ABSTRACT

Multimedia data and application systems accessible over the Web are valuable assets for developing instructional materials for teaching, training, problem solving, and decision support. These assets can be used to construct learning objects, each of which is a reusable granule of instruction designed to meet a specific instructional objective. In order to find and use learning objects, an infrastructure for the registration, discovery, binding, and invocation of these objects is needed. Also, there is a need for an e-learning service infrastructure for people in a virtual e-learning community to construct, evaluate, and deliver learning objects. In this work, we model distributed and sharable learning resources by two types of Learning Objects (LOs): Atomic Learning Object and Composite Learning Object. Both types of LOs are published uniformly as Web services in a constraint-based broker in order to make them sharable and reusable. This article presents the learning object models for the specifications of these two types of LOs and an e-learning service infrastructure, which consists of authoring tools for constructing LOs, software components for processing LOs and performing assessments, and an extended Web services framework for the registration, discovery, binding, and invocation of LOs as Web services. This article also presents techniques such as dynamic binding of LOs, rule-based execution of learning processes, and model-based assessment used to make the processing of LOs active, flexible, customizable, and adaptive. The roles and functions of virtual e-learning community members are also discussed.

Keywords: adaptive learning; database; e-learning; learning object; learning object repository; online learning community; virtual communities; Web-based learning; XML

INTRODUCTION

Multimedia data and application systems that are accessible on the Web are valuable assets for constructing instructional materials for teaching, training, problem solving, and decision support. One approach to make use of these distributed, heterogeneous data and application systems is to apply object-oriented technology and wrap them as distributed objects. These distributed objects then can be used to compose learning objects (LOs) for instruction and training purposes.
In recent years, there has been a number of initiatives in developing and standardizing technologies for Web-based learning. The Advanced Distributed Learning Initiative (ADL, 2003), the IMS Global Learning Consortium (IMS, 2004), and the Open Knowledge Initiative (Eduworks and O.K.I. Leadership, 2002) are a few examples. The Sharable Content Object Reference Model (SCORM) (ADL, 2004a) is a reference model initiated by the Advanced Distributed Learning (ADL) program of the Department of Defense (DoD) and the White House Office of Science and Technology Policy (OSTP). According to the SCORM’s specification, it is envisaged that Internet users and heterogeneous LMSs would use the Web as a universal platform for accessing and launching sharable content objects and for establishing close communication, interaction, and coordination among content object developers, course authors, users, and administrators. To realize this vision, sharable content objects must be durable, interoperable, accessible, and reusable. In order to meet these requirements, it is necessary to have a uniform way of modeling not only learning resources but also heterogeneous learning tools and LMSs, as well as an information infrastructure to enable the interoperability and sharing of their contents and functionalities. Also, the aggregation model that defines the learning sequence or process has to be flexible, adaptable, and customizable in order to meet different learners’ needs and learning contexts. Our research and development work to meet the above needs is consistent with the vision and goals of the ADL Program.

A virtual community is a Web site through which members of the community can share useful information related to their common interests. Virtual educational communities, such as MERLOT (2004), EOE (2004), and CLOE (2004), provide learning object repositories, from and to which people can find and provide useful learning materials. They provide Web-browser-based user interfaces for the registration and search of learning objects. However, they do not support application interfaces for programmatic searches and accesses to learning materials. Such interfaces would facilitate the reuse of learning objects by learning management systems that bind learning objects dynamically at runtime.

In York et al. (2002, p. 4), it was envisioned as “building the technological infrastructure to support dynamic, ad-hoc communities of lifelong learners who interact within an environment of learning objects through a creative blend of advanced computing technologies, high performance networks, authoring and collaboration tools.” In the same context, it is useful to establish an infrastructure over the Internet to allow people who are interested in specific subjects of learning to form their own virtual communities.

In this work, we model distributed and sharable learning resources by two types of Learning Objects (LOs): Atomic Learning Object and Composite Learning Object. LOs are uniformly published as Web services in a constraint-based, Web-service registry and are made sharable and reusable. This article presents the learning object models for the specifications of these two types of LOs and an e-learning service infrastructure, which consists of authoring tools for constructing LOs; software components for processing LOs and performing assessments; and an extended Web services framework for the registration, discovery, binding, and invocation of LOs as Web services.

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