Adaptivity in Problem-based Learning: Use of Granularity

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Abstract

This paper discusses the limitations of PBL learning environments and introduces the student adaptivity technology into PBL environments to improve the effectiveness and efficiency of the learning process. A web-based prototype is implemented by using PHP, MySQL and Apache, and uses the accounting as subject domain. With the system, students work on the real world costing calculation problems, and the system evaluates students’ performance results on the problems to provide adaptation to the students.

1. Introduction

Constructivist approach to learning has been around for quite some time. The constructivist theory has resulted in the development of a wide variety of learning environments, however the problem-based learning (PBL) lends itself as one of the most suitable candidates for its deployment [2]. PBL is an attractive approach to foster learner’s critical problem solving and self-directed learning skills. However, it is difficult to implement effective PBL environments. A majority of existing PBL environments suffers from the fact that the students easily get inundated by the fine granularity of the problems and loose focus of overall aims of the learning process. This paper describes a problem-based learning environment that attempts to address this problem by introducing student adaptivity technologies.

2. Constructivism Theory and Problem-based Learning

Like other learning theories, constructivism has multiple roots in the philosophical and psychological viewpoints of this century. A number of contemporary cognitive theorists have adopted constructivism theory, which considers: knowledge is a function of how the individual creates meaning from his/her own experiences during learning and understanding [1]. This theory is characterized by following three propositions [2].

- A) Knowledge is in the interaction of humans with the environment (the core concept of constructivism).
- B) Cognitive conflict is the stimulus for learning and determines the organization and nature of what is learned: when human beings are in a learning environment, there is some stimulus for learning.
- C) Understanding is influenced by the processes associated with collaborative learning.

The features of constructivism outlined above have been the basis of a wide variety of learning environments, including problem-based learning environments. The problem-based learning model has its roots in the apprenticeship. It emphasizes a "real-world" approach to learning: a student-centered process that is both constructive and collaborative. PBL is a motivating way to learn because learners are involved in active learning, working with real problems. Within PBL environment, students are able to build and improve their problem-solving and self-directed learning skills.

However, in practice, PBL is difficult to implement, with or without computer-based support. In the traditional face-to-face PBL, teachers must be specially trained as guides and students often become frustrated by the lack of information. In the computer assisted intelligent PBL environment, since the PBL does not limit what students may choose to learn, and the process may provide little guidance on the best ways of achieving learning goals, students may be concerned that their learning strategies are misdirected or inefficient. Thus, it is much harder for student in the computer intelligent learning systems with PBL, and students easily get lost during learning and become frustrated by feeling out of control in their study.

3. Student Adaptivity in Computer Intelligent Learning Systems

Student adaptivity in intelligent learning systems provides the systems ability to adapt themselves to the goals and tasks of student by monitoring their performance. The adaptivity is one of the core components in intelligent learning environment.

The main reasons that student adaptivity is so important to intelligent learning systems are as follows:

- A wide student spectrum: the student spectrum may be from one extreme (naïve) to another extreme (advanced), that means that students may have...
different backgrounds, preferences, and knowledge levels. The systems with student adaptivity can improve the effectiveness and efficiency of learning.

- The intelligent systems have major focus on student centred learning. These systems usually are used by students in different place, and are more appropriate for adopting student centred learning model instead of teacher centred learning model.

4. System Conceptual Model

Figure 1 shows the high level architecture of this system. Based on the architecture of the web-based intelligent educational systems, the problem base module is introduced into this architecture.

As shown in figure 1, the basic architecture of the system is a typical three-tier, client-server structure. The client has the presentation interfaces that are implemented as HTML frames and run in a web browser. The application programs for performing adaptation reside in the middle layer, and they communicate directly with the backend database: problem base, knowledge base, and student model. The web server, acting as the communication channel, also resides in the middle tier.

5. Implementation

The topic of Process Costing in the Accounting discipline is chosen as the domain of this system. The system attempts to help accounting students understand the Process Costing in the problem-based learning environment. The main characteristics of this system are:

- **Problem base:** the system uses a set of different levels of real world problems to be solved by students, and each problem usually consists of several parts.

- **Flexible assessment for each problem based on student performance:** each problem consists of several parts, and each part is assessed according to its degree of difficulty that is out of 100 points for whole problem.

- **Teacher defines the criteria for assessing student’s level:** teachers are able to define and modify the criteria to assess student’s performing level on each problem.

- **Student adaptivity:** the system adapts according to the student level. For example:
  a. If the student got less than 60 points in an exercise, the system infers the student at the beginning level of the defined assessment criteria. The system in this case will present the student with the information from introduction and basic concepts to examples, and let the student do the same or similar exercises again.
  b. If the student scores between 80 and 95, then the system infers the student to be at the medium level. In this case, the system will present the student related example for reviewing, and then recommend to go to the next problem.
  c. If the student scores greater than 95, then the system will recommend the student to go directly to the next problem.

- **Knowledge base:** a set of course contents and the relationship between the content elements; and

- **Student model:** a set of student data or profile.

6. Conclusion

The system has successfully introduced the student adaptivity into the PBL environment. The strategies used in this system can be applied into the pure PBL educational systems or the assessment parts within generic intelligent educational systems to improve their adaptation capability.

7. References
