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Web-Mediated Problem-Based Learning and Computer Programming: Effects of Study Approach on Academic Achievement and Attitude

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Abstract

In the relevant literature, it is often debated whether learning programming requires high-level thinking skills, the lack of which consequently results in the failure of students in programming. The complex nature of programming and individual differences, including study approaches, thinking styles, and the focus of supervision, all have an effect on students' achievement in programming. How students learn programming and the relationships between their study approaches and their achievement in programming have not yet been adequately illuminated. In this regard, the present study aims to investigate the effect of the study approach used on students' attitudes toward programming and on their academic achievement within an online problem-based learning environment. In this study, a single-factor, pretest posttest single group and semiempirical method was utilized. The study was conducted on 41 students from a public university in Turkey. To implement problem-based learning activities, a teaching environment was created with the Moodle platform, allowing for group work and discussions. Seven status of the problems were prepared exclusively for the 12-week application period so that students could make suggestions about how to solve them. In the data collection phase, the Study Approach Scale, the Attitude Towards Programming Scale, and the Academic Achievement Test were

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employed. T-test and covariance analyses were carried out in the statistical analysis phase. According to the findings of the present study, students adopting the “deep” study approach were more successful than the students adopting a “superficial” approach. Moreover, it was determined that the problem-based learning application had a positive effect on students’ attitudes toward programming and that the study approach did not significantly affect the students’ attitude toward programming.

Keywords
problem-based learning, study approach, attitude toward programming, academic achievement, blended learning, web-based learning

Introduction

Activities related to problem solving constitute a major part of our domestic and business lives (Jonassen, 2000). In this sense, individuals need to analyze and find solutions to the problems that they encounter. Learning is not only considered to be the acquisition of a large amount of information or the ability to recall this as well as various principles and practices but also aims to educate individuals with problem-solving, analysis, and evaluation skills (Bates, 2000). It seems likely that this can only be accomplished through the constructivist approach. Constructive instructional design consists of reproducible and feasible techniques that lead to learners’ cognitive learning strategies and critical thinking skills (Jonassen, 1994). According to the constructivist approach, there are various learning models available, one of which is the Problem-Based Learning (PBL) model. This aims to develop students’ problem-solving and high-level thinking skills (Edens, 2000). PBL allows students to construct the information they are learning in an individual manner. In this method, teachers are not considered as solely people who transfer information to student directly; instead, they are mentors who guide students toward a solution to the problem. Student-centered active learning in which instructors are mentors has been a focal point of modern education systems. Active learning is a process in which students take responsibility for their own personal learning. In addition, it allows students to make decisions about the different aspects of the learning process and their personal performance (Açıkgöz, 2003). In the active learning process, learning becomes a personalized process, rather than one of formal teaching, so that students’ problem-solving skills, critical thinking, and learning skills can be enhanced.

The issues that PBL aims to resolve are complex situations which could be experienced in daily life. These problems require algorithmic thinking skills. To find the correct solution requires having skills in numerous major areas. For instance, proficiency in programming requires coding skills as well as adequate knowledge of math. In the PBL system, students use their own knowledge and skills to determine the status of the problem and its solution. Learning thus becomes more effective and productive owing to the active participation of student. The PBL is an active learning model which allows students to become aware of and describe their own problem-solving skills and learning needs (Akınoğlu & Özkardeş Tandoğan, 2007). Students take more responsibility for their personal learning processes in classrooms applying the PBL model.

In the PBL model, the concepts, learning objectives, and status of the problem are first determined. Students are informed about the basic elements of PBL before it is used. Then, students are divided into small groups. Students are given the opportunity to investigate and to understand the problems posed. Students can make suggestions regarding a solution if they are able to collect adequate information about the issue. If they are not sufficiently knowledgeable, they are encouraged to carry out further research by utilizing various data resources. All information collected in this process is shared and discussed among and assessed by group members. The suggested solutions are presented to other groups. All information regarding the problem is obtained through further discussion of results under the supervision of the teacher (Dori & Herscovitz, 1999; Duch, Groh, & Allen, 2001). The PBL model transforms students from passive information receptors into active, self-learning, and problem-solving individuals. What is expected from education is to ensure that individuals become problem solvers in their real lives (Brooks & Brooks, 1993; Chin & Chia, 2004; Gallagher, 1997; Herreid, 1997; Tobin, 1986). Hence, educational programs have shifted from a focus on teaching to a focus on learning. This model motivates students to learn new information when they face new problems.

PBL, which has recently been applied in a large number of major institutions, was first introduced in the Medical School of Case W. University in the United States in 1950, followed by the McMaster University Faculty of Medical Sciences in Canada in the late 1960s (Herreid, 2003). It was observed that university-level research on the PBL has usually focused on education in medicine, engineering, natural sciences, and math (Blake, Hosokawa, & Riley, 2000; Gülsüm & Sungur, 2007; Liu, 2003). On the other hand, research on secondary and primary education has usually focused on the natural sciences, math, and social sciences courses. For example, Uslu (2006), Gülsüm and Sungur (2007), Demirel and Turan (2010), and Uygun and Tertemiz (2014) reported that PBL was effective in terms of enhancing students' academic achievement and ensuring that it lasted; Günhan (2006) and Tandoğan (2006) concluded that PBL has a positive effect on the attitudes of students toward the course.

Preliminary research on the effect of PBL and students' learning approaches was initiated by Marton and Saljo (1975, 1976) in Sweden in Göteborg University in 1970s (Ozan, Köse, & Gündoğdu, 2012). In this precursor study, which employed a qualitative research method, students were assigned the task of reading a scientific article so as to assess their level of comprehension of the content of the article. According to this study, students' learning approaches can be classified into two groups with respect to their comprehension levels. If students comprehend the subject well, they are assumed to have a "deep" learning approach, otherwise they have a "superficial" learning approach.

Ramsden (2000) reports that students who adopt a deep learning approach are looking to have a better understanding of the subject, are interested in the structure of the learning task, establish connections between theoretical opinions and daily experiences, and structure the content that they are studying into a coherent whole. Moreover, they emphasize that when students adopt the deep learning approach when considering a subject, they have positive attitudes such as showing interest, caring, and enjoying learning. Students using the deep learning approach aim to comprehend the subject of study.

The superficial learning approach has the intention of completing the task with minimum adverse consequences while still fulfilling the requirements of the learning task. Ramsden (2000) reports that students who prefer the superficial approach only consider fulfilling the requirements of the assigned task, memorize information for evaluation purposes, are unable to make distinctions between principles and examples, and perceive the task as an external obligation. This approach results in study behaviors which produce poor learning, lack of analysis and integration of the subject among learners, and which do not provide them with the opportunity to produce accurate work (Batı, Tetik, & Gürpınar, 2010).

In the present study, a Computer Programming course was investigated in terms of the PBL study approach because it required a high level of problem-solving skills. Computer programming has become one of the more prominent professions today due to the significant growth in the Information Science industry. Achievement in computer programming depends on individual's problem-solving, logical, and numerical thinking skills (Korkmaz & Demir, 2012; Lau & Yuen, 2009). Programming courses are some of the subjects which students find most difficult to understand (Askar & Davenport, 2009; Başer, 2013; Milne & Rowe, 2002; Pillay & Jugoo, 2005). This is because programming knowledge requires a high level of problem-solving skills (Lau & Yuen, 2009). Moreover, individual differences and attitudes toward programming (ATP) have an effect on students' programming achievement. According to the relevant literature, various methods and techniques have been applied to enhance efficiency in programming education. To make programming education more simple and interesting, there have been various prominent applications such as the development of the "Edujudge" e-learning platform (Verdú et al., 2012), implementation through and interactive game-based approach (Rodríguez Corral, Civit Balcells, Morgado Estévez, Jiménez Moreno, & Ferreiro Ramos, 2014), application through a system in which a cooperative teaching method is utilized (Hwang, Shadiev, Wang, & Huang, 2012), support using online forms (Shaw, 2012), application by increasing the evaluation range (Brito & De Sá-Soares, 2014), performing group code monitoring (Wang, Li, Feng, Jiang, & Liu, 2012), implementation of evaluation by means of interviews with students based on stories (Hawi, 2010), investigation based on learning styles (Lau & Yuen, 2009), application of a virtual reality environment (Esteves, Fonseca, Morgado, & Martins, 2011), and support using a cellular robot and similar tools (Pereira, Zebende, & Moret, 2010).

Individuals think differently and look for different solutions when they are faced with a situation in which they are expected to resolve a problem or to make a decision. Instructors could create learning environments to allow them to gain the capacity to develop different point of views and to increase their effectiveness in discussions (Von Oech & Oech, 1983). Playing an active role in learning environments and actively participating in courses both make students more academically successful. The transition from the instructor-centered teaching to student-centered teaching has been fundamentally based on this idea. The active usage of computers and the internet in education and training activities contributes positively to the interaction between instructors and students and to student achievement. Educational activities can be helpful tools for individuals to develop better styles of thinking with regard to problem solving (Duman & Çelik, 2011) and individuals' preferred intellectual styles could change (Esmer & Altun, 2013).

From a review of the relevant literature, it is possible to see that there are a number of studies on study approaches and the effect of PBL on achievement and attitudes of students. However, no study has so far been carried out, which investigates PBL in terms of the study approach used in programming teaching, which requires both problem solving and high-level thinking skills. For instance, Abdul-Rahman and Du Boulay (2014) investigated the achievement levels of students classified according to their learning styles in programming languages course. The researchers reported that the different learning approaches of students in programming education produced different levels of academic achievement. An investigation of the teaching process as it is used in programming education, the method and techniques employed, and the reasons for achievement or failure will contribute to the literature. In this sense, it is considered that the present study could guide teachers and instructors in terms of which programming education method should be followed for what is one of the most difficult courses to teach.

The reason for examining PBL and two different study approaches in programming education is that all three concepts have some common points, as indicated later: The objective of PBL is to enhance students' problem-solving and thinking skills (Edens, 2000); competency in programming require superior problem-solving skills (Lau & Yuen, 2009). PBL ensures "deep" learning (Newble & Clarke, 1986), and one of the results of quality learning, the development of analytic skills, could be acquired by means of the deep learning approach (Gordon & Debus, 2002). The essential objective of PBL is to be a model which assists students to gain the capacity of versatile thinking and problem-solving skills (Edens, 2000); Programming teaching requires superior problem-solving skills (Fesakis & Serafeim, 2009; Kalelioğlu & Gülbahar, 2014; Schwartz, Stagner, & Morrison, 2006). In PBL, students enumerate possible solutions and make a judgment about the best solution (Davis & Harden, 1999); in the deep learning approach, students investigate the logic of theories carefully and from a critical point of view (Entwistle, 1997). In PBL, students learn by means of research and data collection (Davis & Harden, 1999); in the deep learning approach, students establish connections between their previous knowledge and experiences and new information (Entwistle, 1997). In PBL, learning is maintained on the basis of a problem (Barrows, 1986; Wood, 2003); in the deep learning approach, students are inclined to make connections between theoretical ideas and their daily experiences with others (Ramsden, 2000). In PBL, students actively participate in learning and take more responsibility (Bridges, 1992; Torp & Sage, 2002); in the deep learning approach, students are more focused on understanding the subject than those with a superficial approach, and they make an effort to structure the content in a coherent form (Ramsden, 2000). Students' learning approaches and study skills are the most important variables which have an effect on the quality of learning (Ekinci, 2008; Senemoğlu, 2011).

The earlier explanations regarding the variables and the relationship among them reveal that it is necessary to investigate whether the approaches adopted by students are determining factors in learning programming languages through the online PBL method. Moreover, no study investigating the PBL study approach in programming language teaching was found in the available literature.

The fundamental problem of this present study is to determine the effect of students' study approaches on their ATP and academic achievement in online PBL. To that end, answers were sought to the following questions:

1. In online PBL, is there a significant difference between the mean ATP scores of students with different study approaches?
   a. Is there a significant difference between their mean ATP scores in the pre- and postapplication periods.
   b. Do the preapplication attitude scores regarding PBL exhibit a significant difference from the postapplication attitude scores in terms of the students' study approaches?
2. In online PBL, is there a significant difference between the academic achievement scores of students with different study approaches?
   a. Is there a significant difference between academic achievement scores measured in the pre- and postapplication periods?
   b. Do preapplication attitude scores regarding PBL exhibit significant difference with respect to the postapplication attitude scores in terms of students' study approaches?

Method

In this section, the research method, work group, and teaching materials used in the study are explained. Data collection tools and statistical analyses of collected data are also described.

Research Method

In cases including two or more groups and pre- and postexperiment measurements, the split-plot empirical method is utilized (Büyüköztürk, 2008). Therefore, the single-factor, pretest posttest single group and semiempirical method was employed. The factor at this point is the variable of the study approach. Whereas the pretest refers to the measurements taken before the application, the posttest refers the measurements at the end of the application. The effect of PBL on both groups was investigated in this study. The effect of this method, which was applied to all groups, on their ATP and on students' academic achievement was investigated.

Workgroup

This study was conducted on 41 sophomore students receiving the Programming II Course and who were attending the Computer Teaching Department of a Faculty of Education at a public university during the spring semester of the 2015–2016 academic year in Turkey. The reason that the study was conducted on this student group was that the work group had taken Programming I during the Fall semester of the sophomore year, and the fact that the programming course requires a high level of problem-solving and thinking skills.

Planning and Instruction of the Course

In carrying out the online PBL activities, the Moodle Learning Management System was utilized. Before the application, students were informed about the usage of the Moodle Learning Management System. Moreover, after PBL was explained, an example study was conducted. Seven individual problems were structured for students to find solutions during a period of 12 weeks in total. To form the problems, stories, tables, and prior course knowledge were utilized. Problems were presented in unique scenarios considering the learning targets. The fundamental targets of the 12-week program were determined to be the development of students' high-level thinking and problem-solving skills, the implementation of collaborative teaching, and the clarification of the effect of PBL in learning a programming language.

Students carried out these PBL activities, including the seven problems given, in a web environment, working collaboratively in groups. All information obtained in this process was shared, discussed, and assessed among members.

Through this, the relevant solution was found. Finally, each group's solution to the problem was presented to other groups.

The following steps were applied in planning the course:

- First, the study approaches of students were determined. Then, the ATP and achievement pretests were applied.
- Student groups were formed on a voluntary basis.
- The problem scenarios were shared in the web environment.
- Group members developed suggestions for solutions to the problems collaboratively.
- Each of the groups was required to share their suggested solutions, to discuss them, and to decide on a single solution.
- At the end of the 12-week process, the ATP and achievement tests were repeated as posttests.

Data Collection Tools

In data collection process, the Study Approach Scale, Attitude Toward Programming Scale (ATPS), and the Academic Achievement Test were utilized.

Study Approach Scale

In determining the students' study approaches, the version of the scale developed by Biggs, Kember, and Leung (2001), which was adapted into Turkish by Yılmaz and Orhan (2011), was employed. While the scale consisted of a total of 20 items, it comprised two factors referred to as the "deep" and "superficial" approaches, each of which consisted of 10 items for measuring the corresponding approach. Students usually prefer the learning approach with which they attain higher grades. The scale items were 5-point Likert type and thus included following answer options: *Never or only rarely corresponds to me* (1), *Sometimes corresponds to me* (2), *Corresponds to me half of the time* (3), *Frequently corresponds to me* (4), and *Always or almost always corresponds to me* (5). The internal consistency scores of the scale (Cronbach's Alpha) were estimated at .79 and .73 for the deep and superficial approaches, respectively. The results of Yılmaz and Orhan's (2011) study suggested that the adapted scale was a valid and reliable measurement tool and had linguistic equivalency for determining the study approaches of students in higher education.

Attitude Toward Programming Scale

To measure students' attitudes toward computer programming, Başer's (2013) "Attitude Towards Programming Scale" consisted of 38 items in four factors structured in a 5-point Likert-type model was employed. The original version of this was developed by Wiebe, Williams, Yang, and Miller (2003). The current scale was obtained after removing 9 items from the original scale consisting of 47 items as a result of the factor reliability analysis. The scale consisted of the subdimensions of "self-esteem and motivation in programming," "benefits of programming," "attitude toward achievement in programming," and "social perception of achievement" in programming. The internal consistency coefficients of the scale were in the range of .618 to .944. The overall internal consistency coefficient for the scale (Cronbach's alpha) was estimated to be .947. Items in the scale were given with the following answer options: 1—*Definitely Agree*, 2—*Agree*, 3—*Undecided*, 4—*Disagree*, and 5—*Certainly Disagree*. The total score that could be obtained from the scale ranged between 38 and 190. As the total score increases toward 190, so the positive attitude toward computer programming increases, and this works in reverse as the score decreases.

Academic Achievement Test

An academic achievement test developed by the researcher was used to measure the academic achievement of students in the C# programming language. The draft academic achievement test comprises seven open-ended questions. To enhance the scope and validity of the test, the weight of subjects in distribution was taken into consideration. Moreover, test validity was maintained by consulting experts in programming teaching, measurement, and evaluation. While six questions were 15 points, one was 10 points, and total of 100 points. The validity of the test was assessed on the basis of pilot study during the spring semester of academic year 2014–2015 on 56 students not in the work group before the present study was carried out. Following the pilot study, two items were removed from the scale in the light of expert opinions.

Analysis and Interpretation of Data

First, it was tested whether the factors employed were distributed normally or not, and whether or not they displayed homogenous distribution.

Fitness of data to the normal distribution is analyzed by the One Sample Kolmogorov–Smirnov Test. In the case that values on the row called the Assymp. Sig. (Significance) are greater than the threshold value of .05 in statistical significance assessment, it can be considered that the analyzed factors are normally distributed, whereas the reverse is the case if the value is less than .05 (Kalaycı, 2009). The significance values of factors used in the study are exhibited in Table 1.

From Table 1, it can be observed that since the significance values of all factors used in the study were greater than .05, these factors were normally distributed, which suggested that parametric tests could be used in the analysis.

Table 1. Factors and Normal Distribution Significance Values.

Factors	Significance
Attitude Towards Programming Scale Pretest	.200
Attitude Towards Programming Scale Posttest	.200
Academic Achievement Pretest	.062
Academic Achievement Posttest	.058

The *t*-test is conducted in empirical studies in which there are two interrelated measurements or scores; in other words, it is used for cases in which repeated measurements of the same subjects are taken and the differences between these two measurements are investigated (Büyüköztürk, 2008). Therefore, the *t*-test was employed to determine whether there was a significant difference between pre- and postapplication measurements of attitude and academic achievement scores.

In general, the analysis of covariance (ANCOVA) test is conducted to determine whether there is significant difference in methods between the pretest-posttest measurements of the experimental and control groups (Büyüköztürk, 2008). At this point, ANCOVA tests whether posttest scores modified according to the pretest scores cause significant difference between groups. Accordingly, single factor covariance analysis (ANCOVA) was employed in order to determine whether the posttest scores displayed a significant difference with respect to the attitude and achievement scores before the application in terms of the relevant study approach.

Findings

Findings Regarding ATP

Table 2 exhibits students' ATP pre- and posttest scores.

Whereas the mean ATP pretest score of students with the "deep" approach was determined as $M = 3.08$, the mean posttest score was determined as $M = 3.21$. Similarly, whereas the mean ATP pretest score of students with the "superficial" approach was determined as $M = 3.10$, the mean posttest score was determined as $M = 3.22$. The overall mean ATP pretest and posttest scores of students were determined as $M = 3.09$ and $M = 3.21$, respectively.

To determine whether there was a significant difference between ATP pretest and posttest scores, the results of the *t*-test concerning observed differences in students' ATP scores are exhibited in Table 3.

A dependent sample *t*-test was conducted to compare ATP pre- and posttest results of the students (Table 3). According to *t*-test results, there is a significant difference between pretest result ($M = 3.09$) and posttest result ($M = 3.21$);

Table 2. Mean Pre- and Posttest Scores Regarding Attitude Toward Programming.

	Pretest			Posttest		
Group	*n*	$\bar{X}$	*S*	*N*	$\bar{X}$	*s*
Deep approach	29	3.08	.18	29	3.21	.18
Superficial approach	12	3.10	.13	12	3.22	.08
Total	41	3.09	.17	41	3.21	.15

Table 3. T-Test Results on Mean Pre- and Posttest Scores Obtained From the Attitude Toward Programming Scale.

ATP	*N*	$\bar{X}$	*S*	*SD*	*t*	*p*
Pretest	41	3.09	.17	40	−7.65	.00
Posttest	41	3.21	.15			

ATP = attitudes toward programming.

Table 4. ANCOVA Results of Modified Posttest Scores According to the ATP Pretest Scores With Respect to Study Approaches.

Variance Re	Sum of squares	*SD*	Mean squares	*F*	*p*
ATPÖ-Pretest	.61	1	.61	64.85	.000
Group	.001	1	.001	.07	.799
Error	.35	38	.009		
Total	424.60	41			

ATP: attitudes toward programming; ANCOVA: analysis of covariance.

$t(40) = -7.65$, $p = .00$. This finding suggests that the online PBL method might have a positive effect on students' attitude toward programming in programming language teaching.

When the ATP pretest scores were considered, single factor covariance analysis (ANCOVA) was employed to determine whether the posttest scores exhibited significant difference with respect to the study approach, and relevant results are summarized in Table 4.

According to the results of the single factor covariance analysis (ANCOVA), no significant difference was determined between the ATP posttest scores corrected according to the ATP pretest scores of students with different study approaches, $F(1,38) = 64.85$, $p > .005$. Based on this finding, students' ATPs are not related to their study approaches.

Table 5. Mean Academic Achievement Pretest and Posttest Scores.

	Pretest			Posttest		
Group	N	$\bar{X}$	s	n	$\bar{X}$	s
Deep approach	29	49.79	11.14	29	68.00	10.69
Superficial approach	12	49.33	18.79	12	54.50	13.30
Total	41	49.66	13.56	41	64.05	12.93

Findings Regarding Academic Achievement

Academic achievement pre- and posttest scores of students are exhibited in Table 5.

Whereas the mean academic achievement pretest score of students with the "deep" approach was determined as $M = 49.79$, their mean posttest score was determined as $M = 68.00$. On the other hand, the mean academic achievement pre- and posttest scores of students with the "superficial" approach were determined as $M = 49.33$ and $M = 54.50$. In general, the mean academic achievement pre- and posttest scores of all the students were determined as $M = 49.66$ and $M = 64.05$.

Regarding the significance of the difference observed in the academic achievement scores, the results of the t-test conducted to determine whether there was significant difference between academic achievement pretest and posttest scores are summarized in Table 6.

According to Table 6, the mean Academic achievement pre- and posttest scores of students were determined as $M = 49.66$ and $M = 64.05$, respectively. According to the t-test results, a significant increase was observed with the academic achievement scores of students in the postapplication period of the online PBL, $t(40) = -6.60$, $p = .00$. This finding suggests that online PBL is positively related to students' academic achievement scores in programming language teaching.

When considering the academic achievement pretest scores, single factor covariance (ANCOVA) analysis was conducted to determine whether the posttest scores exhibited significant difference with respect to the study approach, and the relevant results are exhibited in Table 7.

According to the results of single factor covariance analysis (ANCOVA), no significant difference was determined between academic achievement posttest scores modified according to the pretest academic achievement scores of students with different study approaches, $F(1,38) = 12.71$, $p < .005$.

Pre- and posttest scores of students with the "deep" approach were determined as $M = 49.79$ and $M = 68.00$, respectively. The mean pre- and posttest scores of students with the "superficial" approach were determined as $M = 49.33$

Table 6. T-Test Results of Mean Academic Achievement Pretest and Posttest Scores.

Academic achievement	*N*	$\bar{X}$	*s*	*SD*	*t*	*p*
Pretest	41	49.66	13.56	40	−6.60	.00
Posttest	41	64.05	12.93			

Table 7. ANCOVA Results of Modified Posttest Scores According to the Academic Achievement Pretest Scores With Respect to Study Approaches.

Variance resource	Sum of squares	*SD*	Mean squares	*F*	*p*
Academic achievement pretest	1289.36	1	1289.36	12.71	.001
Group	1502.74	1	1502.74	14.81	.000
Error	3855.64	38	101.46		
Total	174884.00	41			

ANCOVA: analysis of covariance.

and $M = 54.50$, respectively. That is, the mean achievement scores of students with the "deep" approach increased at higher rate.

To determine the significance of this difference, effect size was investigated, and it was determined that study approaches had a high effect size $(\eta^2 = 0.280)$ on students' academic achievement scores.

As a result, a significant difference was determined between the academic achievement levels of students using different study approaches. Students with the "deep" approach were more successful than those with the "superficial" approach.

Discussion and Conclusion

It was observed that applying online PBL had a positive effect on students' ATP. Moreover, blended learning might have a role on this result. This finding suggests that the PBL has positive effect on students' attitudes toward the programming course, a course in which a relatively negative attitude and low motivation levels are usually observed. No study was found in the relevant literature concerning ATP in an online PBL programming course. The study results can only therefore be compared with the results of studies investigating student attitudes in other courses in which PBL was utilized. In one of the relevant studies, Tekedere and Mahiroğlu (2014) investigated PBL in terms of the variable of "supervision" and reported that online PBL had a positive effect on students' attitudes toward online learning and PBL. Pereira et al. (2010) claimed that the logical thinking capabilities of programming students could be enhanced through PBL. These researchers employed various programming tools such as the *Turing Machine and Cellular Robot* programming in their study. One of the objectives of PBL is to increase productivity by means of collaborative teaching. Serrano-Cámara, Paredes-Velasco, Alcover, and Velazquez-Iturbide (2014) investigated student motivation in an environment in which programming teaching was supported by collaborative teaching tools. Their results showed that the cooperative teaching method had a positive effect on motivation. In similar studies in which the PBL method was applied, positive changes were observed in student attitudes (Akınoğlu & Özkardeş Tandoğan, 2007; Günhan, 2006; Karaöz, 2008; Korucu, 2007).

Furthermore, with regard to the pretest scores concerning students' ATP, it was determined that the corrected posttest scores did not exhibit significant variance according to their study approaches. This finding suggests that the study approaches of students did not have an effect on their ATP. In the relevant literature, no study focusing on the effect of the PBL on ATP was found. However, our findings can be supported by results reported in studies in which the effects of different personal characteristics on attitude and achievement were investigated. Alper and Deryakulu (2008) studied the effect of the level of cognitive flexibility in student-directed PBL in a web environment on students' achievement, attitudes, and the durability of learning. The researchers reported that the use of PBL did not have an effect on the cognitive flexibility level. Similarly, Lee (2013) reported that there was no significant correlation between students' learning approaches and their participation in online discussions and their academic performances. On the other hand, Tekedere and Mahiroğlu (2014) revealed that a focus on supervision produces a significant difference on students' attitudes toward online learning. Cheng and Chau (2016) reported a significant correlation between learning approaches and online participation. Hwang et al. (2012) designed an online collaborative teaching environment to facilitate programming education. As a result of applying this, researchers found that learning styles have a positive effect on learning achievement.

The second question in this study was about the effect of the use of PBL on academic achievement. As a result of online PBL, the academic achievement levels of students with both "deep" and "superficial" approaches increased. However, this increase was observed to be more significant with the students from the "deep" approach group. This finding is supported by the studies investigating the relationship between PBL, study approaches, and academic achievement levels. In their study investigating the effect of PBL on student achievement in a math course, Uygun and Tertemiz (2014) reported that the students from the experimental group using PBL were more successful. Ersoy, Madran, and Gülbahar (2011) concluded that robot programming techniques and programming education have a positive effect on student achievement. Similarly, other studies also concluded that PBL has a positive effect on academic achievement

(Akınoğlu & Özkardeş Tandoğan, 2007; Cerezo, 2004; Çalışkan Çiftçi, Meydan, & Ektem, 2007; Sifoğlu, 2007), supporting the findings of our study. On the other hand, Alper and Deryakulu (2008) concluded that there was no significant difference between the achievement levels of students with various levels of cognitive flexibility level using PBL. Moreover, it was stated that this could be because the multioptional measurement tool used in the evaluation of student achievement is not sufficient when it is used alone.

Students' posttest scores modified according to their pretest scores according to their academic achievement exhibited significant differences in terms of the study approaches used. The academic achievement scores of students with the "deep" approach were found to be higher than those with the "superficial" approach. This finding suggests that the study approach produces a significant difference in students' academic achievement scores. Thus, it can be suggested that, similarly to those with a negative attitude, students using the "superficial" approach need more support to improve their academic achievement. Unfortunately, no study investigating the effect of PBL on academic achievement in terms of study approaches could be found in the relevant literature. Therefore, studies that could support our finding here could not be included.

Finally, programming teaching is considered to be one of the hardest subjects for students to handle because programming teaching requires high-level problem-solving and thinking skills. One of the methods that could be chosen in order to develop these high-level skills is the PBL method. For this reason, the PBL method was used in the programming course in this study. The study concluded that online PBL has a positive effect on students' ATP in programming teaching. Attitude is an essential factor in achievement and productivity. This finding indicates that similar forms of teaching could be used in order to develop the ATPs of programming students. However, students' study approaches did not have a significant effect on their ATPs.

Online PBL in programming teaching produced a significant difference in academic achievement with respect to the study approach adopted by students. This difference was to the advantage of students adopting a "deep" study approach. This conclusion suggests that different study approaches should be taken into consideration in the use of PBL. Furthermore, it was observed that students preferring the "superficial" study approach experienced difficulty during the PBL in terms of understanding the problems given and coming up with solutions.

Limitations

A research in which a large target population will be studied can be designed so that the results could be more generalizable. Another limitation is that the students are not accustomed to the learning process based on problem based.

Suggestions

Since the present study is precursor research, which takes the effect of study approaches into consideration in the use of online PBL, it is expected to make a contribution to the literature on PBL. Investigation of online PBL in programming language teaching in terms of different personal characteristics would make a significant contribution to this major topic. Additionally, students' individual differences should be taken into consideration when problems are formulated. An open-ended questionnaire was utilized in the present study to evaluate students' achievement. In PBL, including students' problem-solving and high-level thinking skills in the evaluation criteria would yield more accurate results.

PBL could be used in teaching courses such as programming languages which require high-level problem-solving and cognitive skills. Course content and learning targets could be updated along these lines. Furthermore, individual differences such as students' study approaches and the focal points of any supervision must be taken into consideration when courses are being planned.

Students in this study experienced PBL in a course setting for the first time. Using this application with a student group with prior experience of PBL would make further contribution toward their achievement, positive attitudes, and motivation.

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