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The effects of problem-based learning on the classroom community perceptions and achievement of web-based education students

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ABSTRACT

Web-based education as an alternative to face-to-face teaching is now being extended as an application to higher education. Much effort is undertaken to provide multimedia rich, attractive content to learners. While the use of multimedia technologies has a noticeable effect on students' learning, so does the selected teaching methodology. Underpinned by the Constructivist approach, problem-based learning is one of the methods that could be applied in web-based learning environments. The current study investigates the effects of problem-based learning on students' classroom community perceptions and their achievement. It focuses on the tertiary level course "Introduction to Computers" offered by the Department of Business Administration of the Distance Education Program at a higher education institution in Turkey. The results indicated that students who worked on problem-based projects felt much more 'connected' to other class members when compared to the control group. They achieved higher scores in the post-tests although their online midterm and final examination scores did not indicate any difference between the groups.

1. Introduction

It is increasingly important for today's learners to become sophisticated consumers of information, which involves developing expertise in the process of problem solving. Nonaka and Takeuchi (1995) state that there is a need for a more flexible labor force to meet the growing amount of knowledge-intensive work. However, when compared to traditional ways of teaching, a problem solving approach requires the use of radically different cognitive goals such as identifying information needs, finding corresponding information resources, and extracting information from each source (Land & Greene, 2000). The achievement of these goals necessitates the provision of powerful learning environments that support constructive, cooperative and goal-oriented acquisition processes. Problem-based learning (PBL) is a learner-centered instructional approach that empowers learners to think critically; analyze and solve complex, real life problems; find, evaluate and use appropriate learning resources; work collaboratively; demonstrate effective communication skills; and become lifelong learners (Duch, Groh, & Allen, 2001). It provides a format for sharing information and working productively with the others (Savery, 2006).

Recent educational research has been guided by social learning theories such as PBL, which emphasize that learning is an internal and social dialogue (Hrastinski, 2009; Jonassen & Land, 2000). Inspired by these studies, the field of education has recently begun to move from the use of traditional pedagogical approaches to innovative ones which encourage lifelong, collaborative, student-centered and self-regulated learning. In the present study, the authors investigated the effect of the PBL method on the classroom community perceptions and achievement of web-based education students. There is limited literature that provides practical examples of how fully online courses can be structured on the principles of PBL. By applying a PBL approach to web-based education, the authors hypothesized that the social community feelings of the students and their capacity for learning might be increased.

2. An alternative approach to traditional teaching: problem-based learning

Vygotsky's (1978) concept of the zone of proximal development, which is based on social learning theory, posits that by interacting with an experienced person, be that an instructor or peer, a learner can complete more advanced tasks, and learn and develop more than he

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might have done by himself. Problem-based learning is an innovative learning method underpinned by social learning theory and the constructivist approach. There are many reasons why PBL is applied successfully as a learning method. The most pressing reason is that today's employers mostly proffer opportunities to graduates who are equipped with the necessary workplace-specific skills (Taplin, 2000). As announced by Hedley and Barrie (1998), student satisfaction and motivation in PBL courses is high due to the real-life experience which contributes to students' future professional activities. Secondly, learning becomes more effective with approaches such as PBL as they encourage students to acquire new knowledge by themselves through information processing and reasoning (Nuy & Moust, 1990). In a PBL environment, students feel the need to learn new knowledge before they can solve a problem; therefore, their higher level thinking skills are tapped (Kingsland, 1994). Therefore, a major feature of PBL is that a problem is encountered before students start any formal study.

In a PBL environment, students are guided to work in small groups where they identify what they do and do not know, and what information they need to solve the problem at hand. Studying the effects of PBL on achievement, a meta-analysis of 164 studies on cooperative learning pointed out that cooperation among learners had a significant positive impact on achievement (Johnson, Johnson, & Stanne, 2000). The primary role of the instructor in the PBL environment is to facilitate group processes and learning. PBL not only provides prompt feedback to learners but also allows more room for personal learning preferences. Compared to traditional teaching, PBL requires that the teacher has a less central role and the students take more responsibility for their learning, which results in higher student involvement (Andersen, 2002). The method also necessitates using critical thinking skills, learning how to learn and working cooperatively with others. Teamwork is the focal point of PBL as the focus is on project organization to solve problems with the identified tasks. Students learn how to conduct themselves in situations that require the discussion of a problem and how to promote their choice of solution by motivating other group members.

PBL has several distinct characteristics which may be identified and utilized in designing a curriculum. These are: (a) a problem is encountered in the learning process prior to formal study; (b) the curriculum is driven by problems. These problems do not test skills; they assist the development of the skills themselves. They are a part of the curriculum, and not an "add-on" (Taplin, 2000); (c) the problems are truly ill-structured – there is no one solution. As new information is gathered in a reiterative process, both the perception of the problem and its solution changes; (d) students are only given guidelines on how to approach the problems. There is no one formula for intervention. Therefore, students acquire self-directed learning abilities by developing their knowledge, skills and attitudes within appropriate contexts; (e) authentic performance-based assessment is carried out at the end of the instruction; (f) students solve the problems and evaluate their own work. Meanwhile, teachers work as facilitators, coaches, helpers or consultants. There is encouragement of motivation for learning.

3. Classroom community

The classroom community can be defined as the feelings of connectedness among community members and their common expectations of learning and goals. Connectedness implies the feelings of friendship, cohesion and satisfaction that develop among students. These feelings later develop into feelings of safety and trust, which encourages the exposition of learning gaps by community members. Another component of classroom community is the feeling that knowledge and meaning are actively constructed within this community, and that the community enhances learning and acquisition (Rovai, 2002a).

Palloff and Pratt (2005) state that there is a cyclical relationship between the community and collaboration: "Collaboration supports the creation of community and community supports the ability to collaborate". Therefore, the social community of learners is expected to be strong in a collaborative learning environment such as PBL. On the other hand, social community and interaction is supposed to be relatively weak in distance learning environments because of the fact that learners are disconnected. This obstacle may be overcome with instructors' efforts, through the effective use of discussion boards, online meetings, e-mail correspondences, video or audio conferencing.

4. Self-regulated learning

Self-regulation is concerned with the degree of students' metacognitive, motivational and behavioral regulative abilities (Zimmerman, 1990). Self-regulated learners: (a) are highly motivational with their proactive performances, (b) direct their learning processes by setting goals for themselves, (c) apply appropriate strategies to achieve their goals, (d) enlist self-regulative influences that motivate and guide their efforts, (e) exhibit a high sense of efficacy in their capabilities, which influences the knowledge and skill goals they set for themselves (Zimmerman, Bandura, & Martinez-Pons, 1992).

Self-regulation includes the process of implementing, monitoring, controlling and regulating one's cognitive activities, motivation and behaviors for the purpose of knowledge growth (Garcia & Pintrich, 1994). There are many research studies indicating that self-regulated learners make greater use of learning strategies and achieve more than learners who make little use of such strategies (Zimmerman & Martinez-Pons, 1990). In PBL environments, students find themselves in situations where they need to use all their proactive capabilities. They need to be motivated and apply appropriate strategies in order to find the solution to a problem, which is the main goal. Thus, PBL requires the self-regulation of students although they are encouraged to work cooperatively with others.

5. Application of problem-based learning to web-based education

There is a view that PBL should not be delivered through distance education because of the need for face-to-face interaction and direct student support mechanisms (Taplin, 2000). However, Schiller and Ostwald (1994) argued that the flexibility inherent in distance education was closely aligned to problem-solving processes required in the workplace and hence an appropriate mode of delivery. Treadwell and Leach (1998) used PBL in a quasi-distance education mode where the Internet was used for part of the course delivery and found that group dynamics were similar to those in traditional face-to-face modes. The difficulties associated with the use of PBL in traditional contexts, such as "dominant or inactive group members, or students' initial confusion" also exist for online PBL applications, for which instructors should take the necessary precautions (Taplin, 2000). As stated by Hall (2007), Vygotskian theories, which are frequently used in online courses,

are the basis of PBL. Despite this, there are very few practical examples in the literature of how online courses can be structured to follow PBL.

6. Methodology

According to Chen (2000), the use of PBL as an educational tool more than an educational philosophy means that changes are made to the delivery strategy with little or no change to the existing curriculum design or assessment practices. Thus, in the current study no change was made to the existing curriculum; only PBL was applied as an alternative online teaching and assessment approach.

Underwood and Dillon (2007) stated that education is a highly complex system, and that any attempt to assess the impact of ICT on learning outcomes needs to take into consideration the complexity of the system in which the use of ICT will be embedded. The Internet self-efficacy scores of participants were therefore measured at the beginning of the present study to establish if this factor might affect their learning outcomes after the intervention. The study did not directly investigate the effect of the media, but the PBL method. An attempt was made to measure the experimental (C1) and control group's (C2) performances in the study under the same circumstances. The intervention by using the PBL approach was undertaken with the experimental group students. All students were taught with the same web-based content, assessed by the same rubric and guided by the same instructor. Differing from many ICT studies, the study investigated classroom community perceptions of the PBL learners who collaboratively worked on projects. The collaborative working students were hypothesized to have higher classroom community perceptions. Secondly, the method, PBL had a first prominence in the study than media which merely delivered instruction, facilitated and supported collaborative working of the web-based education students by providing a set of tools and the environment. This is what Clark (1983, 1994) suggested about media and method distinction.

The intervention consisted of a blend of project application and online course, and included the following characteristics: (a) problems given in the form of projects were supposed to stimulate or focus learning, (b) the instructor and the researcher coached the students and facilitated their progress by supporting their learning, (c) asynchronous discussion boards were used to facilitate student interaction and cooperative learning, (d) students were supposed to self-direct themselves to achieve their individual learning objectives.

The course aimed to enable the students to undertake basic computer applications similar to real workplace ones by the end of the course. To achieve this learning outcome, the following objectives were specified for the application: (a) provision of practical real-life experiences, human–computer interface and Internet technology information; (b) exposing students to design work for document preparation and spreadsheet handling where there was no single correct design; (c) encouraging cooperative team work to develop communication and interactive skills for expertise sharing and knowledge construction.

For the development of the course model, the following preparations were made: Firstly, a web-based learning environment was prepared. Secondly, asynchronous discussion boards were used. These helped students to work collaboratively and share their knowledge. Next, weekly synchronous (real-time) sessions were held. These tool enabled students to work collaboratively with their instructors to obtain consultancy and guidance, as well as to share know-how with other group members at real-time. Issues which were not well understood in the course were also revised during these sessions. Finally, real-life projects were determined. The course introduced real life examples for further investigation and presented students with the opportunity to explore office applications.

On the other hand, the traditional model applied to the control group included only online lecturing, knowledge acquisition and weekly synchronous (real-time) online meetings which were in the form of weekly course revisions.

6.1. Research problem

This study measured the effects of problem-based learning on higher education students' web-based classroom community perceptions and achievement. The study did not focus on the online technology itself, but the effects of online PBL on learning outcomes. The online environment provided the setting for the students who were not able to otherwise study cooperatively with their virtual group members. As stated by Sage (2000), while there are substantial and growing research studies on computer-supported collaborative learning, limited research has been made on students' problem-solving processes using asynchronous tools. Believed to meet this need to some extent, this study aimed to answer the following questions:

- Is there a significant difference in the Internet self-efficacy and self-regulated learning scores for experimental and control group students?
- Is there a significant change in the students' pre- and post-test scores after participating in the online PBL intervention?
- Is there a significant difference in the achievement and average assignment scores for experimental and control group students after participating in the online PBL intervention?
- Is there a significant difference in the classroom community scores for experimental and control group students after participating in the online PBL intervention?

6.2. Method

Control and experimental students' achievement, social community perception, Internet self-efficacy and self-regulated learning scores were compared.

6.3. Setting and sampling

Participants were taught the "Introduction to Computers" course entirely via the Internet using a learning management system. Students only came to the campus at the end of the semester for a proctored final exam. These students did not meet on campus until the final exam. The participants in the study were enrolled in the Business Administration Department of the Distance Education Program

at a higher education institution in Turkey. Students from the same department were divided into two groups, namely experimental (C1) and control (C2). The study commenced with 75 students in each group, 150 in total. While participation was obligatory with given assignments, almost half of the students dropped out of the study soon after it started. The final number of participants was 78. Of these, 43 (23% male, 77% female) comprised the C1 group and 35 (23% male, 77% female) comprised C2. The final grouping was therefore equal in gender distribution (Table 1).

6.3.1. Control group

Students were taught using the standard online tutorials for the course and through synchronous meetings.

6.3.2. Experimental group

Besides online tutorials, the students worked on and were provided with guidance about their PBL project assignments at weekly online meetings. The asynchronous discussion board of the learning management system was also used by these students for collaborative work with their group members.

6.4. The characteristics of the online learning environment

The web-based "Introduction to Computers" course was offered entirely via the Internet through a learning management system (LMS). Students did not meet each other or the course instructor except for the weekly online meetings that were text-based. The online course was embedded in a LMS that consisted of an integrated set of tools in the following categories: (a) content management tools that allowed the course instructor to present multimedia content, supplementary course materials and weekly course schedule; (b) assessment tools such as online test/exam preparation, online testing and test/exam question pool; (c) student tools such as student lists, student reports and grade book; (d) communication and collaboration tools, which consisted of e-mail messages, online meeting, announcements, discussion boards and an agenda to take personal notes.

6.4.1. Online meeting

This was the session where students met online with their course instructor and fellow students in real-time.

6.4.2. Discussion board

Students in the experimental group were guided to interact with other group members and work collaboratively using the discussion board. Students had the opportunity to work collaboratively on the web via the discussion board on the LMS or at online meetings.

6.5. Data collection techniques

6.5.1. Pre- and post-tests

The same test was applied as a pre- and post-test prior to and after PBL intervention to both the experimental and control groups. The online test included 40 multiple choice questions prepared by the course instructor. Each correctly answered question was scored as 2.5 points with a maximum possible score of 100.

6.5.2. Achievement tests

Students' online midterm and face-to-face final exam scores were recorded to measure both groups' course performances.

6.5.3. Project report evaluations (assignments)

Students in the experimental group were divided into groups of three participants. Each group was assigned four PBL projects in total throughout the semester and information about the projects was given to students at each online meeting. The projects were based on a problem which the students were likely to encounter after graduation. Each project in itself could be divided into sub-tasks which were assigned to individuals in the groups. In order to solve the problems, the students needed to work cooperatively within their team on the discussion board. In the process the following route was followed: Firstly, each group was assigned a problem-based project which the members of each group would discuss and solve. Secondly, group members studied individually their sub-tasks, which would lead to the problem solution through undertaking the necessary research on the Internet or at a library. Students were constantly encouraged by their instructor and the researcher to share their new knowledge with the others. These questions laid down the actual learning outcomes of the course. Thirdly, students shared their new knowledge with other group members on the asynchronous discussion board. Finally, each group submitted a report regarding their project by uploading it to the learning management system at the end of the semester.

Table 1
Gender of students in both groups.

	N	*P*
Experimental group (C1)		
Female	33	76.7
Male	10	23.3
Control group (C2)		
Female	27	77.1
Male	8	22.9

N: Number of students who participated in the study, *P*: Percentage of students who participated in the study.

These assignments were appraised by the course instructor as students' semester assignments and they were evaluated through a rubric prepared by the course instructor in order to enhance the validity of grading.

Students in the control group, on the other hand, were tasked to prepare two project reports (assignments) as individuals without cooperation, they were not asked to use the discussion board or to work in groups. All student assignments in both groups were graded by using the same rubric.

Students were given assignments focusing on word processor (Word), spreadsheet (Excel) and impress (PowerPoint) applications. The details of the activities were as follows:

6.5.3.1. Word processor assignments. Students in groups were assigned two word processor assignments: First, they were assigned to write a formal letter of complaint to an "arbitration committee for consumer problems" as a notification concerning a broken laptop they had purchased a week previously and the seller's rejection of refund. The students were expected to collaboratively work on ways to write a formal letter of complaint taking into account the standards (overall letter layout, details such as type size, typeface, page margin, numbering, heading, adjustments, etc.) required by the course instructor. Secondly, they were assigned to write an autobiography of someone in their group taking into account the standards required by the course instructor. Students were especially guided to write not about themselves but about someone else in their group. It was held that this activity would encourage collaboration and interaction among group members.

6.5.3.2. Spreadsheet assignment. Students were assigned to prepare a questionnaire by choosing one of the issues offered by the course instructor. Students were again asked to follow the required standards (line and column adjustments, naming the sheets, etc.).

6.5.3.3. Impress assignment. Students were assigned to prepare a PowerPoint presentation on the issue they had previously studied for the Spreadsheet assignment. Again there were standards required from them such as "On the first page you are expected to describe the audience of the survey; University logo will appear as a background on the slides; On every page the elements will appear in this order: question, answer choices, bar graphic, interpretation of the figures, etc.".

6.5.4. Student surveys

Three surveys were applied to both the experimental and control groups.

6.5.4.1. Internet self-efficacy scale. Adapted from Joo, Bong, and Choi (2000), this scale was used to determine the perceived capability of students to use the Internet. The scale had a high internal consistency as demonstrated by the Cronbach's α of .95. There was a five-point Likert-type scale of potential responses: very true, mostly true, somewhat true, mostly not true, and not true at all, with assigned values between 5 and 1. The answer 'very true' received a score of 5 and the answer 'not true at all' a score of 1. The scale included 13 items and was administered shortly after the semester began.

6.5.4.2. The self-efficacy scale for self-regulated learning. This scale was used to measure students' perceived capability to use a variety of self-regulated learning strategies. It was developed by Bandura (1989) and included 11 items. A coefficient of .87 was obtained for the scale (Zimmerman et al., 1992). It was administered in the first week of the semester.

6.5.4.3. The classroom community scale. Developed by Rovai (2001), this scale measures the sense of community in a learning environment and consists of 20 items such as: "I feel that students in this course care about each other," "I feel that I receive timely feedback" and "I feel that my educational needs are not being met." There is a five-point Likert-type scale of potential responses: Strongly agree, agree, neutral, disagree, and strongly disagree, with assigned values between 4 and 0. The scale was presented to and rated by a panel of experts of professors by Rovai for content and construct validity. Its internal validity was additionally calculated using Cronbach's coefficient α and found to be .93. For the connectedness subscale, the alpha value was .92 and for the learning subscale, it was .87. This scale was applied at the end of the semester before the final exams.

6.5.4.4. Online midterm and face-to-face final exam results. These exams were prepared by a commission at the university and applied to all students. The results were analyzed in order to reveal student achievement in these tests.

7. Results

7.1. The changes in the students' pre- and post-test scores after participating in the online PBL intervention

Table 2 shows the mean pre- and post-test scores for experimental group students (C1). The means before and after the intervention were $M = 57.33$ and $M = 64.65$, respectively. A paired-samples t-test was employed to determine whether there was a statistical difference between the pre- and post-test scores.

The results indicated that the mean score for post-test was greater than the mean score for pre-test and there was a statistically significant difference between pre and post-test scores of the students. There was therefore a significant difference in the pre- and post-test scores of the experimental group students after participating in the PBL intervention.

Similarly, control group (C2) students' pre- and post-test scores from the same tests were measured. The results indicated not a statistically significant difference between the pre- and post-test scores of the students (Table 3).

7.2. The difference in the achievement and average assignment scores for experimental and control group students

In order to reveal the prospective difference between the control (C2) and experimental group (C1), differences between scores for final and midterm exams, and average assignment scores were investigated. Only 39 students from C1 and 34 from C2 submitted their

Table 2
Results of paired-samples *t*-test on pre- and post-tests of experimental group (C1).

		Mean	*N*	Std. deviation	Std. error mean
Paired samples statistics					
Pair 1	pre-test	57.326	43	16.4967	2.5157
	post-test	64.651	43	13.1337	2.0029

		N	Correlation	Sig. (*P*)
Paired samples correlations				
Pair 1	Pre-test and post-test	43	0.404	0.007

		t	df	Sig (2-tailed) (*P*)
Paired samples test				
Pair 1	Pre-test–post-test	**−2.925**	42	**0.006**

Table 3
Results of paired-samples *t*-test on pre- and post-tests of control group (C2).

		Mean	*N*	Std. deviation	Std. error mean
Paired samples statistics					
Pair 1	Pre-test	53.929	35	14.5305	2.4561
	Post-test	55.571	35	15.4121	2.6051

		N	Correlation	Sig. (*P*)
Paired samples correlations				
Pair 1	Pre-test and post-test	35	0.464	0.005

		t	df	Sig (2-tailed) (*P*)
Paired samples test				
Pair 1	Pre-test–post-test	−0.626	34	0.535

assignments. Only 43 students from C1 and 35 from C2 undertook the midterm and final exams (Table 4). The effect of PBL intervention on students' various scores was then checked by an independent samples *t*-test.

The independent samples *t*-test was significant for average assignment scores. There was also a 25.27 mean difference between the average assignment scores of C2 and C1. The results were statistically significant in favor of group C2. The average assignment scores of the students seemed to change with respect to the groups of students. However, the test was not significant for midterm and final exam scores.

7.3. The difference in the Internet self-efficacy scores for experimental and control group students

In order to reveal the prospective difference between the control (C2) and experimental group (C1) students, their Internet self-efficacy scores were investigated. Only 25 (28% male, 72% female) students in C1 and 24 (17% male, 83% female) students in C2 participated in the survey (Table 5). Cronbach's coefficient α of .90 was found for the scale.

The independent samples *t*-test was not significant for Internet self-efficacy scores. The Internet self-efficacy questionnaire included 13 items but none of the questions indicated a significant difference in favor of groups C1 or C2.

Table 4
Means and standard deviations of midterm, final exams and average assignment scores. The effect of PBL intervention on student scores.

	Group	*N*	Mean	Std. deviation	Std. error mean
Group statistics					
Average assignment scores	C1	39	51.051	27.8114	4.4534
	C2	34	76.324	27.6835	4.7477
Midterm exam	C1	43	84.426	10.0468	1.5321
	C2	35	77.060	25.6582	4.3370
Final exam	C1	43	54.395	18.3888	2.8043
	C2	35	58.286	10.0486	1.6985

		t-test for equality of means		
		t	df	Sig. (2-tailed) (*P*)
Independent samples test				
Average assignment scores	Equal variances assumed	**−3.881**	71	**0.000**
Midterm exam	Equal variances not assumed	1.601	42	0.117
Final exam	Equal variances assumed	−1.122	76	0.265

Table 5
Means and standard deviations of Internet self-efficacy scores.

	Group	N	Mean	Std. deviation	Std. error mean
Group statistics					
Total	C1	25	58.96	6.439	1.288
	C2	24	58.17	8.370	1.709

		t-test for equality of means		
		t	df	Sig. (2-tailed)
Independent samples test				
Total	Equal variances assumed	0.373	47	0.711

7.4. The difference in the self-efficacy for self-regulated learning scores for experimental and control group students

In order to reveal the prospective difference between the control (C2) and experimental group (C1) students, their self-regulated learning scores were investigated. Only 25 (24% male, 76% female) students of C1 and 19 (16% male, 84% female) students of C2 participated in the survey (Table 6). Cronbach's coefficient α of .92 was obtained.

The independent samples *t*-test was not significant for self-regulated scores. The self-efficacy for self-regulated learning scale included 11 items but none of the questions indicated a significant difference in favor of groups C1 or C2.

Additionally, in order to measure the effect of Internet self-efficacy, self-regulated learning and classroom community scores of students on their final exam scores, a regression analysis was conducted.

It was found that the three independent variables did not explain a significant amount of variance in students' final exam scores for the experimental group, C1 (Table 7). Similarly, the analysis revealed that the three independent variables did not explain a significant degree of variance in students' final exam scores for the control group, C2 (Table 8).

7.5. The difference in the classroom community scores for experimental and control group students

Classroom community scores were investigated in order to reveal the prospective difference between the control (C2) and experimental group (C1). Only 33 (21% male, 79% female) students of C1 and 35 (26% male, 74% female) students of C2 participated in the survey (Table 9). Cronbach's coefficient α of .82 was found for the scale. The effect of PBL intervention on students' classroom community scores was then checked by an independent samples *t*-test.

The independent samples *t*-test was not significant for the classroom community scores for C1 and C2. The groups of students were found to have no difference regarding their classroom community scores. Additionally, the effect of PBL intervention on students' connectedness and learning was investigated by using the subscales of the classroom community (Table 10).

The independent samples *t*-test was significant for connectedness scores for C1 and C2 but it was not significant for learning scores.

8. Findings

In our study, we first investigated the Internet self-efficacy scores of two groups of students. The results of our analysis did not indicate any significant difference in their ability to use the Internet, which might have potentially affected their achievement scores and their perceptions.

Similarly, the groups did not display any difference in their self-efficacy for self-regulated learning. The scores for this test enabled us to establish whether the participants were self-regulated learners or not. Students of the two groups did not seem to differ in the way they self-regulated themselves. Both groups were found to be similar in implementing, monitoring, controlling and regulating their cognitive activities, motivation and behaviors for the purpose of knowledge growth similar to what Garcia and Pintrich (1994) declared about self-regulated learners. This finding counters the results of Young (1996) who found that learners with superior self-regulatory capabilities performed better in learner-controlled computer-based instruction. For this reason, it cannot be stated that one group was superior to the other in terms of this construct.

Although both groups were found to be similar regarding self-regulated learning and Internet self-efficacy, the results of the pre- and post-test mean scores indicated a significant difference. This difference was much greater for the experimental group (C1) than the control group (C2); therefore, the experimental group students exposed to PBL intervention were found to be more successful. Throughout the

Table 6
Means and standard deviations of self-regulated learning scores.

	Group	N	Mean	Std. deviation	Std. error mean
Group statistics					
Total	C1	25	42.52	8.785	1.757
	C2	19	42.47	7.366	1.690

		t-test for equality of means		
		t	df	Sig. (2-tailed)
Independent samples test				
Total	Equal variances assumed	0.019	42	0.985

Table 7
The effect of Internet self-efficacy, self-regulated learning and classroom community scores on experimental students' final exam scores.

Model		df	*F*	*p*
1	Regression	3	0.717	0.553[a]
	Residual	21		
	Total	24		

[a] Predictors: (constant), Internet self-efficacy, self-regulated learning, classroom community.

Table 8
The effect of Internet self-efficacy, self-regulated learning and classroom community scores on control students' final exam scores.

Model		df	*F*	*p*
1	Regression	3	0.337	0.799[a]
	Residual	15		
	Total	18		

[a] Predictors: (constant), Internet self-efficacy, classroom community, self-regulated learning.

Table 9
Means and standard deviations of classroom community scores. The effect of PBL intervention on classroom community scores.

	Group	*N*	Mean	Std. error mean
Group statistics				
Total	C1	33	52.55	1.878
	C2	35	49.09	1.998

		t-test for equality of means		
		t	df	Sig. (2-tailed)
Independent samples test				
Total	Equal variances assumed	**1.258**	66	**0.213**

Table 10
Means and standard deviations of connectedness and learning scores. The effect of PBL intervention on connectedness and learning scores.

	Group	*N*	Mean	Std. deviation	Std. error mean
Group statistics					
Connectedness	C1	33	26.58	6.933	1.207
	C2	35	23.37	6.984	1.180
Learning	C1	33	25.97	6.267	1.091
	C2	35	25.71	7.797	1.318

		t-test for equality of means		
		t	df	Sig. (2-tailed)
Independent samples test				
Connectedness learning	Equal variances assumed	**1.898**	66	**0.062**
		0.148	66	**0.883**

semester, students in the experimental group were exposed to problem-based learning intervention via projects which they were supposed to conduct and report. The difference between the groups might have stemmed from the fact that problem-based learning projects make Web-based education students more active, eager to study and learn consciously or unconsciously while working collaboratively. This finding is supported by the meta-analysis of 164 studies on cooperative learning, which concluded that cooperation among learners has a significant positive impact on their achievement (Johnson et al., 2000). The course instructor observed that even when one student did not want to participate in the project, other members' eagerness or assistance encouraged him to complete his responsibilities for the project group. Moreover, students were aware that the course instructor was observing their correspondence via the discussion boards, which may have made them more active and alert. Students were observed to display "online participation", which is a process of learning by taking part and maintaining relations with others as defined by Hrastinski (2008).

Although there was a difference in the pre- and post-test scores, there was no difference between the groups of students regarding their online midterm exam and face-to-face final exam scores. Unexpectedly, means of the average assignment scores of both groups indicated a significant difference in favor of the control group. Students of the experimental group scored lower than the control group. It is thought that working collaboratively might have decreased these students' performances on their project reports compared to students in the control group who were working individually. This finding indicates that a "politeness syndrome", defined by Borthick and Jones (2000), may also have encouraged PBL group students to be positive to one another but not to be constructive and honest while writing project reports. Moreover, dominant or inactive group members might have created difficulty for these group members. Although the students in the

experimental group achieved higher scores than the other group regarding their individual performances in the post-achievement test, their group performance regarding collaborative working was weak.

The study also investigated the effect of PBL intervention on students' perceptions of classroom community. The mean score for the 'connectedness subscale' was significantly higher for web-based education students who worked collaboratively on projects. This finding suggests that they felt more connected to the virtual classroom community than the control group who worked individually on their projects. Experimental group students felt friendship, cohesion and satisfaction; thus, they developed feelings of safety and trust. Regarding this finding, Rovai (2002a) suggests that a strong sense of community can be created by a combination of team-building activities, facilitation skills and group interaction. Reference to the connectedness subscale items indicates that students in the PBL group who got higher scores in the post-test did not feel alone or experience a lack of social integration. These feelings are regarded as two of the problems of distance education affecting student learning in the literature (Hill & Raven, 2000; King, 2002; Saba, 2002). On the other hand, the mean score for the 'learning subscale' did not indicate a significant difference between the two groups, which implied that they did not differ in the way they felt that knowledge and meaning were actively constructed within the community and that the community enhanced learning and acquisition.

Additionally, the effect of Internet self-efficacy, self-regulated learning and classroom community scores of students on their final exam scores for both groups of students was checked by a detailed analysis. The results indicated that these variables did not have any effect on students' final exam scores. While a PBL intervention leading to collaborative working on problem-based projects enhances students' feelings of connectedness in a web-based learning environment, whether it has an effect on students' learning remains unclear.

To recap, community exists independently from geography, physical neighborhoods and campuses only if people view community as what activities they do together rather than where or through what means they do them as stated by Wellman (1999). The sense of community means more than doing a project with a group of people. Although people feel connectedness to a community, they might not as well feel a sense of community which is a stronger feeling that gathers people around common expectations of learning and goals. Besides, Rovai (2002b) suggests that a strong sense of community should facilitate interactions in any classroom community. Therefore, it is suggested that to measure a strong sense of community, the quantity and quality of students' interactions and correspondences among themselves and with their instructor during the educational process should be analyzed in a detailed way.

9. Conclusion

This study investigated the effects of problem-based learning on students' classroom community perceptions and their achievement. It was undertaken using a web-based computer application course offered at a higher education institution in Turkey. The results indicated that experimental students who worked on problem-based projects and got higher scores in the post-tests felt much more 'connectedness' to other class members when compared to control students, who obtained higher scores in the assignments although their final and midterm scores did not indicate any difference between the groups.

The current study found that various pedagogical interventions such as problem-based learning might enhance students' connectedness to their virtual learning environment and their achievement scores; and that web-based education students feel connected to their virtual classroom community, which affects their learning positively. Collaborative working might sometimes hinder the development of successful learning outcomes due to inactive and dominant students or for some other reason. As there might be some other variables leading to the failure of collaboratively working students in web-based learning environments, further studies are required with other sample groups and controlling other variables such as instructor's guidance, students' individual characteristics and communication styles, or student collaboration and their use of discourse.

This study assumed that the participants were typical web-based education students, and that the instructor and course design was representative of online courses. To generalize the findings of the present study would be difficult since the learner characteristics, course content, applied pedagogy and instructional design might not be fully representative of other instructors and other distance learning environments.

Social community is believed to be relatively poorly experienced within distance learning environments due to learners' disconnection. However, with the course instructor's support in applying various pedagogical interventions and by increasing social interaction, community and learning in the virtual classroom might be enhanced. Although the study revealed interesting findings about the effect of PBL on the achievement and sense of classroom community of students, a better and more definitive understanding of sense of classroom community, identification of the factors effecting the community feeling and achievement is still needed. The quality and the degree of online collaboration might as well be examined in further studies.

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