PROBLEM-BASED LEARNING METHOD SIMULATION
BY PBL VIRTUAL ENVIRONMENT

Hernane Borges de Barros Pereira
Universidade Estadual de Feira de Santana
Km 03 da BR 116, Av. Universitária s/n, Feira de Santana/BA – Brasil – CEP.: 44.031-460

Gabriela Ribeiro Peixoto Rezende Pinto
Universidade Estadual de Feira de Santana
Km 03 da BR 116, Av. Universitária s/n, Feira de Santana/BA - Brasil – CEP.: 44.031-460

ABSTRACT

Problem Based Learning (PBL) is a new teaching-learning method originated from the changes that have occurred in the world economical basis and in the information and communication technologies. The purpose of this paper is to describe the architecture of PBL Virtual Environment and the initial simulation results of tutorial sessions carried out by staff and students participating on the Computer Engineering course at the State University of Feira de Santana (UEFS). The modeling of the PBL method and its mapping in XML schema based on the PBL tutorial sessions have allowed to implement an application that supports presental and distance PBL tutorial sessions. The main contribution of this paper consists on findings obtained from the application of PBL Virtual Environment to a group of students related to the course of Computer Engineering (UEFS). These findings would be used to improve the development of collaborative learning environments.

KEYWORDS

Problem-Based Learning, PBL Virtual Environment, XML Schema, Collaborative Learning, Distance Education.

1. INTRODUCTION

Information and communication technologies (ICT) and the new pedagogical techniques have caused a series of changes in the way of teaching and learning. Consequently, new methods of teaching-learning have been created to give support to processes’ changes and to the new demands of the working force, such as Problem-Based Learning method. However, it is noticed that the concerns to follow up with the new tendencies and demand of a remolded market force have caused individuals to overlook a few topics. These topics are of extreme importance and they might have been overlooked because of poor prioritization.

The use of computational tools and of the computer itself, as a support for the PBL method, is not explored extensively. The technological resources available are normally used for message changing among the people who take place in the process. The lack of computational tools that could be used to support the PBL method is evident. Thus, the modeling of the PBL method (i.e. identification of the actors, their activities and possible relationship among them) and the implementation of a virtual environment, which can produce the dynamics of the tutorial groups at distance, become necessary.

The purpose of this paper is to describe the architecture of PBL Virtual Environment and the initial simulation results of tutorial sessions carried out by the staff and students participating on the Computer Engineering course at the State University of Feira de Santana (UEFS).

The main contribution of this research is to support, by Problem Based Learning Virtual Environment (PBL-VE), the collaborative learning basically used in distance education. PBL-VE guarantees important technical features such as interoperability, adaptability, scalability, portability, etc. Moreover, some artifacts
The structure of the paper is as follows. Section 2 surveys the theoretical foundation of Problem-Based Learning method. Section 3 extends the previous section and presents the PBL virtual environment. Section 4 describes the simulations and presents some results considerations. Section 5 provides the conclusions and points out future research activities.

2. PROBLEM-BASED LEARNING: A GENERAL REVIEW

Problem-Based Learning (PBL) is an educational strategy centered on the student to help develop the reasoning and the communication, which are essential abilities for success in the professional life. The method based on the constructionist theories of Jean Piaget and Vigotysk, involves the conflict of students with problems of the real world. The student is constantly stimulated to learn and to take place in the process of construction of his/her learning (Deslile, 1997; Boud and Feletti, 1998; Duch et al, 2001).

In Brazil, some Universities are using the PBL in their curricula. In the Medicine area, the College of Marília and the State University of Londrina were the pioneers to use the PBL as a medical teaching method. The Medicine program of the São Francisco University was the third school of medicine in Brazil to use the PBL. In the first semester of 2003, the State University of Feira de Santana started two new programs, Computer Engineering and Medicine, using the PBL method in their curricula as well.

2.1 Structure of PBL Method

PBL method contains a group of well-defined participants: tutor, student, coordinator, secretary, lecturer, and consultant. Each one of these participants has specific functions, which are presented in Table 1.

<table>
<thead>
<tr>
<th>Participants</th>
<th>FUNCTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>Contributing with the tutors, coordinators, and secretaries during the session; cautiously read the problem; relating the unknown terms; expressing their ideas; pointing hypothesis related to the problem; selecting notable ideas; establishing learning goals; defining the activities schedule; studying; searching; keeping contact with the tutors; preparing reports requested by the tutors, among others activities</td>
</tr>
<tr>
<td>Lecturer</td>
<td>Taking place in theoretical sessions, giving speeches, debates, etc.</td>
</tr>
<tr>
<td>Consultant</td>
<td>Guiding the students and explaining possible doubts.</td>
</tr>
<tr>
<td>Coordinator (student)</td>
<td>Guarantees that the discussion of the problem is given on a methodical way and that all the members of the group take place in the discussion.</td>
</tr>
<tr>
<td>Secretary (student)</td>
<td>Faithfully and rigorously register all the discussion and the events that has happened in the tutorial group.</td>
</tr>
<tr>
<td>Tutor</td>
<td>Knowing the objectives and structure of the thematic module; assuming the pedagogical responsibility in the teaching process; guiding in the choice of the coordinator and secretary and when necessary choose them; stimulate, support and help the students in a way that they can actively take place in the process of construction of their learning; participating in the development of the problem and evaluate the groups and the tutorial sessions.</td>
</tr>
</tbody>
</table>

2.2 Tutorial Group

The tutorial group is generally formed by a tutor and 6 to 10 students. Two students are initially selected to perform as the discussion coordinator and the secretary of PBL tutorial session (Section 2.3), and in some cases, as the course of Computer Engineering from UFES, it is also defined another secretary called “blackboard secretary”. These functions shift among students for different problems in a way that, at least once during the module, all students can perform as the coordinator and as the secretary.

After the coordinator and the secretaries are appointed, the tutor hands the group a problem previously elaborated by the Problem Elaboration Commission. This problem must be similar to the curriculum determinations patterns and based on a thematic module, suggesting the knowledge theme.
2.3 Tutorial Session

During the semester, the tutorial groups get together, complying with a calendar previously defined by the specialists commission, to perform what is named tutorial session. During this session, after defining the coordinators and secretaries, the problem to be studied is presented and discussed, so that the learning goals can be identified. In a second stage, after an individualized study is made out of the tutorial group, the students discuss about the problem having in mind the acquired knowledge. These two stages involve the seven steps presented by the Table 2.

Table 2. PBL steps

<table>
<thead>
<tr>
<th>STEP</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>In this step the students receive the problem. Then they must read it, get the idea, and identify the words, expressions, technical terms, illustrating this way the specific aspects related to the problem;</td>
</tr>
<tr>
<td>Step 2</td>
<td>It is linked to the “brainstorm”. During this step, the students must freely associate ideas referred to the scenario presented by the problem;</td>
</tr>
<tr>
<td>Step 3</td>
<td>The students must create hypotheses based on the ideas developed from the step 2;</td>
</tr>
<tr>
<td>Step 4</td>
<td>The creation of learning questions is made on this step and is related to the raising of questions that help in the process for solving the problem;</td>
</tr>
<tr>
<td>Step 5</td>
<td>In this step the students must create learning goals, which can answer the questions from Step 4, and develop the action plan to reach the proposed goals;</td>
</tr>
<tr>
<td>Step 6</td>
<td>During step six, the students and tutors judge the learning process. The tutor judges each student, the group and the tutorial session. This valuation is made by printed forms given by the tutor during the tutorial session;</td>
</tr>
<tr>
<td>Step 7</td>
<td>After the individual study, the students return to the tutorial group to perform this step, in which the students must relate what they have learned, evaluate the utilized resources, reexamine the ideas and hypotheses and undo eventual mistakes. In addition, they must associate the information obtained with the problem scenario and evaluate the proposed learning goals. If they notice that there is something more to be done, the students must go back to Step 1, if not they will begin another problem.</td>
</tr>
</tbody>
</table>

3. PBL VIRTUAL ENVIRONMENT

Using the UML diagrams and the proposed XML Schema as a starting point, PBL Virtual Environment (PBL-VE) has been developed to assist tutors and students during the performance of the PBL tutorial sessions.

Pereira et al (2004) have used UML and XML language to format the data and the design of the documents structure, respectively. Moreover, Java language has been used (1) to guarantee the communication between the client application and the server (using the servlets Java), and (2) to process the XML documents through the API JDOM (Figure 1).

![Figure 1. PBL Virtual Environment Architecture](image)
From a browser, the user sends a HTML page request to the Web application server. Then, the server calls, through the TOMCAT (i.e. servlets repository), the indicated servlet for the development of the service. That servlet writes or receives data in HTML documents through the API JDOM and generates the content (HTML page) answering the user’s solicitation. Finally, the server transfers the generated result through the servlet to the client taking into account a HTTP answer.

With the use of the PBL-VE, the tutorial sessions could happen face-to-face or at distance. For that to happen, the tutor must execute the tutorial session opening, which corresponds to (1) the attribution of an identification and password, for itself; (2) the selection of a problem (previously registered) that will be manipulated and (3) the indication of a student as coordinator and another as secretary. Figure 2 represents the PBL-VE screens that enable the tutor to register problems and to perform the opening of the tutorial session, respectively.

![Figure 2. PBL-VE: Tutor view screens](image)

Once the tutorial session is opened, the students and the tutor himself will be able to have access to the virtual room through the initial screen of the PBL-VE, which is responsible for the user’s permission to access the virtual room. Starting with the user’s enrollment through the login and password, the PBL-VE verifies if such data belong to a tutor or a student. In case of a student, identification screen of the tutorial session is showed allowing to the student to choose the PBL tutorial session.

Figure 3a depicts the PBL-VE room, which provides the student’s access (1) to general information about the chosen session (i.e. institution, course, group, module, tutorial group, tutor, coordinator and secretary), (2) to the problem that will be developed, (3) to the students’ operations (i.e. unknown terms, explanation of unknown terms, doubts, explanation of doubts, idea, hypothesis, goals, learning questions and evaluating the tutorial session), (4) to a entitled frame “PBL frame” containing the information registered by the members of the tutorial group (Figure 3b) and (5) to the frame “Tutor’s observations”, that contains the orientations given by the tutor to the students as a guide throughout of the problem resolution (Figure 3c).
In case the identification and the password of a user belong to a tutor, the PBL-VE shows a screen related to operations only used by the tutor. The tutor can, besides monitoring the PBL session, open the session and register the problems, but a student couldn’t. By choosing the option “Monitoring PBL Session”, the tutor will be leaded to the PBL-VE room, which is very similar to the student’s, differentiated only by specific operations (i.e. explanation of unknown terms, explanation of doubts, general information, orientation and evaluating the tutorial session), that can be performed during the PBL dynamics (Figure 4).

**4. SIMULATIONS**

PBL-VE application has been implemented and two simulations have been performed involving tutors and students of the course of Computer Engineering at UEFS in order to observe not only the students’ behavior, but also to test and analyze the PBL-VE functionalities. The goal of two simulations has been to develop a tutorial session supported by PBL-VE application. The following scenarios have been used:

- **First scenario:** A PBL tutorial session has been developed in a computer laboratory at UEFS, with computers that have the same hardware configurations and different operating systems and browsers (Figure 5). One tutor and six students have participated of this session. It is important to mention that the students are coursing the second semester, and they have discussed the shortest path calculus problem related to the graph theory (this theme will be studied on the third semester).
Second scenario: The main goal of second simulation has been to test and to analyze PBL-VE application during a tutorial session performed at distance. In order to carry out this simulation, four computers located at the UEFS with different hardware configurations and two computers located at the Brasfrut Company have been used, including Internet (Figure 6). One tutor and fours students have participated in this session (students coursing the second semester) and the same problem has been discussed.

4.1 Some Considerations from Results Obtained

Besides the organization of the scenarios and the invitation of the participants to accomplish the simulation, there has been a concern to create a schedule containing accurate parameters in order to evaluate the PBL-VE application. A questionary has been designed and given to each member before starting the activities. Each
participant has registered their observations during the simulations. After performing the PBL tutorial sessions supported by the PBL-VE application, the results are presented as follows:

- The response time of PBL-VE application, while used in a LAN or WAN network has showed an excellent result (i.e. 0s to 2s). However, when the PBL-VE application was used with a dialup connection (it has been tested with a 56Kbps connection), the response time has increased, for such case the result obtained has been “good” (i.e. 5s to 7s);
- PBL-VE application have not had any error during the simulations;
- The PBL-VE application has been used by computers with different configurations of operational systems and browsers (e.g. Linux and Windows, Konqueror, Internet Explorer and Netscape). This way, its portability (i.e. platform independence) has been confirmed;
- There hasn’t been any change with respect to the PBL-VE application stability when a PBL standard amount of users accessed the application at the same time.

From the PBL functionality perspective, the participants of the tutorial session have noticed that:

- through PBL-VE application, it is possible to carry out a complete tutorial session, in which a problem is presented, the unknown terms are registered and illustrated, the students’ questions can be showed and illustrated and the ideas, hypothesis, goals and learning questions can be established;
- In addition, it has been affirmed by the simulation participants that it is possible, through the PBL-VE application, people who have special needs (e.g. deaf and dumb) can effectively participate of the tutorial session. In this respect, without the use of the application, it would practically be impossible the participation of those people in the PBL discussion;
- One of the students has registered the lack of option to draw schemes. As he said, during the tutorial sessions, the ideas can be presented through frameworks. Furthermore, it has been suggested to add an option to attach files. Those suggestions will be considered in the next version of the application.

Finally, the participants of the simulations identified some other advantages in using PBL-VE application to support the PBL tutorial sessions:

- The secretary and coordinator students can effectively participate of the PBL tutorial session because of the time saved during the data recording process. This time saved could be converted into discussions and researches;
- The problems are quickly solved. The students rely on the Internet support to search for material and information related to problem in question. Thus, the research that would be carried out after the tutorial session, can be performed at the moment the students are discussing the problem;
- The students’ motivation have been noticed during the discovery of the problem solution by using the PBL-VE application;
- The students have even commented on the idea of making tutorial sessions at distance that it would solve the problem they face: most of the students live in distinct places and during the weekends they normally go back to their cities. Using the PBL-VE application, they could perform tutorial sessions at distance, each one in their respective cities.

5. CONCLUDING REMARKS

This paper is based on Pinto’s master dissertation (Pinto, 2004) and on the Pereira’s paper (Pereira et al, 2004) that presents the UML modeling of PBL tutorial session and its mapping using XML Schema. The simulations presented on this paper take into account the State University of Feira de Santana educational scenario and the authors of Computer Engineering course that adopted PBL method in their curricula.

The development and implementation of PBL-VE application have allowed us to verify and validate the efficiency of the collaborative learning work in distance education.

It is important to mention that during this research, specific usability issues have not been deeply studied. However, some suggestions have been presented by the participants in order to improve the usability of the PBL-VE application. Among them, the main one has been the automatic “PBL Frame” update. This one and some other suggestions are already being considered for the next version of the application, which is in development. Besides the considerations presented by the members of the tutorial group who participated on
the simulation, some other virtues and possible problems have been also noticed.

There is a fact that could not be left out: it has been noticed that even without base for solving some classic computer problems (e.g. graph theory concepts to solve the problem of the shortest path), two simulation groups using PBL-VE application have solved the problem in less than 2 hours.

Finally, it has been also noticed that the students have got carried away by the challenge, actively participating on the process construction with their knowledge, emitting their ideas, trying to solve the problem; working in a constructive way, learning how to deal with the divergences of thoughts and opinions, and making decisions by themselves. Based on all of the above, it is reiterated the confidence on the PBL method and it is strongly recommended its use. Therefore, in order to support the PBL tutorial sessions, PBL-VE application is recommend.

ACKNOWLEDGEMENTS

This research has been partially supported by the Fundação de Amparo à Pesquisa do Estado da Bahia (FAPESB) – Brazil, under the project number BI 04/2004. In addition, we would like to thank project team.

REFERENCES

Deslisle, R., 1997. Use Problem-Based Learning in the Classroom. ASCD, Virginia.