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Implementing Learning Content Management

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Abstract: The concept of Learning Objects has been introduced in the e-learning field to enhance the accessibility, reusability, and interoperability of learning content. Despite intensive international standardization, learning content and its management still needs more detailed specifications for the implementation of a Learning Objects based system. This paper proposes strategies that a Learning Content Management System should support in order to enhance reusability of learning content: the use of small modular Learning Objects, a standard mechanism to embed multimedia, standardized structured content, cross-media publishing, centralized content management, workflow support, and internationalization. A Learning Object information model based on these strategies is presented, and a possible functional architecture of such a system is outlined.

Keywords: learning objects, learning content management, reusability, e-learning, education

1 Introduction

The production of learning content for computer-based training is demanding and expensive. It is therefore a necessity to reuse e-learning material as many times as possible. Unfortunately, existing electronic courses are seldom reused, as there is usually always a need to change some part for a new course to be held To encourage reuse, the approach widely proposed is to use small modular *Learning Objects* that can easily be assembled into new courses (Downes, 2001).

There are many different *definitions* of Learning Objects (Polsani, 2003). The often cited definition of the IEEE Learning Object Metadata specification (LOM), "a Learning Object is defined as any entity, digital or non-digital, that may be used for learning, education or training (IEEE LTSC, 2002)", does not sufficiently specify relevant characteristics of learning content that enhance reusability. The definition of the Wisconsin Online Resource Center addresses such characteristics and defines Learning Objects as small learning units, ranging from 2 to 15 minutes, which are self-contained, reusable, tagged with metadata, and can be aggregated (Chitwood et al., 2000).

Recently, there have been many *standardization* activities in the field of Learning Objects. Some of them are the above mentioned LOM standard specifying learning metadata, the IMS Content Packaging describing and packaging learning materials into interoperable, distributable packages (IMS, 2001), and the SCORM Content Aggregation Model (ADL, 2001), which integrates the specifications of IEEE, IMS and others to provide a reference model that enables interoperability, accessibility and reusability of Web-based learning content.

Despite the many standardization activities, there are no established specifications for the structure of learning content itself. Learning Objects today come in a variety of data formats (HTML with JavaScript, Shockwave, Flash, Java). Most of them are individually designed and styled, and navigational and user interface controls are directly integrated into the Learning Objects. Aggregating them to courses is hardly possible, due to inconsistencies in the graphical and navigational design. This prevents the presentation of aggregated learning modules to learners in a coherent way.

For the effective handling of small modular Learning Objects users need technical support by Learning Content Management Systems (LCMS). But the lack of widely established standards for the structuring and representation of learning content is a hindrance for the application of Learning Objects (Hitzke et al., 2002).

The implementation of a Learning Objects based system needs further specifications and formalization. Successful reusability relies heavily on well designed learning content management. Aiming for such reusability, this paper defines the strategies to be supported by a LCMS (section 2). Then it presents a Learning Object information model based on these strategies (section 3), and it outlines a possible functional architecture of such a LCMS (section 4).

2 Learning Content Management Strategies

To enhance reusability of learning content a LCMS should use the following strategies: (1) use of small modular Learning Objects, (2) a standard mechanism to embed multimedia, (3) standardized structured content, (4) cross-media publishing, (5) centralized content management, (6) workflow support, and (7) internationalization.

2.1 Small Modular Learning Objects

Small modular Learning Objects are the basic building blocks. The user should be able to assemble them to courses easily.

Learning Objects should be sharable and reusable in varying contexts. This requires Learning Objects to be self-contained. Self-containment cannot be guaranteed by technical means and standards only. Organizational workflow procedures are needed as well.

2.2 Embedding Multimedia

Learning information uses many different media types. Depending on learning objectives and target groups of learners the media will be selected according to its suitability to illustrate the topic to be taught.

A whole range of media can be employed: text, images, audio, video, animations, simulations etc. Multimedia can be characterized by three dimensions: (1) static – dynamic, e.g. images versus video, (2) auditory – visual, (3) pure presentation – interactive. Multimedia items use a big number of different data formats. To be useful, Learning Objects must be able to integrate the whole range of media.

2.3 Standardized Structured Content

Standardized structured content separates content from presentation and control. It is the basis for flexible publishing and ensures future-proof data.

Using general mark-up languages, like XML, formal data structures can be defined, which specify required and optional information elements, and enforce a consistent ordering scheme for these elements. Formal structuring separates content from style, assigning semantic meaning to the elements.

2.4 Cross-Media Publishing

Learning content can be used for various publication types (online learning course, paper-based lecture notes etc.).

Even though online and computer-based learning is heavily promoted, the need to deliver learning material in various media cannot be underestimated. Today usually the following delivery media are used:

- Online (online learning system, static web-site),
- CD-ROM (electronic book, help system),
- Paper (lecture notes, handout, book),
- Presentation (slides).

2.5 Centralized Content Management

Through centralized content management a larger number of potential users have access to the available learning resources. This enhances the possibility of reuse as well as the number of authors who contribute to the collection of Learning Objects. Powerful search mechanisms will help learning designers to find the content they need.

2.6 Workflow Support

Next to the specification of data formats, organizational measures must be taken to ensure semantic and didactical quality of Learning Objects. Many different roles are involved in the life cycle of learning material. Workflow procedural rules support building large, consistent and well structured collections of learning resources with many actors involved. They support the publishing process, defining roles, actions and notifications according to a set of procedural rules.

2.7 Internationalization

Learning content is created and available in various languages. Some of the content is universally applicable. Other content is country dependent, e.g. legal regulations. Adapting Learning Objects to multiple languages and countries enhances its potential for reuse.

3 Learning Object Information Model

The learning object information model defines the required information types, standards and data formats to be used to ensure proper aggregation of Learning Objects, a standard integration scheme for multimedia, a metadata scheme, a multiple-languages strategy, and a content map.

Three levels of learning resources shall be defined (Figure 1): Assets, Learning Objects and Learning Units. Learning Objects are the basic building blocks, which are used to compose Learning Units. Learning Objects themselves may embed Assets, which might be multimedia objects, bibliographic entries and other references.

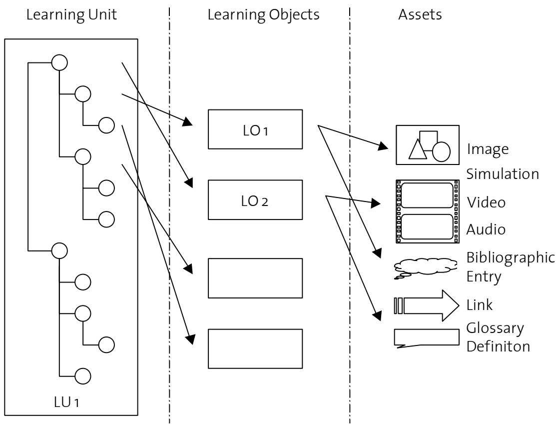

Figure 1: Three levels of learning resources.

3.1 Learning Object

Learning Objects use standardized structured content, which separates content from presentation (style and format) and control (navigation etc.). This ensures that Learning Objects can be coherently aggregated to Learning Units and courses.

They serve as the standard interface to embed multimedia objects into the building blocks system. Metadata describes a Learning Object in a standardized way, which enables well-directed search for existing Learning Objects.

3.2 Assets

Assets are information items that are stored separately and linked to Learning Objects: they are not self-contained, e.g. images are usually combined with text describing the image shown. Assets are potentially reusable in more than one Learning Object. Assets may be grouped into two categories: structured and unstructured.

Structured Assets are used for information items, which already have an inherent structure, but are not intended to be learning material on their own. These are manly reference entries, i.e. bibliographic entries, glossary definitions, web references.

Unstructured Assets are information items, which are supposed to be integrated into learning material "as is". They are typically multimedia objects and use binary data.

3.3 Content Map

A content map classifies learning resources stored in the LCMS in a standard manner. It supports search and retrieval of content and provides an overview of what is available.

The content map uses a tree structure to cover the knowledge domain. The classification ideally reflects the traditional classification schemes of the corresponding field of science.

4 Functional Components

From a functional point of view, a LCMS must implement the learning content management strategies mentioned above using an architecture with the four basic components:

1. Acquisition and authoring,
2. Repository,
3. Assembly and linking, and
4. Publishing.

4.1 Acquisition and Authoring

Acquisition and authoring supports the creation of structured XML content. Authoring tools must validate structured content to ensure that structuring is applied correctly.

As most authors of learning material are not computer specialists, they should not be forced to learn XML. Therefore the tools must be easy to use and ideally support WISIWYG editing. The users should be guided writing structured content.

4.2 Repository

The heart of the LCMS is the repository. Its main components are: database, access and security control, workflow and version management, search and retrieval, content map.

The database is the main storage unit for Learning Objects. It allows centralized content management and flexible retrieval of learning resources. The database supports sophisticated search.

Content is organized in a standard manner using the content map. Topics will be classified according to the taxonomy of a knowledge domain the user decides to use.

4.3 Assembly and Linking

Learning Objects are aggregated to Learning Units. Navigation in the assembly and linking stage. The main component of the assembly and linking process is the Learning Unit Builder. With this tool teachers and lecturers will assemble Learning Objects to Learning Units.

The Learning Unit builder automatically generates the table of contents or a hypertext navigation based on the aggregated Learning Objects. Further indices and glossaries are created and added.

4.4 Publishing of Learning Units

Publishing, the last stage of the LCMS, adapts Learning Units according to the delivery media and type of publication to be used (cross-media publishing). These might be: packaged e-learning courses for a Learning Management Systems (LMS), dynamic delivery to online learning systems, lecture notes, handouts, slides.

Layout and styling is applied to Learning Units depending on the publication type and delivery media requested. Packaged e-learning courses should be compatible to e-learning standards, e.g. SCORM, IMS, LOM, etc.

4.5 Publishing of Assets

Cross-media publishing issues of Assets are very challenging. E.g. how should interactive simulations be published for paper-based media. “Rendering rules” will solve the problem. They specify, how specific multimedia formats will be output to various publications.

Images for example might use a high-resolution version for paper based publications, whereas a low-resolution derivation will be provided for online media to grant acceptable download times. The rendering rule for images would then select size and resolution according to the publication type and an appropriate image version would be generated and delivered.

For other multimedia types, substitutes have to be created manually. Substitutes could be a replacement text, a single image, a sequence of images, or any combination of these

Different types of rendering rules can be defined: (1) general rendering rules specify one general rule for every type of delivery media. General rendering rules will most likely be used for images, where size and resolution can be adapted automatically. (2) Asset based rendering rules will be specified for every multimedia object separately. (3) With Learning Object based rendering rules the author of a Learning Object can select or create the substitutes, which fit his teaching needs best.

5 Conclusions

Despite intensive international standardization, Learning Objects and their management still need more detailed formalization and specification for the implementation of a Learning Objects strategy. As successful reusability relies heavily on well designed learning content management, strategies to be supported by a LCMS are defines in this paper. The proposed Learning Object information model is based these strategies. The outlined functional architecture should constitute a solid basis for the further development of a LCMS.

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