Integrating Animated Pedagogical Agent (APA) into Problem Based Learning (PBL) Approach

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Abstract

The concept of problem-based learning (PBL) is currently seen as an innovative measure compared to face-to-face teaching in encouraging students to learn via real-life problems. It gives learners full control during their learning process and encourages learners to self-learn and explore the learning materials provided. Although students are required to think actively while doing PBL, it is always argued that guidance is still need to support students' thinking process. Thus, we integrate APA as an alternative approach as scaffolding in a PBL environment to guide learners and enhance the learning performance among learners.
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Keywords: Problem-Based Learning (PBL); Animated Pedagogical Agent (APA); scaffolding

1. Introduction

Problem-based learning (PBL) is a learning concept increasingly applied in our educational settings and recent years have witnessed more and more educational transformations towards PBL. PBL is one of the teaching techniques used by educators from all level to teach their students in more effective way. It is an instructional method that is said to provide student with knowledge suitable for problem solving where learners have full control in their learning process. By applying PBL, learners will become more competent and better able to deal with their working memory limitations besides helping students to understand the subject better.

Besides, pedagogical agent research and development has also made significant strides over the past few years. Animated pedagogical agent has begun to appear to facilitate learning and offer great promises in computer-based learning environments. Several studies show that animated agents can improve student's learning, engagement and motivation [6].

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

2. Problem Statement

Although students are demanded to think actively while doing PBL, it is always argued that they still need guidance to support student's thinking process.

These are few of negative comments found from the review of existing applications that used PBL as their approach [7], [1].

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.

3. 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, learning through real life scenarios and multimedia rich learning resources to support learning process.

4. Problem-Based Learning (PBL)

4.1. PBL Background

In the 1960s McMaster Medical School introduced a learning environment that was a combination of small group, cooperative, self-directed, interdependent and self-assessed [3]. Since

4.2. PBL Characteristics

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; (e) teachers act as facilitators [9].

In this research, interactive multimedia PBL (IMM-PBL) principles are used in designing the application.

4.3.   PBL Characteristics

Based on [1], there are eight principles of IMM-PBL which PBL is incorporated with interactive multimedia environment to enrich the experience in PBL.

- Principle 1: Begin with an authentic problem
  PBL should begin with an authentic problem which is genuinely problematic for the learner and representative of problems found in professional practice.
- Principle 2: Incorporate relevant cases
  Learning from example or cases, especially when accompanied by explanations has been found to be effective foe developing expertise.
- Principle 3: Represent multiple viewpoints
  It is characteristic of ill-structured problems that there is no single correct solution and presenting alternative points of view through group discussion of problems is an important feature of PBL.
- Principle 4: Stimulate activation and elaboration of knowledge
  Activation of prior knowledge to facilitate linking to new learning and elaboration of new knowledge through immediate application are key tenets of PBL.
- Principle 5: Scaffold learner performance
  In conventional PBL, scaffolding is usually in the form of support from a tutor or facilitator.
- Principle 6: Provide a strong narrative line
  It may be possible to engage the learner as a participant in the story rather than as an observer with appropriate design.
- Principle 7: Provide access to relevant information
  The inclusion of information resources in IMM offers a level of convenience but does not preclude students to going outside the materials in search for additional resources.
- Principle 8: Encourage self-evaluation

then this approach has been called problem-based learning (PBL). Its applications were continuously extended to graduate schools, colleges to K-12 and many special educational institutes [12].

  Providing learners with frequent opportunities for self-evaluation during task performance has been reported to lead to enhanced self-efficacy.
- Principle 9: Suggest individual and collaborative learning
  The trend towards flexible and distance education and the desire to encourage continuing learning by professionals make the possibility of providing PBL to individuals.

5.   Animated Pedagogical Agent (APA)

Animated pedagogical agents are autonomous agents that support human learning in interactive learning environments [11]. They appear to the student as animated characters. They can engage in a continuous dialogue with the student, and emulate aspects of dialogue between a human teacher and student in instructional settings. They should give the user an impression of being lifelike and believable, producing behaviour that appears to the user as natural and appropriate to the role of a virtual instructor or guide. It is useful to give our agents behaviours that make them appear knowledgeable, attentive, helpful, concerned, etc [8].

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 (Fig. 1) [6].

Fig. 1. Herman, Cosmo and Whizlow (North Carolina State University's IntelliMedia Initiative)

5.1. APA's Characteristics

Empirical studies [7], [8] have shown that animated pedagogical agents can enhance the student's quality of learning. Lifelike pedagogical agents offer particularly significant potential for *constructivist* learning environments [9]. 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 [7].

ii. **Emotions**

Agent should show that they care about students and their progress by appearing to 'understand' emotions and respond accordingly [4].

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 [4].

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 [7].

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 [8].

6. Integrating APA into PBL Environment

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 [8]. 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. [9] 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 [1].

In this application, Mdm. Linda and Melissa (agents) 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 questions.

Fig. 2 shows the two characters of the APA, Mdm. Linda (left) and Melissa (right).

Fig. 2. Mdm. Linda and Melissa as APA characters

6.1. Expected Benefits Using APA in 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.

1. 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.

2. 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.

3. 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.

4. The introduction of APA whose rich and interesting personality should make learning using PBL approach is more interesting and fun.

5. Agent should 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.

7. Application Prototype

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

Fig. 3 shows the main page and introduction of the system. Agent 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.

Fig. 3. Main Page

Fig. 4 shows page of problem introduction which is the trigger to the problem scenario. Leaner 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.

Fig. 4. Main Page

Fig. 5 shows that the system is provided with the access to relevant learning materials and information such as ask tutorial, web links and glossary to support student learning. User can access and utilize all the learning resources provided to get the answer to each problem in the system.

Fig. 5. Learning Resources

8. Conclusion

APA is integrated into PBL approach to improvise the existing of 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. It is hoped that the application can play significant role to motivate the learners as well as to improve their thinking and problem solving skills.

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