E-learning Personalization based on Itineraries and Long-term Navigational Behavior

Enric Mor
Universitat Oberta de Catalunya
Av. Tibidabo, 39-43, 08035 Barcelona, Spain
emor@uoc.edu

Julià Minguillón
Universitat Oberta de Catalunya
Av. Tibidabo, 39-43, 08035 Barcelona, Spain
jminguillona@uoc.edu

ABSTRACT

In this paper we describe a practical framework for studying the navigational behavior of the users of an e-learning environment integrated in a virtual campus. The students navigate through the web based virtual campus interacting with learning resources which are structured following the SCORM e-learning standard. Our main goal is to design a usage mining tool for analyzing such user navigational behavior and for extracting relevant information that can be used to validate several aspects related to virtual campus design and usability but also to determine the optimal scheduling for each course depending on user profile. We intend to extend the sequencing capabilities of the SCORM standard to include the concept of recommended itinerary, by combining teachers expertise with learned experience acquired by system usage analysis.

Categories and Subject Descriptors

K.3.1 [**Computing Milieux**]: Computers and Education; H.5.2 [**Information Systems**]: Information Interfaces And Presentation

General Terms

Standardization

Keywords

E-learning, SCORM, data mining, navigational patterns, personalization

1. INTRODUCTION

E-learning is one of the most promising and growing issues in the information society nowadays. The growth of the Internet is bringing online education to people in corporations, institutes of higher learning, the government and other sectors. The growing need of continuous education and the inclusion of new multimedia technologies become crucial factors for this expansion. The use of e-learning standards such as SCORM [1], for example, is a key factor in the success of this technology. Among several things, the SCORM standard describes a content aggregation model and a runtime environment for reusable learning objects to support adaptive instruction based on learner objectives, preferences, performance and other factors (like instructional techniques). One of the most important features of SCORM is that allows the instructional content designer to specify sequencing rules and navigation behavior while maintaining the possibility of reusing learning resources within multiple and different aggregation contexts. Therefore, learning objects may be structured depending on several personalization issues, ranging from student preferences to instructional designer and teacher teams expertise, including also knowledge extracted from the usage in previous semesters. In order to do so, we propose the use of data and web mining tools for clustering students using all information available about the learning process: user profile, navigational behavior [2], and academic results.

WWW2004, May 17–22, 2004, New York, New York, USA.
ACM 1-58113-912-8/04/0005.

2. E-LEARNING ENVIRONMENT

The Universitat Oberta de Catalunya (UOC, in English known as Open University of Catalonia) is a completely virtual campus which offers 19 official degrees, several graduate programs and post-graduate studies, with more than 26000 students and more than 1500 people including instructional designers, teachers, tutors and academic staff. The UOC virtual campus is an integrated e-learning environment which allows users to communicate with other users using a mail system, and includes an agenda, a news system, virtual classrooms, a digital library and other e-learning related tools. Although the use of classical text books is still massive, there is also a growing use of web based e-books, so the introduction of new e-learning standards such as SCORM is becoming a necessity for maintaining the constant evolution of the virtual campus.

Basically, a student taking part in a course has an environment for communicating with the teachers and the other students, and a calendar which includes a basic schedule for the activities needed to follow the course. This calendar is a default itinerary which is created by the instructional designers and the teachers of the course. The student has access to several learning resources (documents, exercises, etc.) accordingly to such itinerary. Because of the typology of the institution and the courses, which usually are taken in one academic semester (around 14 weeks), the time unit used for designing itineraries is one week. Therefore, when we talk about navigational patterns we need to combine all the different user sessions along the academic semester in a single long-term session, rather than using the information contained in a single login session. It is remarkable that, although it is not possible to predict user behavior for a single session, the set of possible actions and activities is known, as the student navigates through a closed environ-

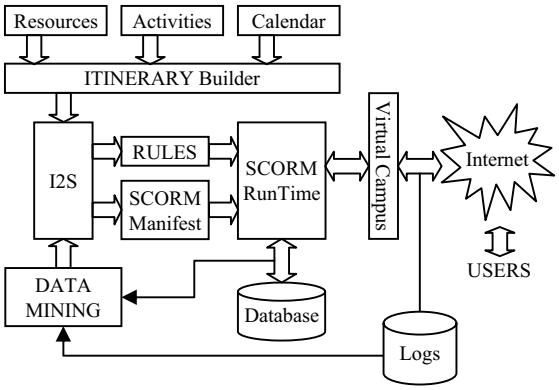

Figure 1: Proposed framework.

ment with a specific goal, that is, to successfully learn the course contents in order to pass the course exams. This fact can be also used to determine the variables used in the clustering process. Each course involves a team of instructional designers, a team of teachers, the students which will take part of such course, and a set of learning resources. These learning resources are structured following the concept of itinerary which it is basically a temporal scheduling involving several activities and the use of several learning resources. The SCORM standard is used to structure all the reusable learning objects following such itinerary. The students use the proposed framework following the recommended itinerary. The information stored in the database of the SCORM runtime module will be used to determine whether such itinerary is appropriated for each student, depending on his or her profile and long-term navigational behavior [4]. Nevertheless, it is important to remark that the itinerary based system must be completely transparent to the student, and that he or she has the total control about the learning process (under the guidance of the teacher and the tutor), so it is necessary to allow the student to change the proposed itinerary. Itineraries must not be a discriminative tool and should be very unintrusive about privacy [3]. In fact, itineraries should be made public at the beginning of the course and each student could accept or not the recommendation of the system, always in consensus with his or her tutor, and choose the most appropriate one.

3. IMPLEMENTATION AND PRELIMINARY RESULTS

Figure 1 shows the basic scheme of the proposed framework describing all the actors and modules around the runtime. The proposed framework is intended to be used in an iterative mode, gathering information from one academic semester and using it for redesigning the planned itineraries. In order to design an initial itinerary for a given course, we need the following information: academic semester dates, learning and evaluating activities, and learning resources. This information is used by the instructional designers and teachers to create a reasonable default itinerary taking advantage of SCORM capabilities. A XML intermediate layer combines all the available information about the course that will be converted to SCORM format by the module I2S, the core of the proposed framework. During the academic semester, the students make an active use of the learning resources, which is monitored and stored in the SCORM runtime database. This information will be used altogether with user profile and navigational pattern to determine whether it is possible to find a relationship between user performance and all available information about his or her behavior during the semester. Therefore, it is important to define the variables which will be used for categorizing students, specially those which measure the time patterns followed by the students along the academic semester. Our main goal is to obtain a system which can be used to design itineraries combining instructional designers and teachers expertise with information acquired from user clustering, but also to improve SCORM sequencing capabilities by dynamically modifying the set of triggers used by the SCORM runtime.

Preliminary experiments show that a single itinerary is not enough to fully describe the different behaviors of the students. It seems that at least a minimum of three itineraries are needed: a regular itinerary, for users which visit the virtual campus almost every day or two days; a weekly itinerary, for users which do most of their work on weekends, and an activity oriented itinerary, for those users which do not follow a regular scheduling but they connect to fulfill the course requirements described by the proposed activities.

4. CONCLUSIONS

In this paper we have described a framework for designing personalized itineraries for courses based on learning objects structured under the SCORM standard paradigm. The concept of itinerary can be easily incorporated into the SCORM standard by combining SCORM sequencing capabilities and expertise from both instructional designer and teacher teams and acquired knowledge of system usage. Personalization is important issue in e-learning as it might help to improve students performance. Current and future research in this subject includes the definition of relevant variables related to the learning process and the evaluation of several data mining clustering algorithms for evaluating the best data mining tool for the kinds of data involved in the process. The possibility of extending the sequencing capabilities of the SCORM standard is also under study. Privacy issues about the use of data mining techniques using personal data must also be addressed. Finally, the connections with other standards for multimedia content distribution, such as the MPEG-7 and MPEG-21 standards, are under consideration.

5. ACKNOWLEDGMENTS

This work is partially supported by Spanish government grant MULTIMARK TIC2003-08064-C04-04.

6. REFERENCES

[1] ADL. Sharable content object reference model (SCORM) 2004. Technical report, Advanced Distributed Learning, 2004.

[2] E. Chi, P. Pirolli, and J. Pitkow. The scent of a site: A system for analyzing and predicting information scent, usage, and usability of a web site. In *Proc. of ACM CHI 2000*, pages 161–168, Amsterdam, Netherlands, 2000.

[3] C. Clifton and V. Estivill-Castro, editors. *Proc. of the ICDM 2002, Workshop on Privacy, Security and Data Mining*, volume 14, Maebashi City, Japan, 2002. ACS.

[4] J. Srivastava, R. Cooley, M. Deshpande, and P.-N. Tan. Web usage mining: discovery and applications of usage patterns from web data. In *ACM SIGKDD Explorations*, volume 1(2), pages 12–23, 2000.