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**GRANULAR APPROACH TO ADAPTIVITY IN  
PROBLEM-BASED LEARNING**

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## **Abstract**

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) environment is one of the most ideal and most popular area that implements the constructivism theory. 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 project has introduced student adaptivity technology into PBL environments to improve the effectiveness and efficiency of the learning process. To demonstrate the idea of PBL with student adaptivity, a web-based prototype is implemented in Process Costing, within the field of Accounting. Based on the architecture of the web-based intelligent educational systems, the problem base module is introduced.

The basic architecture of the system is a typical three-tier, client-server structure. The client tier has the presentation interfaces that are implemented as HTML frames and run in a web browser. The application programs for performing adaptation, which were developed using PHP, reside in the middle layer, and communicate directly with the backend database: problem base, knowledge base that is the third tier. The web server as the communication channel also resides in the middle tier.

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.

In summary, this project has successfully introduced the student adaptivity into the PBL environment. The strategies used in this thesis can be applied into the pure PBL educational systems to improve their adaptation capability.

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# **Chapter 1**

## **Introduction**

### **1.1 Introduction**

The Problem-Based Learning (PBL), as an effective learning environment for improving students' problem-solving and self-directed learning skills, has been applied some disciplines successfully. But the potentials of PBL are not exploited yet, because its limitations, such that students easily loose focus and get frustrated by lack of adequate guidance. This thesis intends to introduce student adaptivity technologies into PBL environment that aims to exploit its potentials.

This chapter first briefly discusses the basic concepts and the relationship of constructivism and problem-based learning environment. Then the main advantages of problem-based learning and its deficiencies are described, followed by the basic concepts of student adaptivity.

Finally, the chapter outlines the objectives of the project, and introduce the steps of this research and the organisation of this thesis.

### **1.2 Constructivism Theory and Problem-based Learning**

Constructivism is not a totally new approach to learning. In recent years, however, constructivism has become a "hot" issue as it has begun to receive increased attention in a number of different disciplines, including instructional design.

Like most other learning theories, constructivism has multiple roots in the philosophical and psychological viewpoints of this century. A number of contemporary cognitive theorists have adopted the constructivism, which considers:

knowledge is a function of how the individual creates meaning from his or her own experiences during learning and understanding. In general, constructivism is a learning theory about how humans learn and know knowledge. This theory is characterized by the three following propositions (Savory and Duffy, 1995):

- A) Knowledge is in human's interactions with the environment: this is the core concept of constructivism. What humans understand is a process of the content, the context, the activity of the learner and the learner's goals.
  
- B) Cognitive conflict is the stimulus for learning and determines the organization and nature of what is learned: when human being are in a learning environment, there is some stimulus or goal for learning.
  
- C) Understanding is influenced by the processes associated with collaborative learning: the experiential world includes, most importantly, the social environment.

The features of constructivism outlined above have founded a wide variety of learning environments (Duffy et al., 1993), and the problem-based learning environment is the almost ideal and most popular area that implements the constructivism theory (Savory and Duffy, 1995):

The PBL model has its roots in the apprenticeship, or learning-by-doing, method. 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, as learners are involved in active learning, working with real problems. PBL intends to foster learner's problem-solving and self-directed learning skills. The PBL provides a more stimulating environment for the learner and a more enjoyable environment for students and teachers.

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 who learn through the computer-based intelligent learning systems with PBL, and students may easily loose focus during the learning process and become frustrated by feeling out of control in their study.

### **1.3 Student Adaptivity in Computer-based Intelligent Learning Systems**

Student adaptivity in intelligent learning systems provides the systems ability to adapt themselves to the goals and tasks of students by monitoring their performance. The adaptivity is one of core components in intelligent learning environments. The application of student adaptivity can create better learning environments in intelligent learning systems.

The main reasons that student adaptivity is so important in 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 very different backgrounds, learning styles, individual preferences, and knowledge levels. The systems with student adaptivity are able to improve the effectiveness and efficiency of learning.
- The intelligent systems focus more on student centred learning. Theses systems are usually are used by the students of different places and in different contexts. The student adaptivity in these systems concerns about individual student's preference and knowledge level, with aim to make the learning more efficient and effective.

## **1.4 Objectives of the Research**

PBL is an attractive approach to foster learner's problem-solving and self-directed learning skills, and these skills are crucial in general life and career. However, PBL is difficult to implement, with or without computer-based support. One of major reason is that students easily loose focus and get frustrated by lack of adequate guidance and help available in PBL environments. This project attempts to address this problem by introducing student adaptivity technologies into computer-based PBL learning environment.

The main objectives of the project are as follows:

- Investigate PBL and student adaptivity technologies, and design a framework of student adaptivity function in computer-based PBL learning environment.
- Design and implement a web-based PBL prototype to test and evaluate the student adaptivity in PBL environment.

## **1.5 The Steps in This Research**

The following steps summarize the plan of this project that is used to reach the objectives described above:

- *Step 1: Literature review:* it covers constructivism, problem-based learning, student adaptivity in intelligent learning systems.
- *Step 2: Design the system architecture:* it introduces student adaptivity mechanism into PBL learning environment, and build up an architecture based on the literature review.
- *Step 3: Exploit some related technologies,* such as CGI, Client-server, and so forth.

- *Step 4:* Implement the prototype.

The outline of steps is shown in Figure 1.1.

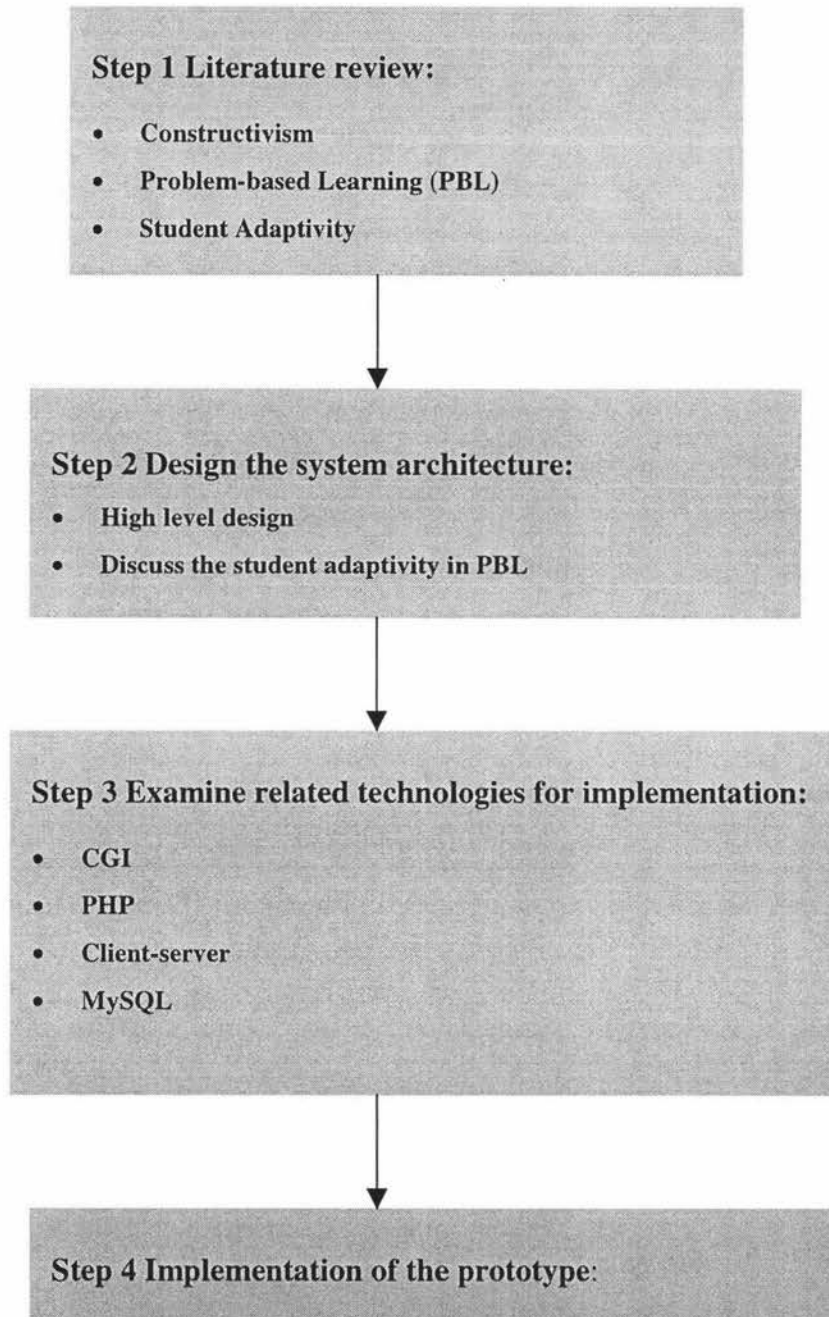


Figure 1.1: The research steps of this project



## **1.6 Organization of the Thesis**

The thesis consists of 8 chapters. They are outlined below:

Chapter 2 reviews the history and features of the constructivism theory.

Chapter 3 moves from constructivism onto problem-based learning area. It overviews the features of PBL, and discusses its advantages and disadvantages.

Chapter 4 investigates student adaptivity technology and introduces this technology to address the problem with PBL in theory.

Chapter 5 designs the system architecture based on the above research results, and describes its mechanism.

Chapter 6 examines the related technologies, such as CGI, PHP, Client-server, and describes the implementation of the prototype based on the architecture.

Chapter 7 discusses how the student adaptivity works in this prototype.

Chapter 8 concludes the contributions of this project and presents some further consideration about this project in future.