Profile Transformation in Mobile Technology Based Educational Systems

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Abstract

In order to meet the learning needs from various types of students, computer aided education systems try to include new methods to provide personalized education to every student. From the early 1970s, a lot of adaptive educational systems have been created to provide training on a variety of subjects. Combined with the Internet, the adaptive educational systems have become web-based and even more popular. Recently, the development of mobile technology has made the web-based adaptive educational systems accessible through mobile phones. It is necessary that the students can also receive adaptive educational contents on mobile phones. This research project investigated the possible student's preference differences between Personal Computer (PC) and mobile phone, and then proposed a student profile transformation framework to address such differences.

This research project conducted two surveys on the student profile transformation between PC and mobile phone. A demo web-based educational system that could be accessed from both PC and mobile phone was also developed for participants of the surveys to give more real and precise responses. Based on Felder-Silverman Learning Style Theory (Felder, 1993; Felder & Silverman, 1988) and the results of the surveys, this thesis proposes a student profile template and a student profile transformation framework, which both fully considered the influences of device capabilities and locations on students' preferences on mobile phones. Furthermore, the proposed framework integrates a solution for unsupported preferences and preference conflicts.

By implementing the proposed template and framework, the students' preference changes between PC and mobile phone are automatically updated according to various device capabilities and locations, and then the students can receive adaptive educational contents that meet their updated preferences.

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Chapter 1 : Introduction

1.1 Introduction

Computers and Internet technologies have become more and more essential for educational purposes. A lot of computer and Internet based education systems have been developed today. The convenience and efficiency of such systems successfully extend the education from the traditional classroom to everywhere in people's daily life. To suit various types of students, the educational systems begin to include adaptive features. Since the mobile phone technology is now available for education, it is also becoming essential for the educational systems to provide adaptive education to the students on mobile phones as well as on Personal Computers (PC).

This chapter briefly introduces the history of Adaptive Educational Systems and mobile learning. Then the research objectives and approaches are described. At the end of the chapter, the complete structure of this thesis is presented.

1.2 History of Adaptive Educational Systems

With the invention of computers, people tend to include computer assistance into a variety of areas for better performance and higher efficiency. Research in Computer-Aided Instruction began in 1950s. A lot of terms had emerged. Computer-Based Instruction (CBI), Computer-Based Training (CBT), Computer Aided Learning (CAL), Computer Mediated Education (CME), and Computer Assisted Instruction (CAI) were all typical examples of Computer-aided Educational Systems. However, those systems did little in providing personalized instruction for different users. Each system set up exactly same learning environment for all its users. The same educational contents were delivered to all users regardless of each user's

preferences and differences in cognitive processes.

In the early 1970s, Intelligent Tutoring Systems (ITS) came into existence, capable of providing students with individualized instruction. They were the combination of Computer-Aided Instruction with Artificial Intelligence technology ("An overview of intelligent tutoring systems", 1996). The individualization of delivered tutoring contents was achieved through the system's adaptivity, i.e. the system adapted its output using some data or knowledge about the learner in a system controlled way (Papanikolaou, Grigoriadou, Ornilakis, & Dagoulas, 2003). Together with a number of ITSs, e.g. SOPHIE (Brown, Burton, & de Kleer, 1982), Geometry Tutor (Anderson, Boyle, & Yot, 1985) and the LISP Tutor (Anderson, Conrad, & Corbett, 1989) being developed, four major components were identified within an ITS: the student model, the pedagogical module, the domain knowledge module, and the communication module (Woolf, 1992). The student module stores specific information of each student; the pedagogical module is the information about teaching process; domain knowledge module contains the information that is going to be taught to the student; and the communication module controls the interactions with the student. The fifth component, expert model, was separated from the domain knowledge module several years later, which contains the expert's perception of the domain knowledge. (Beck, Stern, & Haugsjaa, 1996). An illustrative figure was also included in their work to explain the interactions among those components (Figure 1-1).

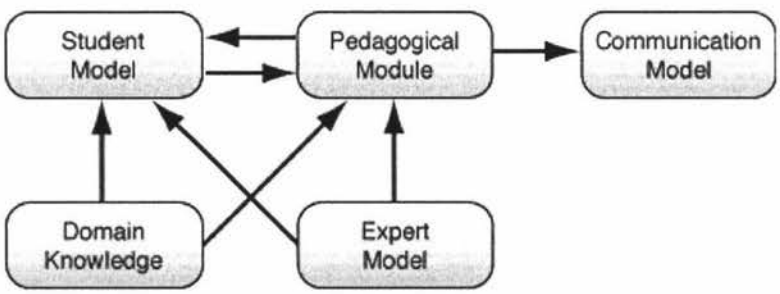

Figure 1-1: Interactions of components in an intelligent tutoring system (Beck et al., 1996)

As in the figure 1-1, the Expert Model in an ITS has knowledge about a particular domain and the Student Model contains measurements of the student's knowledge of the problem area ("An overview of intelligent tutoring systems", 1996). These two models interact to ensure that the educational contents being presented to the students are well individualized.

In the early 1990's, another great invention, the Internet began to allow limited commercial traffic ("Internet facts and statistics", 1999). With the advent of the World Wide Web (WWW) and the graphical web browser, the Internet expanded very quickly throughout the world. By using Hypertext Markup Language (HTML), browser software and WWW systems, various Internet protocols could then be accessed on a single interface (Berners-Lee, Cailliau, Luotonen, Nielsen, & Secret, 1994; Cohen, 2003; Musciano & Kennedy, 1998). As the result of the popularity of the Internet, Adaptive Hypermedia Systems (AHS) emerged to attract research efforts. Generally, AHSs were hypertext and hypermedia systems that stored some personal features about the user in a user model and applied this model in order to adapt several visible aspects of the system to the user (Brusilovsky, 1996). The Adaptive Hypermedia technology was believed to be helpful in providing personalized educational contents and navigation supports for different users. Web-based Adaptive Educational System (Web-based AES) or Adaptive Educational Hypermedia (AEH) was an inheritance form of the earlier ITS and AES. It was developed and became a hot research area (Khan, 1997) after 1996. These systems could be simply regarded as ITSs with WWW accesses (Brusilovsky, 1996). Since Web-based AESs were independent of classroom and platform (Brusilovsky, 1998), learners could enjoy more computer assisted education on their own. However, the educational systems seemed to ask for more adaptivity features. This was because these systems aimed at not only students but also life-long learners, whose knowledge levels and learning environments were even more diversified. A lot of such systems have also been developed quite successfully, such as ELM-ART (Brusilovsky, Schwarz, & Weber,

1996), AST (Specht, Weber, Heitmeyer, & Schoch, 1997), AHM (Pilar da Silva, Durm, Duval, & Olivie, 1998), AHA! (De Bra & Calvi, 1998), Arthur (Gilbert & Han, 1999), InterBook (Brusilovsky, Edlund, & Schwarz, 1998), ACE (Specht & Oppermann, 1998), and TANGOW (Carro, Pulido, & Rodriguez, 1999). A reference model called Adaptive Hypermedia Application Model (AHAM) was also defined to provide a sound basis for AHS development in 1999 (De Bra, Houben, & Wu, 1999). This reference model clearly distinguished four easily confused items in the AHS: domain model, user model, teaching model and adaptive engine. The information structure stored in Domain Model and the user information stored in User Model were combined together by the pedagogical rules set by Teaching Model, and then the adaptation would be performed accordingly (De Bra & Calvi, 1998; De Bra et al., 1999).

1.3 The Emergence of Mobile Learning

However, this is not the end of adaptive learning systems. New technologies keep emerging all the time. Availability of high bandwidth infrastructure, such as GPRS, 3G and UMTS networks, and the increasing number of mobile subscribers ("Mobile subscriber numbers exceed 1.5 billion", 2004) make mobile internet applications more and more common into our daily life. One important emerging mobile internet application is mobile learning (Sharples, 2000). With the help of wireless network adaptors, it is possible for the handheld mobile devices, such as Personal Digital Assistants (PDAs) and mobile phones, to enjoy the exciting world of the internet anytime and anywhere wirelessly. The researchers of adaptive learning systems will certainly not miss this technological revolution. Empowered by wireless communications, e-business can become m-business (Mobile Business), which will reach the users more effectively and enable instant access to business-critical information and communications (Deitel, Deitel, Nieto, & Steinbuhler, 2002). Similarly, e-learning can be extended to m-learning with the help of wireless

technologies. Quite a lot of attempts have already been made on mobile learning systems. Among them, the two famous examples are m-learning project (http://www.m-learning.org) and MOBIlearn project (http://www.mobilearn.org).

It is quite natural to think that the mobile learning is another form of web-based learning, except that the connection is wireless. But, will a mobile learner have same preferences for the adaptive contents on both mobile devices and on PC? According to (Vavoula & Sharples, 2002), learning can be considered as mobile only if it is mobile in terms of space, time and different areas of life. A similar definition for mobile education can also be found in (Lehner & Nosekabel, 2002, p. 103) as "any service or facility that supplies a learner with general electronic information and educational content that aids in the acquisition of knowledge regardless of location and time". These two definitions indicate that mobile learning will offer learners even more freedom in carrying out learning activities than PC based web learning systems. Learners can access learning systems from any location. Further, their access devices for mobile learning are quite different from PCs. Because of the limitation of mobile devices' capabilities, some functions will be not available on some mobile devices, e.g. the capability to display a video file on webpage. Such differences between PC and mobile learning are likely to make the same learner behave differently under PC and mobile learning environment.

1.4 The Need for Modeling Students under Various Environments

From the development of Adaptive Educational Systems, we can find that it is not incidental for the Adaptive Hypermedia technology to attract so much attention in the design of educational systems. The development of computer technology and the World-Wide Web made web-based educational systems much easier to access than ever before. Easy and convenient access directly resulted in the increase of users.

More and more people accepted such a revolutionary way of learning, but the one-size-for-all systems would certainly not be enough to meet the needs of a number of students with totally different background, knowledge level and learning habits. The definition of students here was greatly extended and the classroom was not the only place where learning could take place. Besides those on-campus students, actually anyone could be a student with the help of web-based educational systems. Use of Adaptive Hypermedia technology in web-based educational systems is indispensable because the users of those systems are so diversified.

The adaptation process can be generalized into three steps, i.e. (1) get the information about the student; (2) process the information to initialize and update a student model; and (3) use the student model to provide the adaptation. The student model plays an important role in the adaptation process. The adaptive educational system will provide the student with most suitable contents according to his/her student model. The information included in the student model is the key component for content selection and presentation.

In order to implement adaptivity on mobile educational systems, we should be fully aware of the student's behavior changes under PC and mobile learning environments. The student model under a PC environment will not always be applicable under a mobile environment. Even if we only consider the mobile environment, there are still various mobile devices with completely different capabilities, which will probably influence a student's learning behavior. Thus, there are situations that the information in the student model needs modifying under different learning environments even if for the same student.

1.5 Research Objectives

Our aim in this thesis is focused on the student profile transformation between PC and

mobile phone. Based on a student's preference settings in that student's profile, we need to provide students with adaptive learning contents in various learning devices including PC and mobile phones. We can conclude that our research objectives are as follows:

- ✧ To identify the main attributes of device sensitive preferences in student profiles when switching between a PC and mobile phone. In adaptive learning systems, the learning contents are customized for an individual student according to that student's preference settings. When learning with a mobile phone, the student is very likely to have different preference settings because the device capability and environment are so different from PC learning. By identifying the possible device sensitive preferences in the student's profile, the student's preference changes between PC and mobile phone can be understood and updated, so that the educational system is still able to provide adaptive learning to the student.

- ✧ To develop a framework that dynamically and transparently transforms student preferences between PC and mobile phone learning environments. Each student has his/her own view towards learning. Students' preferences for learning contents are very different from each other. Therefore the possible student preference changes on various devices or platforms should also be diversified. The framework we are going to develop should be able to capture and update the preference changes for each student according to various device capabilities and locations. In addition, the synchronization of student profiles on various devices should also be achieved.

1.6 Research Procedure and Organization

To fulfill the above research objectives, the research is planned in the following steps:

- ✧ Step 1: A literature review is conducted on student modeling technologies, especially on the application of learning styles theory in adaptive learning systems. This step includes the introduction (Chapter 1), the literature review on student modeling technologies for adaptive learning systems (Chapter 2) and the literature review on application of learning styles theories in adaptive learning systems (Chapter 3).

- ✧ Step 2: A questionnaire based survey is designed and carried out to get useful feedback from the students. Through the survey, we identify the attributes to be included in student profiles and understand how the mobile learning environment influences student's preferences for learning contents. This step introduces two questionnaire surveys conducted for the research. The first survey investigates the possible preference changes in mobile phone learning environment (Chapter 4) and helps to decide the attributes to be included in the student profile (Chapter 5). In the second survey, we try to analyze how students' preference changes are affected by various device capabilities attributes and locations. The methods for student profiles synchronization are also discussed (Chapter 6).

- ✧ Step 3: Based on the results analysis of the two surveys, the framework is designed that can dynamically and transparently transform student profiles between PC and mobile phone. This step includes the proposed framework for student profile transformation (Chapter 7).

- ✧ Step 4: Summarize and conclude the whole research. This step includes the conclusion and future work (Chapter 8).

1.7 Summary

In this chapter, we have gone through each development stage of adaptive learning systems. Today, the mobile phone has become a new media for adaptive learning which requires the adaptive learning systems to take the various device capabilities and locations into consideration when providing adaptive learning contents. In this chapter, the research objectives, research approaches and structure of the thesis have been presented.