

# DESIGNING ANIMATED PEDAGOGICAL AGENT (APA) TO SCAFFOLD STUDENT LEARNING IN ONLINE PROBLEM-BASED LEARNING (PBL) ENVIRONMENT

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## ABSTRACT

*This paper describes on the idea in integrating animated pedagogical agent (APA) as an alternative approach as scaffolding in Problem-Based Learning (PBL). APA will be operated as a virtual tutor and guided learners through the learning process in PBL. It is suggested to provide the potential solution to replace the human tutor request in PBL.*

**KEYWORDS:** *Problem-Based Learning (PBL), Animated Pedagogical Agent (APA), Scaffolding.*

## 1.0 INTRODUCTION

Issues related to the achievement of students in higher learning institutions in Malaysia have always been of concerned to the society. Reports on students' passive attitudes, lack of motivation, weakness in problem analysis and lack of communication skills has prompted certain authorities to recommend Problem Based Learning (PBL) approach in teaching and learning.

Despite the potential of using PBL approach, very little empirical research has been conducted to integrate APA in PBL environment.

## 2.0 RESEARCH BACKGROUND

In conventional PBL, scaffolding is usually in the form of support from a tutor or facilitator. This metaphor implies that the tutor provides support so that students think for themselves. There are a few assumptions on scaffolding. One assumption underlying scaffolding

is that a cognitive distance exists between what learners know and can do on their own and what they know and can do with the assistance of a more knowledgeable person (Willem S. *et.al.*, 1993). Another assumption of scaffolding is that interaction and dialogue between the teacher and the learner or between peers plays a central role (Willem S. *et.al.*, 1993). From (Andrews P., 2007), scaffolding provides a few types of support which is:

- Generate interest
- Simplify task
- Provide direction
- Highlight crucial task features
- Manage frustrations
- Model task

In addition, (Zimitat C., 1994) has reported that student surveys revealed that 70% of students in a PBL course found the tutor's roles essential to the success of the method. Thus, it is clear that the effect of the tutor is one of the important roles in effective PBL, and that the tutor is well placed to provide scaffolding to learners.

In this research, we are developing the PBL application and integrating APA as a virtual tutor to scaffold student learning into it. The study also proposes a model to integrate three different pedagogies (constructivism, PBL and APA) by connecting them to enhance the quality of learning in PBL.

### 3.0 RESEARCH OBJECTIVES

The main purpose of this study is to investigate the effectiveness of scaffolding in PBL approach. The scaffolding will be provided in two ways:

1. Animated agent as a virtual tutor
2. Access to relevant learning materials such as glossary, web links, ask expert, notes.

The instructional content will focus on structured problem solving technique, a collections of real life scenarios, online forum and discussions, multimedia-rich learning resources and web based learning elements to support learning process.

## **4.0 RESEARCH METHODOLOGY**

The methodology contains three main tasks which involved the method of sampling and selecting respondents, data collection and data analysis.

### **4.1 Data Collection**

Data and information have been collected using three main methods and sources which are:

- Questionnaire form – distributed to the students and lecturers.
- Interview – to a few selected students and lecturers.
- Books, Journals and Publications – to get the information, theory and concept related to the research

### **4.2 Sampling and Respondent**

20 lecturers and 50 students from Faculty of Communication and Information Technology (FTMK), Universiti Teknikal Malaysia Melaka (UTeM) were involved during the preliminary analysis. The survey was done to get the feedbacks on students' performance in class during the lecture and lab session. Two sets of different questionnaire, rated using the Likert scale were made for both lecturer and student. The scale is used from 'strongly disagree' to 'strongly agree'. The analysis from the survey shows that the students are too dependent on their lecturers to feed them with information. Students prefer to be passive in class rather than being an active learner.

### **4.3 Data Analysis**

The results from the analysis are used to continue in the designing and development phases of the application.

## **5.0 PROBLEM-BASED LEARNING**

(Valle I. L. and Margaret B., 2001) consider PBL as a constructivist pedagogy, in which they organize and ask tutors to guide or supervise students learn knowledge step-by-step and develop solutions component-by-component in building up learners' comprehensions to solve the learning problems. They need to find out whether the problems are understood during the learning discussion and whether the students had understood the concepts. This methodology is

the complete opposite of the traditional lecture where students are responsible for acquiring the knowledge to solve problem and the teacher functions as a facilitator rather than an instructor.

However, there are a few of negative comments found from the review of existing applications using PBL approach where it is sometimes led to the misconception by students (Lai H. Y., 2007), (Albion P. R., 2000).

- i. There are too many resources to look up for and questions have to be more specific.
- ii. Sometimes, it is not easy to understand the concepts, I tend to get frustrated.
- iii. Because there is so much to do (so many things to click into). I had just to look at everything still.
- iv. I need more experience to even understand the problems posed in these scenarios.

Thus, there are a few of essential characteristics of PBL to be applied in producing effective PBL applications. The characteristics of PBL include: (a) learning is student-centered; (b) begin with an authentic problem or ill-structured problems; (c) new information is acquired through self-directed learning; (d) learning occurs in small groups; and (e) teachers act as facilitators (Lester J. C. *et.al.*, 1999). However, the trends towards flexible and distance education and the desire to encourage continuing learning by professionals make the possibility of providing PBL experiences to individuals attractive (Albion P. R., 2000).

In this research, we hypothesize that integrating animated pedagogical agent (APA) into PBL environment can overcome the shortage of tutors or assistants in facilitating many PBL groups. APA as an alternative approaches to scaffolding for PBL will be a virtual tutor through the entire learning process.

## **6.0 ANIMATED PEDAGOGICAL AGENT**

Animated characters in the interface of pedagogical systems have become increasingly popular in the recent years. For instance, North Carolina State University's IntelliMedia Initiative has developed three animated pedagogical agents: Herman the Bug, Cosmo and WhizLow (FIGURE 1) (Johnson W. L. *et.al.*, 2000).



FIGURE 1

Herman, Cosmo and Whizlow (North Carolina State University's IntelliMedia Initiative)

Empirical studies have shown that animated pedagogical agents can enhance the student's quality of learning (Lester J. C. *et.al.*, 1999a), (Lester J. C. *et.al.*, 1999b). Lifelike pedagogical agents offer particularly significant potential for constructivist learning environments (Lester J. C. *et.al.*, 1999). There are a number of characteristics that an effective pedagogical agent should display.

- i. Motivator  
Pedagogical agents should always encourage students to spend more time interacting with the application and attempt more problems besides congratulate users when they successfully solve problems (Lester J. C. *et.al.*, 1999a).
- ii. Emotions  
Agent should show that they care about students and their progress by appearing to 'understand' emotions and respond accordingly (Elliot C. *et.al.*, 1999).
- iii. Enthusiasm  
Whenever the student feels frustrated, the agent should intervene with assistance before the student loses interest and display concern over students' progress that may convince students to take learning seriously (Elliot C. *et.al.*, 1999).
- iv. Fun  
An agent should also possess a rich and interesting personality, so that it can simply make learning more fun. A student who enjoys a learning environment would undoubtedly spend more time there, which is likely to increase learning (Lester J. C. *et.al.*, 1999a).

- v. Other factors (body language, eye contact, emotional expressions)

Pedagogical agents should be visually expressive to clearly communicate problem-solving advice and simultaneously have a strong motivational effect on students. Factors such as eye contact, body language and emotional expressions should be modeled and exploited for instructional purposes (Lester J. C. *et.al.*, 1999b).

## 7.0 DESIGNING APA IN PBL

We hypothesize that integrating animated pedagogical agent (APA) into PBL environment can enhance the scaffolding in conventional PBL.

PBL is a learning process where students are presented with a problem and are asked to apply reasoning, questioning, researching and critical thinking techniques to find a solution to the problem (Liu M. *et.al.* 2006). Since students are responsible for acquiring the knowledge to solve the problem, agent that is integrated into the learning process will be responsible as a tutor or facilitator. (Lester J. C. *et.al.*, 1999) suggest that these lifelike characters are ideally suited to serve as tutors, coaches, or guides in knowledge-based learning environments. Despite the potential of using animated pedagogical agents to emulate the actions of human tutors while operating in a computer-based learning environment, very little empirical research has been conducted to incorporate APA in problem-based learning environment.

APA as an alternative approaches to scaffolding for PBL will be a virtual tutor and guide learners how to solve problems and deliver instructional explanations either textually or aurally, while simultaneously using gaze and gesture to direct the learners to focus their attention while solving the problems given and make the learning experience more effective and enjoyable. APA offer problem solving advices by appearing as animated “humanlike” characters, which allows them to exploit nonverbal communication typically reserved for human–human interactions. For example, the agent can focus a learner’s attention by moving around the screen, using gaze and gesture, providing nonverbal feedback, and conveying emotions. While learners are actively engaged in problem-solving activities, learning environments should monitor their progress and provide them with feedback in a manner that contributes to achieving the twin goals of learning effectiveness and learning efficiency. Moreover, providing

agent as assistant (scaffolding) can support student thinking process. It is predicted that by supporting students thinking, it will gradually develop students' capabilities to be more self-dependent in doing PBL (Albion P. R., 2000).

In this application, Robotee will interact and communicate in three main categories: introductory, explanatory and congratulatory.

- i. Introductory – introduce the system; introduce itself; welcome users; introduce system's user interface; introduce PBL phases.
- ii. Explanatory – explain problem scenarios; explain system flow; guide learner to solve problems; give advice to solve problems; provide hints to user; display partial solution; explain errors; display complete solutions.
- iii. Congratulatory – congratulate user; encourage user to try; encourage user to attempt more problems.

In order to meet the objective to integrate APA into PBL, we proposed a model that integrates three different pedagogies (constructivism, PBL and APA) by joining them together to enhance the quality of learning (FIGURE 2). Constructivism is one of the educational theories which 'claim that reality is more in the mind of the knower, and the knower constructs or interprets a reality from his or her perceptions' (Albion P. R., 2000). From the research, we conclude that both APA and PBL are implemented in several learning styles to enhance the scaffolding in learning. They have the same main purpose which is to provide effective learning for learners. Based on FIGURE 2, APA is a guided-learning style while PBL is more to self-learn but both support the constructivism learning environment. Therefore, it is possible to integrate APA into PBL environment.

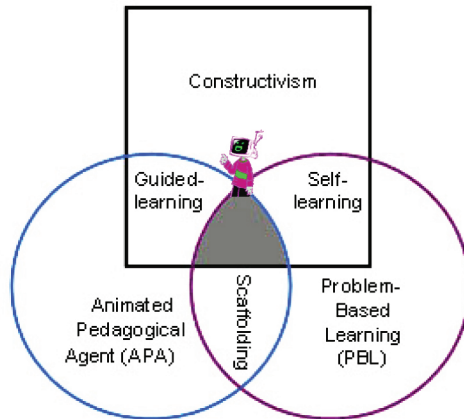


FIGURE 2  
Connection of APA, PBL and Constructivism

## 8.0 EXPECTED BENEFITS OF INTRODUCING AN AGENT INTO PBL

Integrated APA in PBL environment gives benefits to learner in terms of motivation, emotions, enthusiasm and other factors in helping learner through the learning process but still give a full control to learner to learn at their own pace. These are a few benefits that may give advantages in integrating APA into PBL approach.

- i. The introduction of APA in PBL is expected to guide and assist students in a number of ways as agents are known to play an important role in motivation. The agent that appears in the background could motivate the users to perform at their best and encourage them to spend more time with the system. The agent's interaction and communication could show an understanding of students' emotions, making the users feel that they are not alone in the learning process and that they are 'in things together' with the agent. It could also make the student feel obliged to perform at his/her best during the problem solving activities.
- ii. The agent should display great enthusiasm to encourage students to be similarly enthusiastic. Students with high enthusiasm are likely to spend more time with the system. Their eagerness may also drive them to learn and master the subject from the materials given.



- iii. One of the most important requirements in teaching is that the students should not become frustrated. Once frustration creeps into students mind, overcoming it takes a major effort on both parties (teachers and students). The agent should intervene by offering assistance before the student loses interest.
- iv. The introduction of APA whose rich and interesting personality should make learning using PBL approach is more interesting and fun.
- v. To increase the student's attention during the learning process. The agents' instructions and communications can be utilized to clearly communicate advice from the application to the user. An agent possesses the ability to hold a high proportion of the user's attention and deliver clear advice could even make the students feel the learning process easier.

## **9.0 SYSTEM PROTOTYPE**

Based on the early study and preliminary analysis, a prototype was developed to represent the system functionality. FIGURE 3 to 5 describe part of the screen interfaces of the system.

Figure 3 shows the main page and introduction of the system. Agent (Robotee) in the introductory level mainly focuses on new users such as introducing the system and itself. Gestures such as pointing are used as visual aids in presenting introductory messages. The agent also displays interactions that welcome the user to the system to grab the user's attention at the start of a session. Introductory category is also used to introduce new problems.

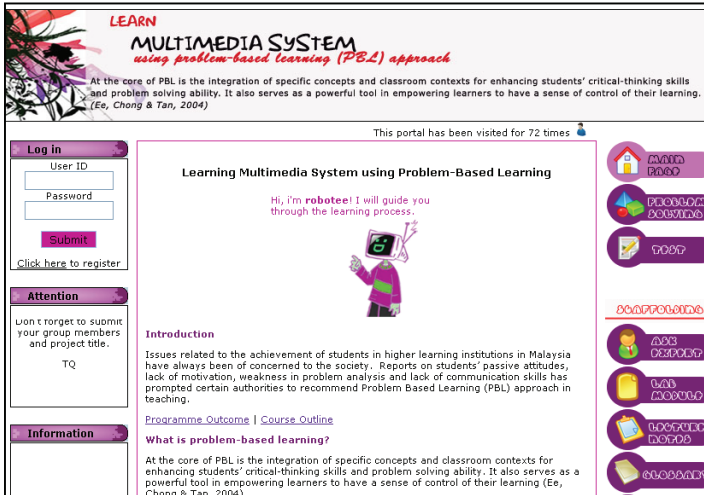


FIGURE 3  
Main Page

FIGURE 4 shows one of the problems scenario design. The image shown in figure below is a trigger to the problem scenario. It gives example on bad web-design. Learner has to solve the problems given by self-learn or explore the scaffolding provided in the system. Agent will also guide the learner by giving explanations, hints and advice.

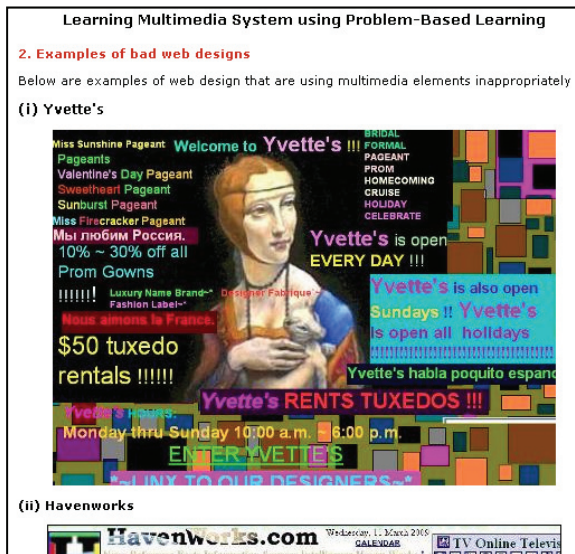


FIGURE 4  
Problem Scenario

FIGURE 5 shows that the system is provided with the access to relevant learning materials and information such as ask expert, lab modules and lecture notes to support student learning. User can access and utilize all the learning resources provided to get the answer to each problem in the system.



FIGURE 4  
Scaffolding

## 10.0 CONCLUSION

The main objective of this research is to develop an interactive web based courseware using a PBL approach to support learning environment. Scaffolding part is the main focus where APA is integrated to enhance it. From the study, PBL and APA can be connected together through constructivist learning environment. Thus, it is possible to integrate APA in PBL approach to improvise the existing PBL applications. Effective design and the well development of the overall system can increase the quality of learning and may give a strong impact to the learners in a good way. Besides, application using web-based platform could be made available 24-7 accessible through the Internet. The learner will be expected to self learned in solving a scenario problem, actively join the online features for sharing ideas, utilised all the learning resources and using a problem solving method to make a learning more effective and meaningful. It is hoped that the interactive web base developed can play significant role to motivate the learners as well as to improve their thinking and problem solving skills.

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