# Design of a Problem-Based Online Learning Environment and Evaluation of its Effectiveness

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## ABSTRACT
Problem-based learning approach present several advantages such as improving students' engagement in learning and fostering their higher-order thinking skills. Although there is a plethora of research regarding implementation of problem-based learning in classrooms, its design and application process for web-based environments need further investigation because of independent nature of online settings. This study developed a problem-based online learning environment based on constructivist learning design model proposed by Jonassen (1999) and evaluated its effectiveness. It was conducted in the spring 2014 semester with an intention to access to total population that is 1,417 students receiving distance education for Turkish II course at six university vocational schools. The online lesson was implemented in one week, and data were gathered through students' performance tasks and self-evaluation form. The research indicated that the problem-based online learning environment has a positive influence on learning. Moreover, it was revealed that dynamic nature of online environment affected learner's participation in the designed activities and collaboration among students could not be fostered. Several suggestions were proposed based on the results.

**Keywords:** Problem-based learning, online learning, distance learning.

## INTRODUCTION
In the process of knowledge construction, interactive learning environments provide different opportunities for stakeholders. These online environments can be designed using the problem-based approach to create an active learning process. Barell (2007) defines problem-based learning as a process of investigation in which the students try to solve curiosities, doubts, uncertainties and problems in real life context. Problem-based learning is a constructivist, self-directed, collaborative and contextual process. Thus, it allows students to improve their questioning, problem-solving, creative/critical thinking, reflective and teamwork skills (Dolmans, Grave, Wolfhagen & Vleuten, 2005; Uden & Beaumont, 2006; Barell, 2007). It also enhances their autonomy and encourages them to construe knowledge using real life problems (Crawford, 2011). In their meta-analysis research, Strobel and Barneveld (2009) state that problem-based learning is more effective than traditional approaches in terms of long-term retention of knowledge and skills.

Recently, studies on the use of problem-based learning in online learning environments have been increasing (Tsai & Chiang, 2013). Studies of applied problem-based learning in online environments indicate that learners develop higher-order thinking skills such as creative and critical thinking and also have more motivation to participate and became more active learners (Şendağ & Odabaşı, 2009; Sulaiman, 2011; Delialioğlu, 2012). Problem-based learning also has a strong influence on learning and achievement (Schmidt, Rotgans & Yew, 2011). Karadeniz-Bayrak and Bayram (2012) determined that students in problem based web environment obtained higher and more significant levels of success than those in traditional courses. Tsai, Lin and Shen (2013) determined that vocational high school students with poor achievement levels attained permanent

improvement thanks to the problem-based online learning environment. In addition, findings indicate that the problem-based learning environment improves students' perceptions of classroom community (Baturay & Bay, 2010). Allen, Donham and Bernhardth (2011) found that learner assessments of problem-based learning implementations were positive. Günbatar and Çavuş (2011) also found that students had positive attitudes towards the problem-based online learning environment. These studies mainly show that problem-based learning approach is more effective than traditional teaching methods with respect to a variety of learning outcomes, and it brings similar positive results when it is applied in online and face-to-face environments.

There are researches which compare implementations of problem-based learning in online and face-to-face environments, as well. The research outcomes indicated that students' attitudes and success levels in the problem-based online learning environment were higher than those in problem-based face-to-face learning environments (Gürsul, 2008; Gürsul & Keser, 2009). In addition to these studies, Ioannou, Brown and Artino (2015) found that wikis are more influential tools than forums with respect to creating collaboration in problem-based learning environments.

Findings on the benefits of problem-based learning lead to higher expectations for its contributions. Therefore, distance education courses can be one of the application area to cope with the problems of low participation rates and students' dropouts (give reference). According to the research conducted by Boling, Hough, Krinsky, Saleem and Stevens (2012) students in distance education courses favor interactive and multimedia-based courses rather than text-based and individualized ones. In order to create such engaging learning environments for the students taking distance education, this study designed a course in accordance with problem-based learning approach based on constructivism. "The Constructivist Learning Design Model" proposed by Jonassen (1999) was chosen as a basis for the design since problem-based learning was developed using the constructivist learning approach. These are the indications that problem based learning is based on the theory of constructivist learning: knowledge being construed by the interaction with the environment, learners being motivated by cognitive conflicts, knowledge being improved by discussion and knowledge being constructed by learners (Uden & Beaumount, 2006). According to Savery and Dufy (1995), problem-based learning is among the best applications of the theory of constructivist learning.
Jonassen (1999) proposed the constructivist learning design model based on the idea that: "A constructivist learning environment is technology-based." Figure 1 shows this model, and Table 1 shows its main components.

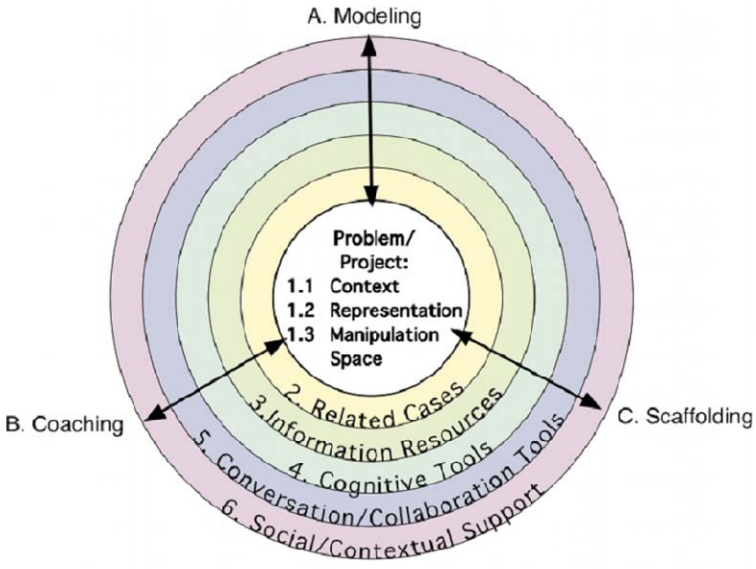


**Figure 1.** Model for designing constructivist learning environments

Table 1. Main Components of Constructivist Learning Environment

| | |
|---|---|
| Problem context | This is the social, cultural and physical structure and the network of relations that generate the problem. Problems are created in a context, and they are endowed with meaning by it. Thus problems should be considered in their contexts. |
| Representation | The problem should be presented in a way to make it interesting, attract students' attention and encourage students to participate. Simulations and cyber worlds are effective tools for this purpose. |
| Manipulation space | This area includes the settings and opportunities to experience the problem and to manipulate it. The learner can see the outcomes of the manipulation and observe the significance of the change. |
| Related cases | These situations include our and others' experiences of the problem and its details. The analyses of exemplary situations provide us with specific data to orient our actions. It is important to create a database including this kind of data. |
| Information resources | These sources include the information necessary for the project or the problem. Some examples of these sources are text files, graphics, information sources that include audio, video and animations and learning object repositories. |
| Cognitive tools | Students need cognitive support to solve a problem that is embedded in its natural complexity. Mind maps, concept maps and dynamic modeling tools are cognitive tools that provide this cognitive support. |
| Conversation/ Collaboration tools | Learning comes naturally when learners study a problem cooperatively. Therefore, collaboration and talks between the groups should be encouraged, and computer-based communication tools should be used. Online conferences, chat rooms, multi-player games and e-mail are some examples of the tools for this purpose. |
| Social/ Contextual Support | Hardware, software and, more importantly, the good faith and social support of implementers are also important factors. |

The focus of the model is the problem and the learner. The teacher is just the guide, and the learner is encouraged to construct their own meaning. The teacher does not play an active role in learning, and s/he only gives guiding feedback. By following these constructivist principles, this study examined the effectiveness of a problem-based online environment with a focus on learning and students' confidence. It sought responses to these questions:

1. What is the effect of the problem-based online course on learning?
2. What is the effect of the problem-based online course on students' confidence?

## METHODOLOGY

This study aimed to design a problem-based online course and evaluate its effectiveness using a mixed model. Qualitative and quantitative data were collected, analyzed and were interpreted to support each other.

### Study Sample

The study was conducted in the spring 2014 semester with an intention to access to total population that is 1,417 students enrolled in pre-licence programs at six vocational schools of a national university. They attended "Turkish II" as an online course.

The research was conducted in the spring 2014 semester with an intention to access to total population that is 1,417 students receiving distance education for "Turkish II" course at six university vocational schools. The students were expected to both complete performance task and to fill self-evaluation form. However, some students filled self-evaluation form without completing performance task. Moreover, some students did not answer all of the questions in self-evaluation form. This situation was arisen from not putting prerequisite for the designed activities. Therefore, the number of students participating in activities changed continuously, and the author did not make a holistic assessment of the group. Participants were asked to write petitions, and 187 students did this performance task. Of the students, 234 responded to the first, second and third questions on the self-evaluation form. Respectively, 70, 59 and 92 students responded to the three sub-steps of the fourth question which were: "To what extent did you learn how to write a petition in this environment?", "How confident are you about writing a petition?" and "What are your weaknesses in petition writing?" Finally, 230 students responded the fifth question. The findings were interpreted regarding the number of participants who responded to each question.

### Problem-Based Online Learning Environment and its Development Process

The authors used the Distance Learning Center at one of the universities in Turkey to implement the online

activities. The problem-based online learning environment was designed for "What Do We Know about Petitions?" unit of "Turkish II" course, which aims to improve students' knowledge and skills regarding the effective use of Turkish language in written form. The problem scenario and the activities related to the course were developed by the authors. Implementation of the online course took one week. Details regarding the design and procedure are provided below.


**Figure 2.** The presentation of a rejected petition

**Problem context and representation**

Learning process began with the presentation of a petition that was rejected by Distance Education Center of the university (Figure 2). The rejection of petition (or its having led to no action or results) made it an authentic problem, and the target group was tried to be motivated by selecting a problem that they experience in their lives. The author asked the learners to examine the sample petition and determine the reasons for its rejection.

**Guiding questions**

The learners were provided with specific guiding questions regarding form, expression and content of the petition. This helped them to take a closer look at the problem.

After the students analyzed the petition in framework of guiding questions and became mentally prepared some caricatures were presented to strengthen the connection between real life and the problem and to make it more interesting as figure 3 shows.


**Figure 3.** A caricature to make writing petition more interesting

Later, the right of petition was discussed to answer student questions such as “Why should I write a petition?” and to let every individual discover their own reason.

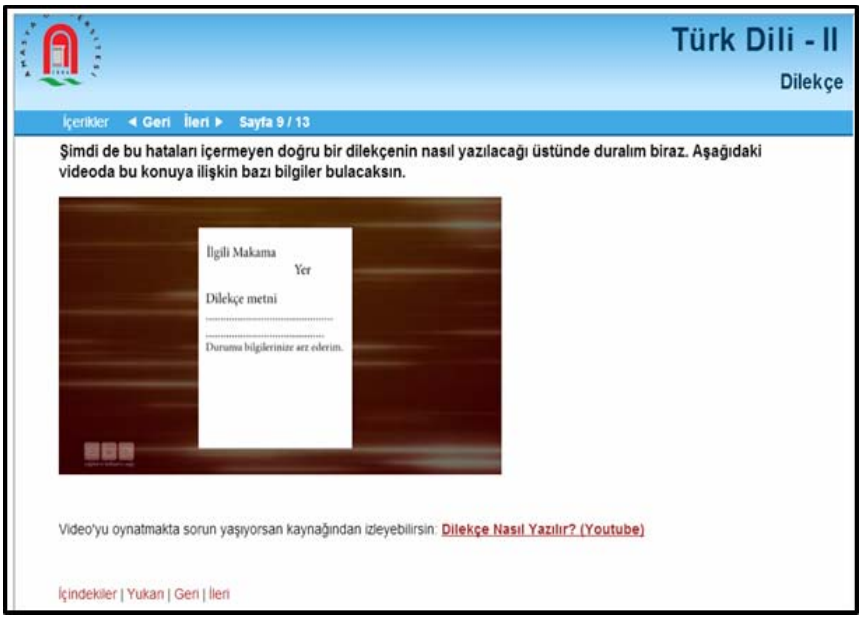


**Figure 4.** A video as an information resource

**Information resources**
The study also included the use of the learning materials shown in Figure 4. The information resources were text files that included the information necessary for the process of petition writing, graphics, videos and web documents. Learners were given a flexible structure so that they could progress according to their own learning preferences.

**Collaboration tools**
The forum tool was activated to create collaboration and enhance dialogue among the students. Students were asked to share sample petitions on the forum as a performance task and to give feedback to each other.

**Teacher support**
Students’ petition writing process was continuously monitored by the teacher. Students were given guiding suggestions rather than correcting remarks, and they were assisted with rethinking the issues. This gave them a foundation to create their subjective meanings.

**Self-Evaluation**
Finally, the students filled out a self-evaluation form at the end of the process. They were asked to evaluate their own learning. Its aim was to determine whether the expected learning outcomes were obtained.

**Data Collection Tools**
The data collection tools used in this study are the performance task evaluation form (for the sample petitions that students were asked to provide at the end of the activities) and the self-evaluation form.

**Performance Task Evaluation Form**
It was created to evaluate the sample petitions shared on the online forum (the forum was developed to measure the effect of the problem-based online course on learning). This form is a tool that consists of three main constructs. They are form, expression and content. Form includes proper use of date, signature, name and surname. Expression includes the difference between submission and request, excluding phrases such as “I would like to” and “it is necessary that...”, using terms of address that are suitable for the administrative structure and avoiding unnecessary details and personal information. Content includes introducing oneself, declaring the reason for writing the petition and providing accurate information about the motives for the petition. All researchers in the current study were involved in the development process of the form to ensure its construct validity.

**Self-evaluation Form**

This form was created to enable students evaluate themselves after the activities in the unit "What Do We Know about Petitions?" in the "Turkish II" course. It has two items:

• To what degree did you learn about writing a petition in this environment? How confident are you about writing a petition?

• What score do you give yourself on a scale of 10?

**Data Analysis**

For the assessment of the self-evaluation form, conducted content analysis of the data. First of all, created codes of students' answers considering the intentions of each student. These codes were arranged in order starting with the most frequent towards the least. Then they were tabulated. The sample petitions were assessed and scored using the criteria in the Performance Task Evaluation Form.

## FINDINGS AND INTERPRETATION

**An Analysis of the Effects of the Problem-based Online Course on Learning**

As part of the sub-problem, the teacher evaluated the students' work at the end of the course. Students wrote petitions since it was required by the curriculum. The researcher assessed these petitions based on the aspects that a petition should include as in Performance Task Evaluation Form. The petitions were given scores on a scale of ten. Scores between 8 and 10 were high scores. Scores between 5 and 7 were intermediate, and scores between 1 and 4 were low scores. The values acquired by scoring 187 petitions that were shared in the online learning environment are shown in Table 2.

**Table 2.** Categorized scores given to written petitions.

| Degree | n | % |
|---|---|---|
| High | 146 | 78,07 |
| Intermediate | 37 | 19,80 |
| Low | 4 | 2,13 |
| Total | 187 | 100 |

Table 2 indicates that 78.07% of students obtained high scores for their petitions, while 19.80% obtained an intermediate scores, and 4 students obtained low scores. At first glance, these findings indicate that the online learning environment has a positive influence on learning, and that students learned how to write a petition. However, it is not possible to determine the extent that the problem-based online learning environment influences the observed performance since there are no systematic data for students' pre-research performances. On the other hand, the author thought that the self-evaluation data (the next sub-problem) might help explain the findings of this study in relation to the online learning environment.

**An Analysis of the Effects of the Problem-based Online Course on Students' Confidence**

In this sub-problem, students did a self-evaluation of their learning in the problem-based online learning environment. The students were asked how much they learned about writing a petition, how confident they were about this issue and their weaknesses about it. The self-evaluation form also asked students to score their own learning on a scale of 10. This scoring was based on all their learning in the online learning environment. The data acquired by this scoring were categorized using the same intervals used by the teacher's evaluation of the students' work. The findings were tabulated and are explained below.

**Table 3.** How much did you learn about writing petition?

| Degree | n | % |
|---|---|---|
| Very well | 25 | 35,71 |
| Enough | 41 | 58,57 |
| Poor | 4 | 5,71 |
| Total | 70 | 100 |

**Table 4.** Do you feel confident in writing petition?

| Degree | n | % |
|---|---|---|
| Yes | 54 | 91,53 |
| Weak | 3 | 5,08 |
| No | 2 | 3,39 |
| Total | 59 | 100 |

**Table 5.** Categorized scores the students gave themselves

| Degree | n | % |
|---|---|---|
| High | 197 | 84,19 |
| Intermediate | 30 | 12,82 |
| Low | 3 | 1,28 |
| Total | 230 | 100 |

An analysis of Table 3 shows that 35.71% of students said they learned to write a petition in the problem-based learning environment very well, and 58.57% of them said they learned enough. Only 5.71% said that they did not learn much about writing a petition in the problem-based online learning environment.

An analysis of Table 4 indicates that a high percentage of students (91.53%) responded affirmatively to the question "Are you confident about petition writing?" Three students (5.08%) said, "Not very confident," and two students (3.39%) said, "No," in response to this question.

Here are some the participants' responses to the questions in Tables 3 and 4:
The student with the code name "STU20" said: "Now I can write a totally correct petition all by myself. I am very confident about petition writing. I used to have doubts about the places of date and address, but I don't anymore."

"STU127" said: "I learned how to submit a request to government agencies. I am confident about petition writing. While I was writing it, I noticed that I did not know enough about the agencies' names."

"STU87" said: "A relative of mine had some things to do at the bank, and he needed to write a petition to the bank. He asked me for help. If he had asked before, I would not have been able to help. But this time, I wrote it in just a minute. I was able to do it without asking someone else."

However, the student with the code name STU26 said "I cannot say that I learned much about petition writing in this environment. I am usually not very confident, and I am not very confident about writing a petition, too. My weakness is that the difference between request and submission is not very clear to me. Besides, I sometimes give unnecessary details."

Table 5 indicates that 84.19% of students gave themselves a score of 8 and above, while 12.82% gave themselves scores between 5 and 7, and 1.28% gave themselves scores between 1 and 4. These values are quite close to the values given by the teacher.

A total analysis of the findings indicate that the majority of the participants learned from the course in the online environment and became more confident about the subject. Of the students, 94.28% thought that they had learned enough about petition writing (Table 3), 91.5% said that they were confident about this subject (Table 4) and 84.19% gave themselves a score of 8 and above (Table 5). These findings are regarded as a positive outcome for problem-based online learning. They also allow for positive thinking about the effect of the online learning environment on learning that was discussed in the previous sub-problem.

## CONCLUSION AND IMPLICATIONS

This study designed a problem-based online learning environment and analyzed its effectiveness. The environment was developed using the constructivist nature of problem-based learning and the constructivist learning design model proposed by Jonassen (1999). The environment aimed to answers the needs of learners and enable them to achieve permanent learning. The researcher employed the learning management system that was already included in the current distance learning program to avoid an extra workload for the learners. Accordingly, the author selected the "Turkish II" course and its unit "What Do We Know about Petitions?" in the distance learning curriculum of a national university. The online environment was created for these lessons, and was made available to the students for one week.

The study employed both instructor evaluation, self-evaluation methods and students' learning were both analyzed. With this purpose, first the instructor was evaluated and then the researcher gave scores to the petitions that students wrote based on the features that a petition should include. The students were grouped in three categories based on their scores. Scores between 8 and 10 points were high scores. Scores between 5 and 7

points were intermediate, and scores between 1 and 4 points were low scores. Students were also asked to evaluate their own learning on a scale of 10, and these values were categorized in the same way as the teacher evaluation.

The research outcomes indicate that the majority of students (78.07%) had high achievement in petition writing. Before interpreting the outcome in favor of the online learning environment, the researcher asked the students two questions: "How much did you learn about petition writing in this environment?" and "Are you confident about petition writing?" The results indicate that 94.28% of students thought that they had enough knowledge about petition writing, and 91.53% were confident about this subject. Along with this, students were asked to give scores to themselves on a scale of 10, and 84.19% gave themselves 8 points or more. A comprehensive analysis of the acquired outcomes shows that the problem-based online learning environment has the potential to contribute both to learning and their confidence. The outcomes of the studies conducted by Tsai, Lin and Shen (2013), Karadeniz-Bayrak and Bayram (2012), Günbatar and Çavuş (2011), Gürsul and Keser (2009) and Gürsul (2008) support the notion that problem-based learning has a positive influence on learning.

The researcher noticed that there were differences between the numbers of participants before and after the research. Possible reasons for this include the lack of a criterion for students' access to the components of the problem-based learning and participant dropouts during the process of learning. Since online environments have a dynamic and flexible structure, it is easier for students to leave them. This reduces students' participation in tasks and activities. In the development of the online learning environment, the links between pages can be structured more effectively, and data from students who left without completing the unit can be excluded from the study after analyzing the log records in order to prevent problems originated from dynamic and flexible structure of online environments. This reduces the gap between the numbers of students who participated in tasks and activities.

Another limitation was the lack of a strong collaboration between the students. Although the participants shared the petitions they had written with the other students, they did not provide enough feedback to each other, which resulted in weak communication between them. Ge, Planas and Er (2010) revealed that students' reading of their peers' solutions to the problems is not an effective strategy to foster their problem solving process, and they recommend that they should interact with each other by giving feedback and suggestions and discussing meanings. In this study, the lack of collaboration might have resulted from time limitations since the entire process was completed in one week. For this reason, it is suggested that researchers choose problems that direct students to do more collaboration and choose activities that increase interaction between students.

One of the main limitations of this study is not determined prequalification. Forthcoming studies be conducted using experimental methods involving pre-test and post-test in order to ensure that learning was resulted from online learning environment. Moreover, future studies can monitor students' interactions in online environment through log records of the learning management system to reveal engagement duration of each student, and it can be compared to that in previous weeks when traditional teaching methods were used. In this way, it will be possible to see effects of problem-based learning on student engagement in online learning environments.

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