Chapter 40
Pervasive Cyberinfrastructure for Personalized Education

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ABSTRACT

The desire to improve contemporary education has led many educators into practices that are amalgamations of different learning and pedagogical theories. Despite government interventions, new pedagogies, and the ever-contentious role of technology, the need for improvement in education remains as students still underperform. This has led to the authors' hypothesis that the personalization of the structure, content, and delivery method of curricula is an effective and readily applicable way for technology to improve learning. The purpose of this chapter is to discuss the authors' early attempts at proving this hypothesis by presenting the methods they have developed. It starts by providing motivation and background research that has influenced their work. The remainder of the chapter discusses the design and implementation of PERCEPOLIS: a pervasive cyberinfrastructure for personalized education and instructional support.

INTRODUCTION

Education-applicable technology, e.g., databases, pervasive computing, computational intelligence, has long been leveraged to support learning online, in the classroom, or elsewhere. As a result, there has been a continuous attempt in using technology to engage those who wish to learn.

The prevalence of mobile computers coupled with wireless connectivity has made a vast amount of information readily available. In addition, many schools are using software that helps teachers to organize their courses and create content that can be easily delivered and graded. Moreover, recently the authors have witnessed an effort in publishing course content for consumption by anyone with an

Internet connection, free of charge. Consequently, a vast amount of content already exists, and many technological solutions are available that deliver content anytime, anywhere. Nevertheless, in spite of all of the content delivery solutions available to us, none have replaced the classroom as the predominant environment for content delivery. The authors' work focuses on developing ways to improve learning by designing solutions that can ensure that students and instructors are better prepared before they even set foot in the classroom.

The first step in this work is to create a model that represents the educational space. This model contains information about entities such as students, instructors, courses, and technology, among others. The authors have created an ontology that is denoted as the *modular course hierarchy* (MCH). The MCH defines and classifies entities, e.g., institutions, curricula, courses, according to their attributes and relationships with other entities. By arranging these entities into layers based on their classification, a hierarchical structure is formed. A curriculum is comprised of many courses; hence the curriculum can be observed as exhibiting modularity and hierarchy. Modularity is applied to nearly all levels within the MCH and is the primary concept used to define the relationships between entities. The authors have divided the educational space into entities and relationships in order to achieve high resolution of information.

When implemented as a database, the MCH can be used by applications to intelligently extract information, such as student interests, skills, learning styles, and performance, at any level of the MCH. One such application is PERCEPOLIS, a pervasive cyberinfrastructure for personalized learning and instructional support, originally presented in two of the authors' previous work (Hurson & Sedigh, 2010). The most recent implementation of PERCEPOLIS is a web-based application that utilizes the MCH in database form. PERCEPOLIS is used to represent curricula (managing entities and relationships) and make context-based recommendations to both students and instructors who are identified as users within the application.

Context-based recommendations are an attempt to personalize the learning experience for students. With respect to PERCEPOLIS, recommendations may range from showing a student a list of courses that they can and should take, to presenting learning artifacts that are likely to be more effective for a particular student. Learners with similar histories (interests, skills, performance, and behavior) can also be readily identified. The resulting "peer groups" can yield information that can be used to personalize the content or sequence of courses for future students with similar profiles, leading to shorter time-to-degree and improved learning outcomes. (Wagner, Sedigh & Hurson, 2014). Within a course, poor performance on a particular topic can be identified as resulting from deficiency of prerequisite knowledge. PERCEPOLIS can take action (recommend supplemental material and/or alert the instructor), reducing the need for thorough in-class review of foundational content. The availability of electronic learning artifacts allows students to study the subject matter outside of class, in a self-paced fashion. However, recommending these artifacts intelligently based on context allows increases the efficacy of their use. As learners use the system, a wealth of context is established that can be used to more accurately personalize the learning experience.

PERCEPOLIS can also provide instructors with information about their course structure and content, with or without respect to their students' performance. Instructors are continually provided with information about each student's interest or progress in particular areas of the course, which can be used to improve the classroom experience or address weaknesses in learning outcomes. This shift of focus encourages greater student engagement by targeting student interests and shortcomings. PERCEPOLIS itself can also support self-paced learning outside the classroom and allow instructors to repurpose their class time. The

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