A Conceptual Framework for Web-based Intelligent Learning Environments using SCORM-2004

Sabbir Ahmed Kazi
Dept. of Educational and Staff Development
Singapore Polytechnic
kazi@sp.edu.sg; kazisabbir@yahoo.com

Abstract

Having a functional web-based learning environment is a norm for a large number of educational institutions today. But publishing plain e-Learning materials in this environment does not contribute significantly to student's learning unless a sound pedagogical framework is adopted behind this process. Substantial researches have been done in the area of Adaptive and Intelligent Tutoring Systems to develop web-based intelligent learning environments (WILE) where the student's current knowledge about the subject matter is stored in a student model database and therefore the materials are presented according to the student's learning need. In most cases, contents are an intrinsic part of these kind of learning environments, and difficult to port to another environment in the case of reuse. This paper introduces a framework to develop dynamic content for a SCORM-conformant web-based intelligent learning environment that can be ported to another similar kind of learning environment.

1. Introduction

The increasing demand for students to acquire multi-disciplinary knowledge and skills, has led to an increased pressure on academics to ensure transfer of adequate skills to all students - some of whom may be less motivated than others. While staff resource for the large class teaching is relatively less affected by this growth (large lecture theatres), the small class teaching (*tutorial* aspects of teaching) requires a large amount of staff resource. To ensure a good and improved quality of educational environment for a large number of students, information technology is an area that educational institutions should exploit properly [1]. Although the benefits of a web-based education system are many [2], Kinshuk et al [3] has warned that "the freedom and flexibility offered by the Internet can, however, turn into an extensive waste of time, effort and resources, if the nature of educational processes and the capabilities of educational technologies are not adequately considered while designing a tutoring system". Kassim et al [4] has surveyed how the computer and Internet technology can play an important role in creating an effective learning environment.

Web-based Intelligent Learning Environment (WILE) [5], which has been evolved from Intelligent Tutoring Systems (ITS), is complex systems that involve several different types of expertise: knowledge on the subject matter, knowledge on the learner's knowledge, pedagogical expertise, etc [6]. But it would be a huge waste of efforts and investment if the contents are not shared and reused among the educational community. Advanced Distributed Learning (ADL), an initiative of U.S. Department of Defense, introduces SCORM (Sharable Content Object Reference Model) [7] in a bid to solve this problem by standardizing the technology-based training and education.

This paper reviews the state-of-the-art in both web-based intelligent learning environments and eLearning standards, therefore, outlines a conceptual framework for developing sharable and reusable dynamic tutoring problems for such environments using *SCORM 2004* specification.

2. Web-based Intelligent Learning Environment (WILE)

Computer Aided Learning (CAL), which has been used in learning and teaching since 1950s, is basically a set of "programmed instructions" used for educational purposes, drawing heavily on the behaviourist views. During the late 1950s and early 1960s, with the advent of Artificial Intelligence (AI), a new type of CAL system, called "*Intelligent Tutoring Systems*" [8], emerged.

The Intelligent Tutoring Systems (ITS) typically consist of an internal model of the expert knowledge, the learner's current knowledge and the pedagogical principles. As the learner proceeds, the model of the learner's knowledge and the model of the expert's knowledge are compared, and using AI, the sequence of instructions is dynamically generated to suit the needs of the learner [9]. Figure-1 shows the structure [10] of an ideal ITS.

Proceedings of the IEEE International Conference on Advanced Learning Technologies (ICALT'04)
0-7695-2181-9/04 $20.00 © 2004 **IEEE**

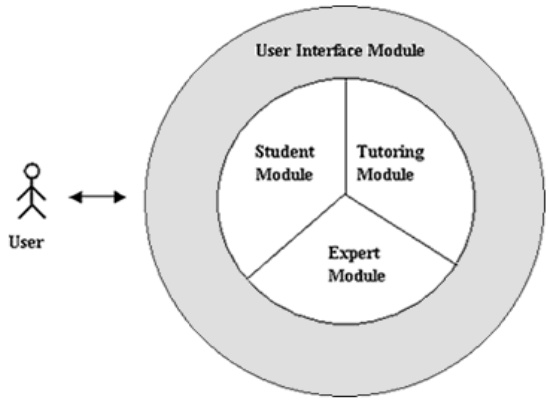

Figure 1. Structure of an Ideal ITS

There was a great paradigm shift in CAL systems with the advert of the World-Wide-Web. The possibility of using the Web for education has generated a great deal of interest among educators worldwide. Khan [11] identified the following key features of web-based learning environments: *interactive*, *device-distant-time independent*, *globally accessible*, *distributed*, *learner-controlled*, *convenient*, *environmentally friendly*, *non-discriminatory*, *cost effective* and etc.

However, the web-based educational system has a number of limitations including high costs of putting the technology in place, and getting teachers and students to get used to this new environment. Additionally, it requires a great deal of effort from instructor's part to convert the existing conventional teaching materials into a web-ready form.

A good number of web-based learning systems have been developed so far. Early versions were hypertext based information retrieval systems [3] and while later versions were adaptive and intelligent [12]. Examples of Web-based intelligent learning environments can be found in [5]. The adaptive nature in the more recent systems was achieved by incorporating a student model which maintains up-to-date information about the learner's background, current stage of knowledge, goal and, etc. But these systems are incapable of sharing and reusing the content among themselves as they are not conformant to any learning standard.

3. eLearning Standards and *SCORM-2004*

The need for eLearning standardizations emerges in order to support rapid and cost-effective course content construction by sharing and reusing the existing course materials which can be operated on an array of standard learning management systems (LMS).

Among the major eLearning standards, the Sharable Content Object Reference Model (SCORM) version 1.3 (a.k.a. *SCORM-2004*), which is an initiative of ADL established 1997, is currently the most dominant one. The SCORM adopts the best of breed standards from different eLearning standard groups such as the IMS [13], AICC [14], ARIADNE [15] and IEEE-LTSC [16] for different aspects like meta-data, content tracking and content sequencing and integrate them with one another to form a more complete model.

SCORM achieves reusability, accessibility and interoperability of the content with use of sharable content objects (SCOs) composed of assets that are packaged for a learning context and launched in a SCORM-conformant run-time environment. Assets are the digital media such as text, images, movie-clips, sound or any other form of computer data that can be delivered to a Web client. They are the smallest building blocks for content in SCORM and can be identified and reused through the meat-data. SCOs are the smallest logical unit of instruction that can be delivered and tracked by a SCORM-compliant LMS.

SCORM also provides the specifications of Run-Time Environment (RTE) for a learning management system (LMS) that can launch and track SCORM-conformant content through a common data model. Figure-2 shows the mechanism of launching and tracking of SCOs by the LMS.

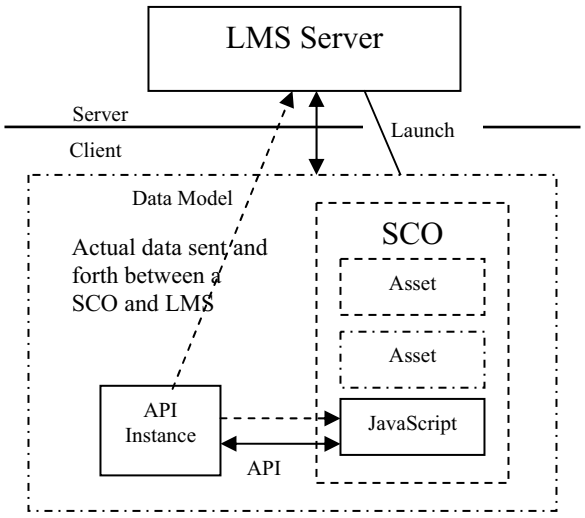

Figure 2. SCORM Run-Time Environment

SCORM describes a means of aggregating SCOs using a scheme (Content Aggregation Model or CAM) that combines Metadata, Content Packaging and Sequencing and Navigation (SN). SCORM Sequencing depends on the Activity Tree (Figure-3) which derived from SCORM Content Packaging, a defined sequencing structure, the Sequencing Definition Model and the Sequencing Behaviours. An Activity Tree comprises several Clusters which include a single parent activity and their immediate

children. The parent activity in a Cluster contains the information about the sequencing strategy, while the non-cluster children (leaf activities) have associated content objects that will be identified for delivery according to the defined sequencing strategy. SCORM Navigation handles the delivery of the identified learning activities to a particular learner. SCORM Sequencing Behaviour is controlled by the Tracking Status Model where each attempt on an activity by a learner generates an array of associated tracking status data. Details can be found in SCORM specification available at ADL website [7].

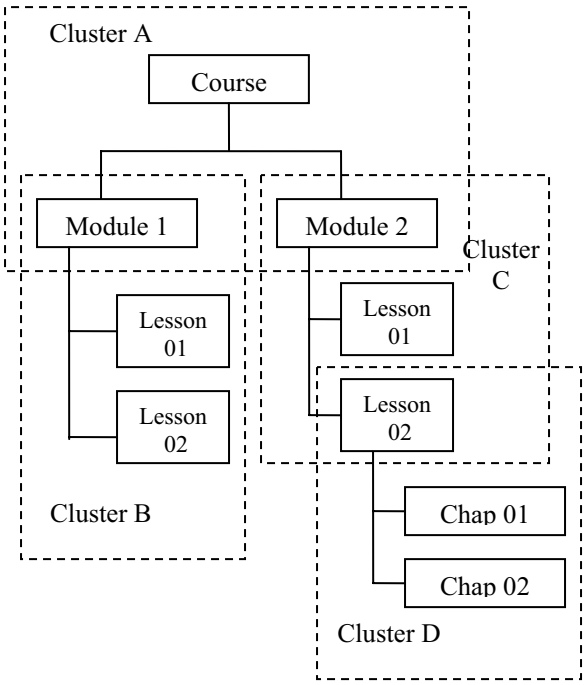

Figure 3. Activity Tree with Clusters

4. Web-based Intelligent Learning Environments with Searchable and Reusable Learning Contents

A web-based intelligent learning environment comprises at least four components as described in Figure-1 and each component has their definite roles in order to meet three core ITS features: *curriculum sequencing*, *intelligent analysis of student's solutions* and *interactive problem solving support* or *feedback*. The *Communications Module* is the user interface module through which all interactions with the system take place. The *pedagogical module* generates problems dynamically and adapts the level of difficulty to a particular student based on the *student model*. Students access the system through the communications module and solve the problem given to them. The *expert module* generates the expert answer, which is used to assess the student's solution. The student's perceived level of understanding is used to update the student model, which in turn helps the pedagogical module to generate the next problem for the particular student. Figure-4 shows the functional model of an intelligent tutoring system.

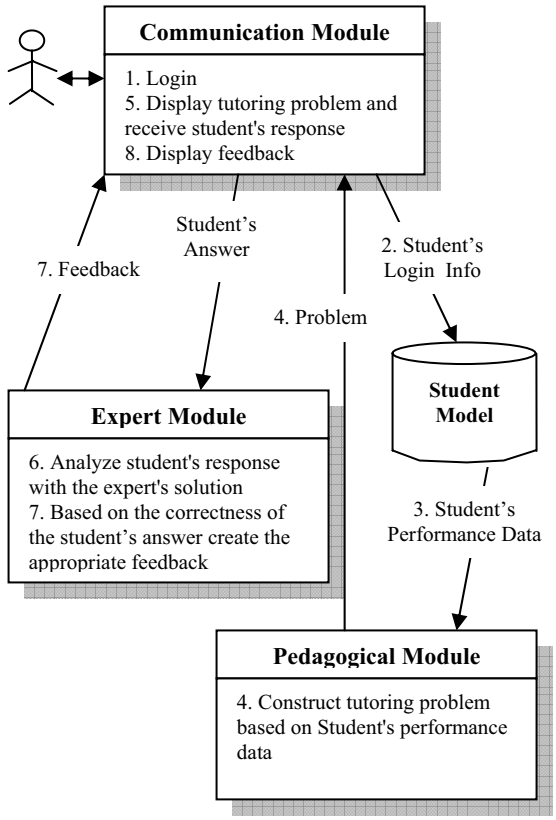

Figure 4. Functional Model of an ITS

If we analyse the functional model of an ITS system, all of its modules can easily be substituted by *SCORM-2004* specification. Communication module falls under the SCORM RTE, SCORM SN together with SCROM CAM can handle the functionalities of the pedagogical module. Student model can be implemented through Tracking Status Model and SCROM RTE Data Model. Since the Expert module is very much subjective, this should be embedded with leaf activities or actual tutoring problems.

SCROM-2004 provides a solid framework where tutoring problems together with expert answer and feedback can be plugged-in as an Intelligent Tutoring Applet or ITA [3]. Randomness of the tutoring problems should be achieved in ITA. Thus, educators with some special knowledge (such as Flash, Java Applet, etc.) in content authoring will be able to build and manage their own web-based intelligent tutoring system.

5. Conclusion

Recently, few researches [17] have been carried out on SCORM (version 1.2) conformant adaptive learning management systems. With the SCORM (version 1.3) Sequencing and Navigation, it would be a big leap forward towards achieving the adaptive nature for such systems. There would be a great deal of sharing and re-using of tutoring problems and contents among the educators. At the end, it would create a bigger community and save human effort and cost.

6. References

[1] H. Li, "Viewpoint: Using Information Technology to Enhance Engineering Education", *Int. J. Eng. Educ*, 13(5), 1997, pp 319-324

[2] G. Webb, "A Theoretical Framework for Internet-Based Training at Sydney Institute of Technology", *In proceedings of AusWeb97 The 3rd Australian World Wide Web Conference*, 1997.

[3] Kinshuk, and A. Patel, "A Conceptual Framework for Internet-based Intelligent Tutoring Systems", A. Behrooz (eds.) *Knowledge Transfer*, Vol. II, .pAce, London, UK, 1997, pp 117-124.

[4] Kassim, A. A., Kazi, S. A. and Ranganath, S., "A Web-based Intelligent Approach to Tutoring", In the proceedings of the International Conference on Engineering Education, Oslo, Norway, 2001, pp.8B4-25 ~ 8B4-30

[5] P. Brusilovsky, "Adaptive and Intelligent Technologies for Web-based Education", C. Rollinger and C. Peylo (eds.) *Künstliche Intelligenz, Special Issue on Intelligent Systems and Teleteaching,* Vol. 4, 1999, pp19-25

[6] Frasson, C., Mengelle, T. and Aïmeur, E. "Using Pedagogical Agents In a Multi-Strategic Intelligent Tutoring System", Proceedings of the workshop *Pedagogical Agent in AI-ED'97*, 8th World Conference on AI and Education. Japan, August 1997

[7] ADL Technical Team: SCORM Specification v 1.2 http://www.adlnet.org

[8] Kinshuk, "Computer Aided Learning for Entry Level Accountancy Students", *PhD Thesis*, De Montfort University, Leicester, England, 1996

[9] T. L. Good and J. E. Brophy, *Educational Psychology: A Realistic Approach.* (4th Ed.). White Plains, NY: Longman, 1990

[10] P. L. Brusilovsky, "The construction and application of student models in intelligent tutoring systems", *Journal of Computer and Systems Sciences International*, 32(10), 1994, pp. 70-89

[11] R. Oliver, A. Omari, J. Herrington and A. Herrington, Database-Driven Activities to Support Web-based Learning, *ASCILITE 2000*, Coffs Harbour, Australia, 2000

[11] B. H. Khan, "Web-based Instruction (WBI): What Is It and Why Is It?", *Web-based Instruction*. Englewood Cliffs, NJ: Educational Technology Publications, 1997

[12] P. Brusilovsky, S. Ritter and E. Schwarz, "Distributed Intelligent Tutoring on the Web", *The 8th World Conference of the AIED Society*, Kobe, Japan, 1997

[13] The IMS Global Learning Consortium, Inc. http://www.imsproject.org

[14] The Aircraft Industry CBT Committee http://www.aicc.org

[15] ARIADNE http://www.ariadne-eu.org

[16] IEEE Learning Standards Technology Committee (LSTC) http://lstc.ieee.org

[17] F. Lin, P. Holt, L. Korba and T. K. Shih, "A Framework for Developing Online Learning Systems", *International Conference Advances in Infrastructure for Electronic Business, Science, and Education on the Internet*, L'Aquila, Italy, 2001