

## Using an Intelligent Agent with PBL approach to Online tutoring and mentoring

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### Abstract

*Online Tutoring and Mentoring is an essential activity for effective e-Learning systems. However, at present Online tutoring/ mentoring is conducted merely on the basis of personal experiences of tutors and mentors, without a theoretically-based approach. This paper presents an approach that exploits the theory of Problem-Based Learning (PBL) for online tutoring and mentoring. The proposed approach drives the online tutoring/mentoring process through a four dimensional framework concerning; identification of facts, generating ideas, identifying learning issues and preparing an action plan. In our approach, online tutor/mentor is simulated as Agent software that runs on a Learning Management System of an e-Learning environment.*

### 1. Introduction

Nowadays, e-Learning has become popular than ever before due to its ability to provide more flexible learning strategies to suit with individuals. In this sense, e-Learning has been used in many countries all over the world to deliver short courses, undergraduate programmes and Postgraduate programmes. For example, Indira Gandhi National Open University of India and Open University of UK offer most of their Undergraduate and Postgraduate programmes through e-Learning [1]. Even traditional universities are moving towards e-Learning by offering some of their programmes online. Another example is the tutorials available via e-learning. In e-Learning, the online learners will have the advantage of learning at their own pace, own time at their own place and the flexibility they can have in their learning process [1]. Despite the advancement in technologies to offer e-Learning strategies, the value of the teachers (or tutors) involvement in learning process is

inevitable. Researchers have shown the value of humanizing e-Learning systems [2]. Since e-Learning does not encourage the physical presence of a teacher, the role of tutor/mentor as the facilitator of the learning process becomes an essential element of the process.

In fact the role of tutor/mentor is more important for e-learning than for face-to-face learning [2]. This is because; online learners tend to feel that they are kept alone and no opportunity for them to get resolved their learning issues instantly. As such, online tutor/mentor plays a key role in motivating and getting learners actively involved during a learning session [3]. Obviously, the role of an online tutor is more difficult than the tutor's role in the face-to-face environment. At present, online tutoring is operating as a process conducted merely by the experience of individual online tutor/mentor, and there is no theoretical approach to guide the online tutoring/mentoring process. Thus, there is a need for developing a theoretical model to drive the process of online tutoring/mentoring to ensure that online learners are facilitated during a learning session.

Our study for addressing above issue has revealed that emerging trend in Problem Based Learning (PBL) could be exploited to develop a model for emulating the role of tutor/mentor. PBL has won wide spread recognition as a learning strategy that inculcates better skills to work in the industry and also to pursue higher studies [5, 6, 7]. It is evident from our research that PBL process is similar to what an online tutor/mentor performs during sessions such as moderation of a discussion forum/chat session and motivating isolated learners. Therefore, we have decided to exploit a PBL model concerning four (4) dimensions to drive a learning process. These four (4) dimensions are identified as

identification of facts, generating ideas, identifying learning issues and preparing an action plan.

This paper presents the theoretical model based on the PBL theory to familiarize the online tutoring and mentoring.

The rest of the paper is organized as follows: Section 2 provides an overview of e-Learning, emphasising on online tutoring and mentoring. Section 3 describes the PBL process and identifies a model that can be used in e-Learning. Section 4 discusses the novel approach to facilitate online tutoring and mentoring. Section 5 describes the designing of Agent software for online tutoring and mentoring. Section 6 concludes the paper with a discussion.

## 2. Overview: E-Learning

e-Learning refers to the use of Information and Communications Technology (ICT) to support learning in general. This ranges from the use of educational software running on a stand alone PC to online learning materials made available on the World Wide Web. It is widely accepted that Web technology and multimedia technologies have revolutionized e-Learning. This is because, Web technology provides not only a multimedia-based presentation environment for e-Learning but also effective communication means with the use of e-mail, discussion forums, chat sessions, etc.

Therefore, the teacher's role will be played by the e-learning materials and an online tutor/mentor will be there to facilitate the learner. A learning process to happen through e-Learning mode or through face-to-face mode, there should be a tutor to facilitate the learner throughout the learning process [8]. One can argue that the tutor's role is not needed in an online learning environment since the learning materials are expected to provide the necessary guidelines for self-learning. However, to reduce the learner isolation and to increase the communication there should be an online tutor/mentor who ensures the active participation of the learner in the different learning activities [9].

As compared with traditional face-to-face learning, e-Learning has three (3) major advantages. Firstly, learner has the ability of learning in his/her own phase. Hence, the learner can use his own free time to study. The second advantage is that the learner can study on his/her own place and do not have to be at a specified place. Thirdly, e-Learning provides the learners with more flexible learning

strategy, within which learners can use their own learning styles.

Nevertheless, there are some disadvantages too, which might occur in e-Learning. Since the learner is learning at a remote place, she/he might experience technophobia and might face difficulties in fixing the technology problems on his/her own. In e-Learning, the learning materials are available in the electronic format and some of the learners will find it difficult to learn using these compared to printed materials. Another major problem is the limited interaction happening among the learners. In the traditional face-to-face learning, students have an opportunity to directly interact with peers and teachers. Figure 1 illustrates the interaction in face-to-face learning. In face-to-face learning, direct interacting between teacher and the learner enables resolving of learning issues instantly.

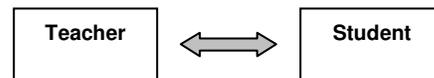


Fig 1: Interaction in Face-to-Face Learning

Furthermore, in face-to-learning, students will have the chance of meeting their friends and discuss the learning issues and share and construct the knowledge in broader manner.

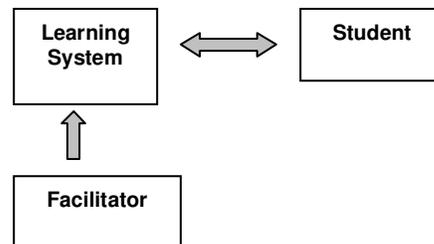


Fig 2: Interaction in e-Learning

In contrast, in an e-Learning mode, learners will directly interact with the online learning system without a direct support from a facilitator. Figure 2 illustrates typical model for interaction in an e-learning environment.

Online tutors and mentors are considered as the facilitators in the model shown in Figure 2. Below is a brief description about the role of online tutors and mentors.

### **A. Online tutoring/mentoring**

Online Tutoring and Mentoring is inevitable for effective e-Learning systems. Unlike a student learning in face-to-face learning mode, an e-Learner will sometimes experience isolation, due to absence of the teacher and peers in the e-Learning environment. Therefore, the online tutor/mentor should be able to facilitate the learners by reducing the isolation and maintaining better interactions with them. Online tutor/mentor should be able to provide relevant guidance in activities such as quizzes, discussion forums, chat sessions and assignments, so the learners will be able perform these activities successfully.

Online tutors/mentors should have a set of special characteristics to perform their duties well. They should be able to motivate the learners throughout the whole learning process by giving positive feedback on time without any delays. The online tutor/mentor needs to write to the learner individually encouraging the learner participation in the specific activities. They should encourage the collaborative learning activities, thus helping the learners to reduce the isolation from the social community [10].

In general, online tutoring and mentoring skills are to be gained through the knowledge of the past experiences, which results in the process becoming personal to the individual tutor/mentor. As such, the current practices to online tutoring have no theoretical-basis, and have a negative effect on the uniformity and quality of services of online tutoring and mentoring. Next section discusses how we exploit theory from Problem-Based learning towards the development of theoretical model to online tutoring and mentoring.

## **3. Problem Based Learning**

### **A. Importance of PBL**

Problem Based Learning (PBL) refers to an instruction method in which the teacher builds his instruction around a practical problem and encourages students to discuss the problem in small groups, with an aim to cultivate active learning, critical thinking, and problem-solving skills among them [6]. PBL facilitates learners to learn to learn. This approach inculcates the learners with many skills including ability to identify a problem, work in teams to solve problems and a variety of soft skills required to solve real world problems [11].

Explicitly PBL is promoted as encouraging the integration of theory and practice, enhancing lifelong learning skills and developing professional competence [3]. It is suggested that institutions that adopt PBL do so because of its potential to deliver a competitive advantage to the institution as much as for educational reasons [6]. It is argued that PBL is being really beneficial for the students to be successful in their learning process [1]. Evidences has shown that PBL is an effective tool to foster students developing the critical and creative thinking skills and enhance their innovation capabilities through the process of problem solving [1].

### **B. Characteristics of PBL**

Problem Based Learning facilitates the learners to learn the subject matter by solving practical, real world problems. Unlike in most other learning methods, PBL covers the breadth of the subject matter rather than the depth of the subject matter. [6]. There are three (3) essential characteristics of Problem Based Learning. The PBL process focuses on problems which are open ended and challenging [5, 6]. In PBL process, learners work in small collaborative teams to solve the given practical real-world problem. The teachers play a facilitator's role instead of the teacher's by directing the students to follow the PBL process.

Before the Problem Based Learning Process begins, it is essential to form teams consisting around five (5) learners in one team. Though, it is possible to select the team members randomly, the most suitable way is to formulate teams with a help of a Quiz which helps to identify the different team roles. The facilitator arranges the teams considering the different team roles which the different learners can play, consequently each team consist of team members that form a good team which consists of all different team roles.

Each team has a facilitator who helps the learners in their Problem Solving Process. The team members will have to conduct meetings time to time with their facilitators. These team meetings will focus on discussing the new things the learners have learned and to clarify issues with the help of the facilitator, if there are any [11]. In order to carry out the PBL process successfully, the team members meet at least once a week. The total time required for solving the problem will depend on the size of the problem scenario and as an average it takes about three (3) consecutive months. It is a required to go

through the PBL process and gain the necessary skills in facilitating, before facilitating the learners [5].

### **C. How PBL process works**

The PBL process comprises of the following steps in constructing a solution through team work for a given problem [11, 12].

- Identification of facts from a given problem stated
- Generating the ideas based on the facts given
- Generating the learning issues
- Generating the action Plan

The procedure in applying the above steps in a PBL process works in the following manner. At the first meeting of the PBL process, the students meet their facilitator and agree upon the plans of communication among the team members and the facilitator. This can be via email or through regular meetings where all the members will be present on any predefined date, on a predefined time and in a specific place. Moreover, it is possible to have the meetings via synchronous chat sessions or online discussion forums. During the next step, the team members identify the different roles each plays within the team. For example, team leader to lead the team, a secretary to record the minutes of their meetings, etc... The real PBL process begins soon after this. Next meeting date should be decided before winding up a team meeting. The facilitator distributes the real-world problem scenario to the learners and the learners are required to go through the problem and identify the facts given in it. The facts are the information which directly extracted from the Problem without making any assumption. After identifying all the possible facts from the problem, the individuals in the team generate ideas leading to a solution. Since the Problem scenarios given to the learners are open ended ones, there can be more than one solution for any given problem. Therefore, the learners come up with several different solutions to the problem. The next step in the PBL process is to identify the learning issues. Learning issues are the areas that the team needs to do research on, in order to get the knowledge in solving the problem. After the first meeting, the learners will have to search for relevant information in library books, magazines or whatever the printed materials of relevant resources. They will have to find additional information from the various different resources available on the World Wide Web. The final step of the PBL process is to

identify the action plan. All the activities that have to be carried out by the different team members should come under this category. For example, if the team needs to interview somebody to get some additional information on certain area, the action plan should contain an entry about the interview and the person who is responsible for that task.

Soon after the first meeting, the team will have to collect the necessary information needed to reach the solution individually. At the meetings the team members are required to present their individual findings and to share the information with others. The facilitator will play a major role here, by observing whether the team is doing the right thing and directing the team towards the correct path. Depending on the information presented by the different team members and the results of the team discussions, the Learning issues and the Action plan will have to be revised accordingly sometimes at every meeting.

### **4. Approach: Online Tutoring/Mentoring Agent**

In our approach to theoretical-based solution for Online tutoring and mentoring, we exploit the four steps of the PBL process to develop a theoretical model for online tutoring and mentoring and develop agent software using this model.

We propose to implement the PBL four-step model as a software Agent that can be delivered as a plug-in for a standard Learning Management System (LMS) such as WebCT [14], Blackboard [15] and Moodle [16]. LMS would be the best e-Learning environment that can be expanded with a special plug-in to implement the role of an online tutor/mentor. This is because, by default, a typical LMS provides most communication facilities such as e-mail, discussion forums and chat sessions that are required by an online tutor/mentor.

Development of our online tutor/mentor Agent is done on the Moodle, a well known and one of the most successful LMS to date. In addition, being a Free and Open source software, it is possible to do development work on the Moodle to integrate with other software.

In addition to standard support for discussion forum, chat sessions, etc., Moodle provides with connection to Wiki like document management systems that are useful in PBL process. Moodle also provides with the facility of a Grade Book

which indicates the marks for different activities out of specified marks, and the time taken to complete an activity out of specified time. By regularly monitoring the Grade book, we can track the progress of the learner easily. For example, we can see whether the learner has completed an activity in the specified time duration and also whether his/her grade is satisfactory. Also it is possible to compare the grades of the different learners. In this particular scenario, if the time taken to complete the activity is greater than specified time or if the grades are not satisfactory then it is obvious that the learner is not up to the standards. Therefore, he/she needs help to improve him/her self. Since he/she learns at a distance, our Agent software has to play a major role here by directing him towards the right path to achieve the learning objectives.

As the first step of the PBL approach, our online tutor/mentor Agent will identify the activity that the learner has failed to do. For this purpose, it uses the Grade book facility of Moodle to retrieve

- the marks for different activities out of specified marks and
- the time taken to complete the activities out of specified time duration

As the second step, it will find out the reasons for the problem. Therefore, the online tutor/mentor analyses data and get the results. For example, if the time taken to complete the activity is greater than the specified time, then the learner has a problem with managing his/her time.

As the third step, the online tutor/mentor Agent will identify the areas in which it could provide guidance for the learner. If we consider the same example mentioned above, then the online tutor/mentor has to provide with the help to the learner to manage his/her time in doing activities. So it will offer the learner with a similar activity that has been covered during the session. These activities are taken from a library which consists of different type of problems that can be solved using Problem Based Learning. Since the Agent has the ability of monitoring the performances of all the learners, it will identify the similar type of learners and help them to form teams that they can work together.

As the final step, the online tutor/mentor Agent monitors the learner closely while he/she engages in the activity, and provide with the necessary

guidance when the learner needs it. Since the learner tries to solve the activity using PBL, the online tutor/mentor agent monitors the times taken to go through the each activity and if the learner takes more time, the Agent helps the learner by indicating the time remaining to complete the activity.

The facilitation provided by the online tutor/mentor Agent will differ according to different learners. It can serve all the learners who connect with the Learning Management System via their individual user profiles. Depending on the grades that the Grade book specifies, this different learners will receive different guidance and the problems to solve by our online tutor/mentor Agent.

It can also be justified the choice of Agent technology [17, 18] for implementing the PBL process into online tutoring and mentoring due to the following reasons. By definition, Agent is a kind of automated software that can support the user without requiring repeated intervention and request from the user. In addition, Agents can learn from past experiences and evolve to provide better solutions in subsequent events. Furthermore, an Agent can handle several users at the same time through the profile of the users. On the other hand, there are so many open source Agent software available, and they can be readily used to develop our online tutor/mentor Agent without requiring to code an Agent from the scratch.

## **5. Design of Online Tutor/Mentor Agent**

Online Tutor/Mentor Agent has been designed to work as a plug-in to standard LMS as shown in Figure 3. This Figure gives an overview showing the entire solution comprises three major components, namely, client learners, LMS running on a server and Agent as a plug-in to LMS.

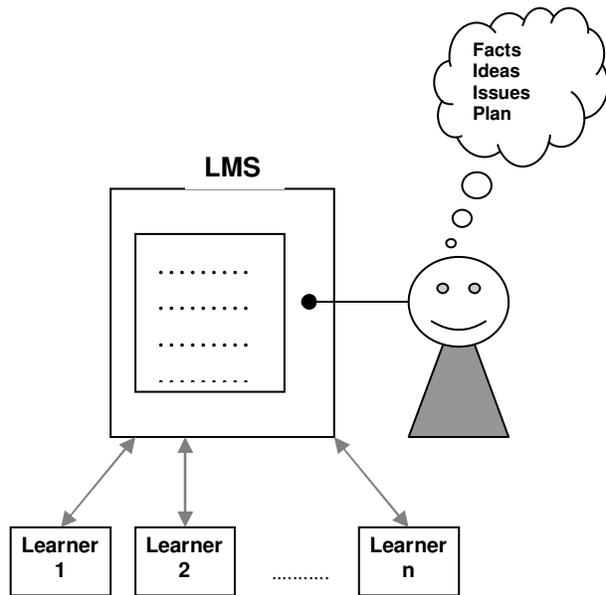


Fig 3: Online tutor/mentor as a plug-in to LMS

### A. Learners

A learner uses a standard web browser for interacting with LMS. There is no special configuration or setting from learners' side. The learners do not even need to know that there is an Agent running on the system. Since the Agent automatically comes in action when necessary. If the performance of the learner is not up to the standard, the online tutor/mentor Agent automatically comes in to action and provides him/her with the necessary support to achieve the learning objectives. If the learner needs any support apart from what he is automatically getting from the online tutor/mentor Agent, then the learner has to request it from the Agent. This request can be done via email, or using short message service available in Moodle. It is also possible to make a request through a chat session or through a discussion forum created for the communication purposes with the online tutor/mentor Agent. The different learners receive different support from the online tutor/mentor Agent according to their performances. Therefore, the learners feel that they are getting a unique service for him/her from the online tutor/mentor agent but not a service that is common to everybody who engages learning in the Learner Management System.

### B. LMS

This is a standard Learning Management System. It will provide with the access to different learning resources like files located in remote places or other different multimedia web resources. The LMS also conducts chat sessions which allow synchronous communication among learners. LMS allows another type of asynchronous communication via discussion forums. LMS has another type of activities called quizzes which helps the learners to assess their performance by them selves. Assignments are another type of activity that included in the LMS. To manage the documents and to get help with the collaborative online activities Wiki like document management modules are available with the Learning Management Systems. Like the above mentioned activities, it is possible that our Agent is plug-in into the LMS in such a manner that LMS administrator can activate the Agent if necessary.

### C. Tutor/Mentor Agent

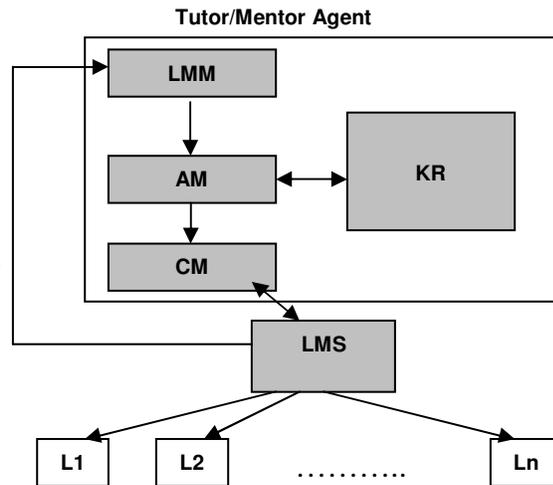


Fig 4: Architecture of the online tutor/mentor

- LMM – Learner Monitoring Module
- AM – Analyser Module
- CM – Controller Module
- KR - Knowledge Repository
- LMS - Learning Management System

Figure 4 illustrates the Architecture of the online tutor/mentor Agent. This is the core of this research work. Our intelligent tutor/mentor Agent has the capability of handling several learners at a given

time. Here the Agent has been designed to instantiate a learner profile for each learner and maintain the profile. The intelligent Agent creates an instance when the learner logs in each time. During the process of learning the Agent monitors whether the learner has actively participated in the prescribed activities in the learning session. This can be done with the use of Learner Monitoring Module. The online tutor/mentor Agent then analyses the information received from the LMM by the Analyser Module and if learner appears to be isolated, performs below other learners, or performs below the specified standards, etc., the Agent assists the learner to be active as per the steps in the exploited PBL model. Since the Agent can have access to performance of a learner, it can provide additional learning advice. The analysed information receiving from the Analyser Module will be stored in the Knowledge Repository. When it is necessary to provide additional learning advices, they are provided with the help of Controller Module. These advices can be provided through email, short message service available on Learning Management System, predefined chat sessions that enables synchronous communication or via discussion forums which enables asynchronous communication. Online tutor/mentor Agent also provide with the help by introducing simple PBL sessions to be completed with the similar type of learners. It also helps the learners by identifying suitable colleagues to form teams. For this purpose, the Agent can maintain a library of problems which are suitable for Problem Based Learning related to topics covered in a session.

## **6. Discussion and Further Work**

We have presented a novel approach to effective online tutoring and mentoring. This approach has several advantages as follows. In the first place, it provides a theoretical-basis for online tutoring and mentoring. Since the solution has been presented as an Agent running on an LMS, many learners can be accommodated at the same time. This is a very big advantage as a typical online tutor can handler only few students at a time. Further, the Agent can provide uniform support for all learners, and this may not be the case with human online tutor/mentors if they are not equally competent.

It is possible to activate the Online Tutor/Mentor Agent while human online tutors are involved in tutoring and mentoring. This process allows the

Agent to learn from good habits of human online tutors/mentors, and improve the Agent performance gradually beyond the human tutor/mentor. Therefore, it is possible to use the online tutor/mentor Agent as an assistant to online tutors/mentors. In the long run this will enable to cut down cost incurred in hiring experienced human tutors/mentors for e-Learning processes.

The online tutor/mentor Agent can perform some tasks, which are in fact cannot be done by a human tutor mentor. For example, learners competency to use LMS and associated tools can be instantly monitored by the Agent, and provide advise to improve. Further, online tutoring by human is generally operates in asynchronous manner, and this does not allow the learner to get the tutoring/mentoring support in a timely manner. However, our Agent can operate all the time, notice the requirement of help and promptly attend the matter.

The Agent can also be extended to enable communication with the LMS through mobile devices. The current Moodle like LMS does not enable such communication, except through PC clients.

In summary the following are the key benefits

- Looking after many students simultaneously
- Improve beyond human online tutors
- Operate timely manner
- Ability to work as an assistant for human online tutors/mentors
- Reduce the cost included in hiring human tutors/mentors
- Automated communication with LMS

Features of the Agent have already been identified and the design model been prepared. Implementation of the Agent commence soon on the Moodle environment.

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