to 15 minutes [14]. The researcher added videos to Moodle each week. Each lesson lasted 90 minutes, once per week. Quizzes were added at different intervals to ensure that students actually watched the videos. When the videos were watched, the system automatically sent the researcher a score sheet via email. The lessons progressed in a group in the form of project-based learning steps, while in the other group, they were conducted using traditional methods.

In the experimental group, students were organised into groups of five students. Each group was considered to be equal to each other. In order to achieve better results from the project-based learning pedagogy, the groups were required to be composed of students with similar skills and interests in the subjects to be learned [15]. As can be seen in Figure 1., this method has project based tasks for students.

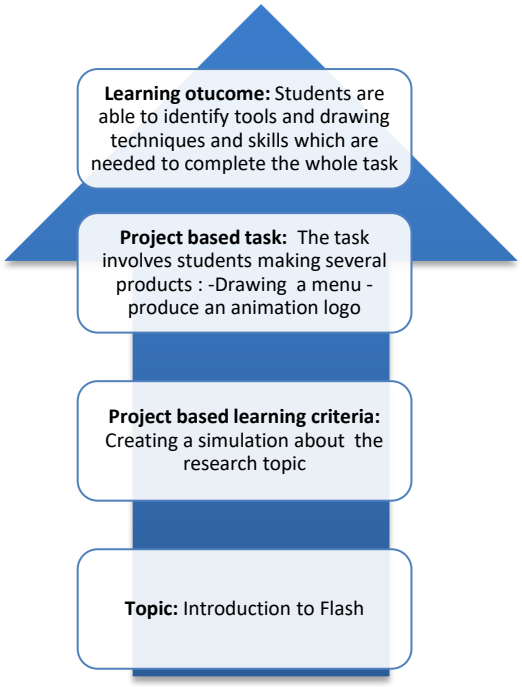


Figure 1: An example from a project-based learning task

Each group was assigned a project that required development of a mobile application and students were asked to develop these projects in a specific time by implementing project-based learning steps. The projects were supported by intra-group and inter-group discussions in the classroom environment and in the online Moodle environment (see Figure 2.).

Figure 2: An example of a discussion on the Moodle Environment

The prepared projects were loaded onto smartphones and were tested after the study (see figure 3.). The project steps, control points and study calendar were reported online on the Moodle system to the students in the experimental group. Additionally, it was intended that students actively participated in the lessons by taking part in the classroom discussions; mistakes were corrected during these discussions.

Figure 3. Examples of Developed Application

Data Collection Tools

In the mobile application development course, an achievement test was developed that included 44 multiple-choice questions to determine whether the

students achieved the course goals. The test was applied to 120 students who had taken this course in the previous semesters to verify the validity and reliability of the test. Following this pilot practice, the correct answers p: item difficulty index and the r: item distinguishing index were calculated. KR-20 (Kuder Richardson) analysis was implemented to state the reliability of the assessment instrument and the reliability co-efficient was calculated. In total, 40 items whose distinguishing index was over .30 and with a difficulty index between 0.40 and 0.80 were included in the test; and 5 items who did not meet these criteria were removed from the test. Consequently, 40 items that met the criteria were selected. KR-20 and KR-21 coefficients were calculated to be .78 and .72. This achievement test was then applied to both the control and experimental groups as a pre-test and post-test.

Furthermore, the researchers conducted face-to-face interviews with all experimental group students. Semi-structured interview questions were prepared by the researcher to collect the engineering students' opinions. Interview questions were generally concerned with the impacts of the project-based learning process on the development of the mobile application. The content validity of the interview questions was verified by literature review.

The prepared semi-structured interview form was presented to three education technologists and two mobile application developers; minor changes were made according to their recommendations. Interviews were recorded using a voice recorder. Each interview lasted approximately 10 minutes. The resulting data has been evaluated and interpreted by categorizing with content analysis. To ensure the reliability of the qualitative data in the study, one of the researchers analysed the texts and the other researcher verified the results. A third additional control was conducted by another expert who had not participated in the study.

3. Results

In line with the aims of the research, the following findings were determined:

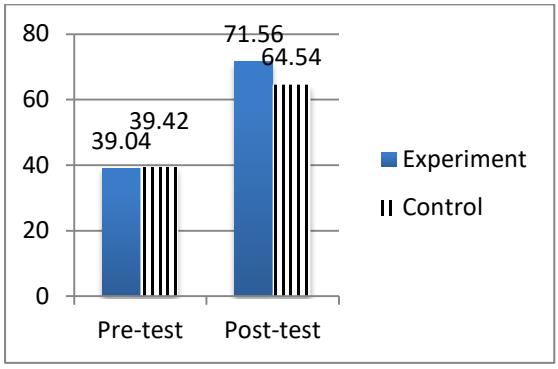
Mobile application development course success of the engineering students

At the end of the study, the "mobile application development achievement test" was used as a post-test to determine if there was a significant difference between the scores of the experimental group whose students who took the training with PBL and the control group's students. An independent t-test was also performed.

Table 2. Achievement test results of the experimental and control groups

Groups	N	X	S	sd	t	p
Experiment	65	71.56	15.6	76	-3.548	.000
Control	65	64.54	11.33			

As can be seen in Table 2., the achievement levels of the control group students trained with traditional approaches are lower than the experimental group educated with the project-based learning approach supported by online environments. Despite an increase in both groups success, the increase in the experimental group was statistically significant ($t = -3.548$, $p<0.05$). According to this finding, it can be said that the project-based learning model, supported by online environments has a more positive impact than the traditional approach in terms of teaching the mobile application development course.



This is an indication that, although the traditional method affected the students' success levels positively, the technology-enhanced project-based learning approach support had a more pronounced effect (Figure 3.).

As seen in Table 3., it has been revealed that there is a significant difference between the grades found in the pre-test and post-test research. According to these results, it can be observed that the use of the project-based learning approach when teaching the mobile programming teaching for the experimental group is significantly different from the control group, when a comparison is made between the pre-test and post-test.

Table 3.: Repeated measures Anova results regarding the pre-test and post-test success grades of students in experimental and control groups

Source of variance	Sum of squares	df	Mean square	F	P
Intercept	8879.502				
Group (Exper./Cont.)	1614.171	1	1614.171	10.9	.002
Error	7265.331	49	148.170		
PBL (Pre-Post)	1176.392	1	1176.392	8.05	.000
Group*PBL	1616.165	1	1616.165	10.8	.002
Error	7259.331	49	148.170		

According to the findings, the change in success of the students exposed to the project-based learning approach in the mobile programming lesson shows a significant difference to the change in success of the students exposed to traditional teaching methods in the control group. It can be said that this change in the students' level of achievement in the mobile programming course is due to the project-based learning approach.

Views of engineering students in the experimental group about the application of technology-supported project-based learning approach and their efficiency

A semi-structured interview form was used in order to gather the views of the experimental group students regarding the application of the technology-supported project-based learning approach. The data that was collated from the interviews are presented in the details below.

Along with the evaluation of the views of the experimental group students about the application of technology-supported project-based learning, various questions were asked to students, such as: "How efficient do you think the application of technology-supported project-based learning of the mobile application development was?" "What are the advantages and disadvantages of technology-supported project-based learning?" and "Have you experienced any difficulties in the project-based learning process? Explain." Table 4. displays the codes and frequencies of the evaluation.

Table 4. Engineering Students' Views on the Effectiveness of Technology Supported PBL

Theme	Code	Frequency (f)
Effective	Contribution to future professional life	41
	Motivation	35
	Collaborative working	34
	Teacher guidance	13
	Earning Income	3
Ineffective	Communication problems	4
	Bad internet connection	4

The students' answers to the questions were categorised into the two themes "effective" and "ineffective", as seen in the above table.

The majority of the students in the experimental group stated that the skills they gained during the technology-supported project-based learning process would provide a significant contribution to their engineering careers in the future.

Student 21 admitted "I would like to think that, besides the content of the courses I have learned, fulfilling the necessary criteria in the process and realizing project phases will have a positive effect in my professional life."

Student 13 stated "While realizing the project-based learning stages, it helped to realize that target audience analysis is important for mobile application development. I also think that the implementation of the project phase through the Moodle system will make it easier for my future projects."

Many students have stated that they are now motivated to work online and development applications collaboratively:

Student 3 commented that, "Online environments always increase my motivation. I was motivated by the fact that the mobile application development course is supported by an online environment and it is a real project."

Student 7, "I watched the course videos and discussed in forums with my group friends while drinking coffee at home and so this increased my motivation."

Student 16 said, “Collaborative learning activities that are required by project-based learning make mobile application development easier, because we can combine our competencies with our teammates to create better applications”

Some students stated that the teacher provided more effective guidance through the technology-supported project-based learning approach:

“Because the activities with collaborative learning groups come to the forefront in the project-based learning process, the teacher allocated more time to guide us effectively”, stated Student 6.

Student 34 admitted, “Our teacher instantly gave feedback to our projects via the Moodle system. So, we have completed our mobile application development project smoothly”

Student 55, “During the project based learning process, our teacher guided us both online and in the classroom environment at each stage, from analysing the target audience to testing the beta version of the mobile application”.

One of the most gratifying answers provided by several students was that they believed that they could even generate revenue by loading their applications on the Google Play Store:

Student 23 admitted, “Thanks to project-based learning activities, we have continued to work effectively with our teammates, so that the mobile applications we have developed are professionally prepared. We can earn money by loading our mobile apps onto the Play Store.”

Very few of the students referred to the negative side of project-based learning. Some of the student's opinions related to communication problems and poor Internet connections determined under the ineffective theme are as follows:

Student 43 indicated that, “During the project, the Internet connection was terrible so I could not follow the course videos and discussions made in the online environment.”

Student 37, “I wanted to meet face-to-face with teammates instead of in online environments, but they wanted to work online, which caused some communication problems between us”

Looking at the participants’ statements, it can be stated that the majority of the engineering students held positive views regarding the technology-supported project-based learning.

4. Conclusion

In this research, the aim was to examine the effects of conducting a mobile application development course using a technology-supported project-based learning approach on the students’ success levels as well as their opinions.

The preliminary test conducted to determine the students' mobile application development competencies before the study revealed that the competencies of the students in both groups were similar to each other. Moreover, it was found that the mobile application development competencies of the students in both groups increased after the study. Another important result is that students studying in the technology-supported project-based learning approach exhibited higher mobile application development success than the students working in traditional methods. Similarly, Ergul & Kargin, in their research, stated that project-based learning positively affects the students’ success [16]. Selwyn reported that virtual environments can be used as a collaborative learning platform and that success can be enhanced accordingly [17].

Many students also expressed the opinion that technology-supported project-based learning has numerous advantages, while there were few students who claimed that there were disadvantages to project-based learning. The most important advantage of the technology-supported project-based learning process for the students was that they had already learned how to implement a project before they had started their professional engineering careers. Long, Carlo, Fraser, Gosav, & Grasman indicated that enabling students to work in a well-designed project provides an invaluable experience for their future careers [17, 18].

According to the results obtained from this research, it has been determined that the engineers of the future can discover the positive effects of collaborative work by combining their skills. Furthermore, Dávideková & Hvorecky stated that, through Information and Communication Technologies, teammates can share the information they need with each other in a timely manner, which means that collaborative teams are more effectively formed [1]. Despite these positive results, it was determined that some of the students had problems communicating with their teammates during the process and their projects were negatively affected. Another negative result is the fact that some students did not have reliable Internet connections and therefore experienced communication problems.

There are some limitations to this study, as with every study. One of these limitations is that the only environment used was Moodle. Project management software can be used to manage the project process better and to improve communication between teammates and between groups. Another limitation is that the only software used in the mobile application development process were "Adobe Flash Professional" and "ActionScript 3". Mobile applications developed with different software should be evaluated in future studies.

It is anticipated that this study conducted with a technology-supported project-based learning approach will contribute to the literature. A well-designed technology-supported PBL approach is expected to have a positive impact on mobile application development projects. Additionally, opportunities for further development through the project-based learning approach can be provided when working with mobile application developers. Finally, it is suggested that the technology-supported project-based learning process that was conducted in this study could be tested on different courses.

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