

Chapter 2

From Content Management to E-Learning Content Repositories

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Abstract The concept of content in an educational context is very different from the one in other fields such as publishing or electronic newspapers, for example. From textbooks to exercises, from software simulations to data sets containing educational data, it is necessary to rethink the way these educational resources or “learning objects” are managed. One of the major concerns for teachers using e-learning environments is the availability of the appropriate structures and tools for organizing such learning resources and making them accessible to learners. This is especially true for e-learning virtual environments where learners have access to both digital libraries and also to any other Web resource, through Google or other conventional search engines. Nevertheless, these systems are usually not directly integrated in the learning process and content and metadata management requires the use of different tools. Furthermore, new pedagogical approaches consider the learner as an active element in the learning process, promoting the acquisition and development of competences through activities which involve the use and creation of learning resources. This chapter explores the relationship of traditional content management systems and the broader scope of virtual learning environments, including aspects of metadata standards, content personalization, the use of semantic web techniques and ontologies, the use and annotation of learning resources and the possibilities offered by the use of Web 2.0 technologies. At the end of this chapter, the possible learning scenarios that will be derived from all the changing forces, combining methodological, technological and organizational issues will be described.

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2.1 Introduction

Nowadays, e-learning is one of the most promising and growing applications that are essential to an information society. The growth of the Internet is approaching online education to people in corporations, institutes of higher education, the government, and other sectors (Rosenberg 2002), and both the growing need of continuous education and the inclusion of new multimedia technologies become crucial factors for the expansion of lifelong learning. Besides pure virtual colleges and universities, more and more traditional educational institutions are adopting the use of Information and Communication Technologies (ICT) to provide learners with a richer environment for their learning process. Furthermore, new Web 2.0 technologies such as wikis and blogs have generated new possibilities for creating and sharing educational content. This fact, combined with the concept of open educational resources, enables a new environment for learners that view the whole Web as a learning space with many possibilities, with no time or space barriers. Quoting Wiley (2007), “content is infrastructure,” the learning process must be created on top of such infrastructure, and there is a real need for managing all those contents available on the Web.

Content management has been traditionally related to content producers such as publishers, portals, news agencies, newspapers, and so on. Web-based content management systems (CMS) support all the phases of content management, from creation to delivery (Boiko 2001). In fact, many educational institutions such as universities are nowadays also the publishers of their own contents, mainly generated by their teachers. These contents are mainly textbooks, but also research papers in academic journals or formal project deliverables such as technical reports (i.e., gray literature). Nevertheless, there are many other contents that are not managed and maintained by the educational institution but by the teachers themselves, such as exercises, resources used in the classroom, or teaching notes. In consequence, the concept of content in educational institutions has not been a simple one by only definition; it depends on the context and the learning goals that must be achieved. Therefore, using CMS in educational institutions needs to face new requirements caused by two main factors: first, content granularity and typologies are very diverse, and second, content should be created and shared with reusability in mind. Reusability has been hypothesized to create economies of scale and to be a major factor in the universal accessibility of high-quality educational resources, which are in general expensive to produce (Downes 2001).

With the creation of the new European Higher Education Area (EHEA), also known as the “Bologna Process” (Ade et al. 1999), it has become necessary to shift from heavily content-based courses to others where the concept of activity is the key. Contents or learning resources in general will become secondary pieces in the learning process, while the activities and the competencies developed by such activities will become the focus of any educational action. This approach has been widely accepted as the most appropriate for providing learners with a learner-centered pedagogical model, instead of a content-driven one. Learners need to

acquire and develop competencies which will be part of their future professional profile. In order to do so, learners follow a sequence of learning activities which have been designed as the basic pieces of the learning process instead of that of contents. Ideally, the learning process is supported by intelligent tutoring systems which help users (learners but also teachers and course managers) to achieve their goals. The learning process becomes a complex path including the handling of educational resources, formative and evaluation activities, interaction with other students and the teacher, so the concept of content management needs to be redefined. From the secondary place of contents in activity-based learning, the need for breaking down contents in smaller, more reusable pieces follows.

In another direction, the appearance of the Web 2.0 paradigm makes the traditional producer–consumer model obsolete, as all the participants in the learning process can easily create and share resources. These new technologies have also changed the definition of content: from books or large pieces of content to micro-contents, which can be created and reused in different contexts. The range of content typologies becomes wider: textual, multimedia elements, but also simulations and even datasets can be considered learning resources, as well as blog posts or wikipedia entries. Furthermore, teachers are not the only content producers: students can also participate actively in the process of creating and sharing content which is part of the learning process. This shift, from a producer–consumer model (one-to-many) to a create–remix–share model (many-to-many), also changes all the aspects related to content management, such as granularity, metadata, and which need to be reconsidered in order to be created and managed collaboratively.

This chapter describes how these methodological changes (that are central to the new EHEA paradigm) together with the technological ones (virtual learning environments plus the new Web 2.0 paradigm and the slow adoption of the Semantic Web approach) have modified the requirements of CMS in educational institutions. Section 2.2 describes the learning process in virtual learning environments as something that is much more than just providing learners with digitized content. Section 2.3 describes the concept of learning object and learning object repositories (LORs) and their relationship to CMS and also discusses their differences with Web 2.0 applications with respect to managing content. The semantic approach to describing learning objects in repositories is discussed in Sect. 2.4. Finally, Sect. 2.5 outlines and discusses the open questions related to the use of LORs in virtual learning environments and its intersection with new trends such as social learning and connectivism.

2.2 The Learning Process in Virtual Learning Environments

Distance education has radically changed with the intensive use of ICT. The use of the internet for not only content delivery but also for improving communication and interaction between students and teachers has created a completely new scenario. Distance education is no longer conceived as just delivering content but as a whole learning

process supported by a virtual learning environment. Learning in virtual environments is more than just accessing PDF or PPT files with content; the whole learning process must be transformed, not just translated, as stated by Thomas et al. (1998).

In this sense, e-learning scenarios can be characterized by three different dimensions: users, platforms (or services), and contents (Holmes and Gardner 2006). A single learner using his or her personal computer for taking a course available in CD-ROM is a possible e-learning scenario, although this is far from the current understanding of what e-learning is nowadays. In fact, we adopt the fourth e-learning generation as described by Taylor (1999), where there is an asynchronous process that allows students and teachers to interact in an educational process specifically designed in accordance with these principles. The place where these interactions occur is the virtual learning environment, which supports users (learners, teachers, managers, etc.), resources, and services. Through the appropriate services, virtual learning environments can be used to provide learners with better support for the new needs created by the Bologna process: personalization issues, a true learner-centered model, an active and more participative learning process, competence-based instead of content-driven activities, etc. In this virtual space, learning is a combination of interaction and content consumption, through the supervision of the teacher, who becomes more a facilitator of the learning process instead of a content producer and provider.

Within this framework, content management clearly becomes one of the most important services that the virtual learning environment must deal with. In fact, most universities already implement what is called the digital library, which tries to reproduce the usual services available in a traditional brick-and-mortar library, i.e., borrowing books and documents, accessing external databases, etc. Nevertheless, the concept of content is much wider, as it needs to include all the resources used by teachers and learners in the virtual classroom: exercises, multimedia resources, simulations, software, etc. Furthermore, it is also necessary to encourage learners to use the resources in the digital library, promoting an active learning process, and not just being a place where to find learning resources. Therefore, it is necessary to rethink the concept of digital library, which is content centered and based on the producer–consumer model, in order to improve the integration of content management as part of the learning process. As we will describe in Sect. 2.3, LORs (as a specific case of institutional repositories) become a key element for supporting a user-centered learning process, combining the services offered by digital libraries with the flexibility of directly providing contents through a simple interface (Conway 2008). In Chap. 4 of this book, the relationship between instructional design (the core of the learning process) and content management is discussed.

2.2.1 New Methodological Approaches

As previously mentioned, the new EHEA paradigm promotes a shift from a content-based learning process to a competence-based one. Instead of creating

content-centered courses with the aim of transmitting knowledge about such content, the lowest competency level in the Bloom's (1956) taxonomy, learning is seen as an active process supported by a set of activities which guide the learner toward the acquisition and development of a set of competences. Each one of these activities involves the use of one or more learning resources which might be different according to the learner's profile and the specific context. In fact, these learning resources can depend on the learner's preferences, with or without a default learning resource related to such activity. It is exactly the "content is infrastructure" sentence as stated by Wiley (2007). Furthermore, these resources are not just chunks of content given that a high degree of interactivity is expected. Readings but also videos, simulations, and exercises are, among others, typical learning resources used in virtual learning environments. In fact, learning objects (which will be addressed in the following section) were initially supposed to be consumed by the learner in only 15 or 20 min, in short sessions, although these figures are nowadays being questioned, as learners request even smaller chunks of content that can be easily downloaded and digested. Learners (and teachers) also request to be part of the workflow of the institutional repository, as they can create their own digital assets and share them easily (Thomas and Rothery 2005). This new scenario causes a fragmentation of the original content (i.e., textbooks, collections of exercises) in a large collection of very small contents which are absolutely related to each other, with some of these relationships directly generated by users.

Therefore, as stated in Sumner and Marlino (2004), it is necessary to bridge the gap between educational scenarios and digital libraries by means of providing users (learners and teachers) with the appropriate tools for creating and sharing knowledge and capturing all the richness of the learning process in virtual learning environments. In order to achieve an ideal learning scenario that gives complete support to its users (Dreher et al. 2004), we propose to introduce the use of LORs as one of the elements of the learning process as true CMS adapted to the specific needs of teaching and learning in virtual learning environments.

2.3 Learning Objects and Learning Object Repositories

The concept of a learning object has been deeply discussed many times in the literature since its appearance. Many authors have provided their own definition, which has not helped to clearly convey the concept, causing confusion and constant reformulations (McGreal 2004). Nevertheless, most of the existing definitions have three main characteristics in common: learning objects are available in digital format; they are described using metadata according to proposed standards formats, and they are oriented to maximize reusability by breaking the resources into pieces that can be reused independently. Reusability can be addressed as an integral part of the instructional design process (Wiley 2000) and it can be approached without a consideration of standards and specifications, i.e., reusing regular content with no specific metadata (Wiley et al. 2004). However, it is by using advanced metadata

schemas that educators can expose the contents and their basic description more explicitly, thus sharing also educational indications and even the prescribed sequencing. The concept of learning object and its implications with respect to content management are deeply discussed in Chap. 3 of this book.

Several specifications address the structure of digital learning resources. For example, ADL SCORM¹ provides a way to structure contents in packages that can be transported across platforms. The structure of SCORM 1.2 is very simple, but other specifications as its successor SCORM 2004 or IMS Learning Design (LD)² offer much more flexible languages for expressing concrete instructional sequencings that are the outcome of instructional design methods (Reigeluth 1999). Concretely, IMS LD focuses on describing learning activities, including multiple learner and tutor roles, sequencing of activities and services, including the resources or “learning objects” that must be used by each role kind in each concrete activity. Furthermore, metadata standards such as IEEE Learning Object Metadata (LOM)³ allow for defining some basic properties that are interesting from an educational perspective like that of interactivity, and more importantly, they provide a way to define types of resources, e.g., differencing exercises from expositive material and the like. Other specifications are very specific to some of these resources, e.g., IMS QTI⁴ is targeted to the representation of tests. These issues are covered in Chap. 9 of this book.

In spite of the diversity of resource types and characteristics of their structure that are covered in current metadata schemas, they are not commonly used nowadays as search criteria in repositories. In consequence, content management in current repositories is still not exploiting these special kinds of characteristics, but many of them stay at the level of “media files” with basic, general-purpose metadata. For example, uploading an IMS LD unit of learning is considered by existing repositories as a single, opaque ZIP-compressed file, and the structure and descriptions of the activities are not inspected and not used for search of versioning, just to name two typical CMS functionalities.

Learning objects are stored in LORs, which can be considered a specific kind of CMS for educational resources. Although, as stated before, traditional CMS tools can be used to store, describe, and share learning objects (such as Drupal or OpenCMS, among many other open source software tools), these tools are usually oriented toward Web content. According to Heery and Anderson (2005), repositories are differentiated from other digital collections because the content is deposited in the repository together with its metadata; and such content is accessible through a basic set of services (i.e., put, get, search, etc.). Depending on the specific needs of the community using the repository, this will provide additional tailored services, but all repositories should at least provide two basic ones: content

¹<http://www.adlnet.gov/scorm>.

²<http://www.imsglobal.org/learningdesign>.

³http://ltsc.ieee.org/wg12/files/IEEE_1484_12_03_d8_submitted.pdf.

⁴<http://www.imsglobal.org/question>.

preservation and content reusing (Akeroyd 2005). As stated in Ferran et al. (2007), it is important to fully integrate the LOR in the learning process in order to promote its usage by learners during the whole learning process. Furthermore, there are several requirements that should be fulfilled in order to ensure a successful repository (McNaught 2006). Chapter 10 of this book covers this subject with more detail.

2.3.1 Learning Object Repositories and Content Management Systems

It would be useful to start by considering how a LOR and a CMS differ. The main features of CMS products are content creation, maintenance and versioning, publishing workflows usually within a predefined work structure with concrete roles and responsibilities, and content dissemination through portal and search facilities. It is also common that a CMS provides a way to add some basic metadata to contents as an aid to search, and that they provide a way for users to provide feedback about the contents, e.g., in the form of ratings or grades. If we think in the development of a digital learning resource from scratch, the aforementioned functionalities of a CMS is still required for its development, at least when the contents are not created in isolation by a single educator, but they are produced by a team in a systematic way. This could lead us to the conclusion that the equation $CMS = LOR$ is correct. However, a more accurate judgment is that a CMS can be used as a platform for the development of learning resources, whenever the functionalities of a CMS are required. In fact, systems such as *Connexions*⁵ do actually provide group editing facilities, versioning, and other functionalities that are typical of a CMS. But there are many LORs that do not support such functionalities for the production of contents, but simply act as mere repositories of the contents produced elsewhere. Merlot⁶ is a popular example of such a system. Moreover, repositories such as DSpace⁷ are useful to keep frozen versions of learning materials of any kind, thus providing the services of a permanent archive that will resist the course of time.

Then, it is worth wondering what are the key distinguishing characteristics of a LOR that make them especially valuable for learners or educators when contrasted with a portal or with a conventional Web search engine. Examining a current LOR considered as best practice (Nash 2005), the following list of elements can be considered as a summary of the aspects that can be found and are specific, even though each LOR provides only part of them or only to a certain extent.

⁵<http://cnx.org>.

⁶<http://www.merlot.org>.

⁷<http://www.dspace.org>.

1. Specific metadata descriptions, addressing information relevant for educational purposes, such as those in the IEEE LOM schema. A typical example is the “educational level” of the target learning, which can be expressed as an age range or an indication of an educational level such as “K12” or “Higher Education.”
2. Special formats that specify instructional sequence or interaction schemes, like those supported by different proposed standards like SCORM or IMS LD. This includes formats for the interchange of interactive materials that are specific for educational settings as the tests that can be specified with the IMS QTI schema.
3. Categorizations used as browsing mechanisms for the learning resources that are significant of the structure of formal education.
4. Search mechanisms based on the specifics of educational metadata and formats.
5. Quality control or quality assessment mechanisms that consider educational aspects. This includes a wide range of possibilities, from user ratings to formal peer reviews conducted by experts in the pedagogy of specific subject areas.
6. An orientation to breaking down the resources in parts that are independent and self-standing, so that they can be reused in an easier way.

In addition to the aforementioned specificities, the actual practice of producing and sharing learning resources is in many cases very different from the production of contents in portals. This is mainly because a large number of learning resources are contributed by individual educators willing to share the products of their instructional preparation for their courses (which may be online, face-to-face, or hybrid). Furthermore, the resources are part of an instructional design process (Gagné et al. 1992), so that a LOR would ideally support such processes (but nowadays none of them provide such explicit support), including educational assessment and the recording of instructional design decisions (Sicilia 2007). Further to this, the emergence of the “open educational resource” paradigm can be considered as the principal driver of the widespread adoption of a LOR as an independent system, as will be discussed later, and this is also a distinguishing characteristic.

Therefore, any LOR featuring all the above characteristics will ideally be:

- More reliable and freer of noise than any portal or web-based CMS, as it has quality control based on educational properties
- Providing more effective search and browsing mechanisms
- Enabling a higher level of effectiveness in the reuse of learning resources produced by others
- Providing resources better prepared for sequencing and delivery within a learning management system (provided that both the LMS and the resource implement the same standards and specifications)

But there is still a long way to go before we have such an “ideal” LOR, as discussed in Dreher et al. (2004). Nonetheless, the constant development and upgrading of tools and learning technology standards and specifications have progressively increased the adoption of the paradigm behind the above characteristics. That paradigm can be called the “learning object” paradigm, which has been previously discussed.

The aforementioned aspects that are a characteristic of LORs also help in separating them from systems that allow the uploading of user-generated contents. Popular examples of such kind of repositories are Flickr⁸ or YouTube.⁹ These systems emphasize the community and informal sharing aspect of resources, but they are not concerned specifically with education. This is not to say that educators cannot find excellent resources for learning in these sites and actually quite the opposite is true, and they are a source of ideas on the important topic of building communities around repositories (Monge et al. 2008). But there is not any kind of education-oriented quality control or categorization. Then, a typical practice for exploiting these sites with user-generated content is that of describing selected resources such as entries in a LOR, so that the LOR acts as a filter for the mass of contents. This can be easily done, for example, using Merlot. Anyone can create an entry in Merlot referring (with a URI) to a YouTube video and then complete metadata about its potential educational usage, and eventually that resource will be reviewed and assessed by experts with regards to its educational properties. Nevertheless, as universities are places where knowledge is generated before and during the learning process, LORs are tailored to store content, not just links pointing to it, pursuing preservation and minimizing the problem of broken links. Furthermore, teachers (and, in some cases, learners) can also act as curators with respect to content quality issues.

2.3.2 *Repositories and Virtual Learning Communities*

As already mentioned, a key element for having a successful repository is the community of users built around it. Indeed, the success of many Web 2.0 applications such as YouTube lies in that they were able to attract a critical mass of users that either provide contents or add value to the existing contents in the site by commenting, rating, and bookmarking. Merlot can be mentioned as an example of a LOR that has succeeded in attracting an active user community, and today Merlot offers the possibility to navigate the resources through the profiles of registered users. Merlot has several mechanisms to award recognition to active users that provide high-quality contributions. Moreover, users are able to select some resources and link them in their “*Personal collections*” (Akeroyd 2005), as repositories cover all the range from individual to national scale (Peters 2002).

Personal collections represent a form of “user profile” or “user model,” because we can reasonably assume that the resources included in the collection of an individual determine indirectly his/her preferences or interests. This opens possibilities for personalization in repositories and digital libraries (Ferran et al. 2005). In this case, a rudimentary but effective way of personalization can be based on computing individuals with similar interests. Trivially, two users A and B that have many resources in common in their personal collections can be assumed to have similar interests. Then,

⁸<http://www.flickr.com>.

⁹<http://www.youtube.com>.

whenever one of them adds a new resource to his/her personal collection, the system could take the risk of “recommending” that item to the other for potential inclusion in his/her personal collection. This similarity-based approach combined with quantitative correlation measures based on numerical ratings is actually the basis of existing approaches to collaborative or social filtering (Konstan et al. 1997), which is also implemented in many e-commerce sites as the popular Amazon bookstore. Personalized actions such as the basic recommendation mechanism provided above can be found in many systems, and synergize with the development of active and engaged user communities (Littlejohn and Margaryan 2006). In fact, it is the information extracted from the real usage that the community makes of the service (or the repository) as the main source for building a recommendation system (Herlocker et al. 2004).

2.4 Semantic Repositories

As discussed above, LORs provide an alternative to search engines such as Google for finding educational resources, and metadata is a key distinguishing aspect. The typical implementation of metadata in learning resource repositories provides compatibility with a widely used metadata schema as Dublin Core¹⁰ or IEEE LOM (or use metadata elements that are similar to them). Metadata-based search represents a significant step in seeking more accurate search functionalities. But current metadata schemas such as IEEE LOM are limited in several aspects. They still rely on natural language descriptions (even though they are given some structure), and in general, the metadata produced is not good enough to be machine understandable. Machine understandability is an ideal in metadata that promises to enable learning object composition, precise selection of learning objects for given learning resources, instructional design aware search, and other advanced functionalities. These capabilities require the use of formal metadata statements and their link with domain ontologies (Sicilia et al. 2005).

To clarify these concepts, the description of a YouTube video clip about genetics will be considered. A fragment of IEEE LOM metadata might be similar to the following:

```
<?xml version="1.0" encoding="UTF-8" ?>
<lom xmlns="http://ltsc.ieee.org/xsd/LOM"
xmlns:xsi="http://www.w3.org/2001/XMLSchemainstance"
xsi:schemaLocation="http://ltsc.ieee.org/xsd/LOMhttp://ltsc.ieee.org/xsd/lomv1.0/
lom.xsd">
<general>
  <identifier>
    <catalog>URI</catalog>
    <entry>http://www.youtube.com/watch?v=WsofH466lqk</entry>
  </identifier>
```

¹⁰<http://dublincore.org>.

```

<title> <string language="en">DNA Transcription</string> </title>
</language> en </language>
</general>
<classification>
  <purpose>
    <source>LOMv1.0</source>
    <value>educational objective</value>
  </purpose>
  <description>
    <string language="en">Introduces the process of DNA transcription.</string>
  </description>
</classification>
</lom>

```

This fragment describes some basic properties of the video, namely its location, title, language, and its educational objective. This kind of metadata is useful for a structured search; however, semantics go one step further by using ontologies. Ontologies are formal, shared conceptualizations (Gruber 1993) that are nowadays being shared through the Web by means of common languages such as OWL, which are part of the foundations for a Semantic Web (Berners-Lee et al. 2001). For example, if we use the Gene Ontology¹¹ (GO) in an IEEE LOM metadata record, we can have something similar to the following:

```

<classification>
  <purpose>
    <source>LOMv1.0</source>
    <value>educational objective</value>
  </purpose>
  <taxonPath>
    <source>
      <string>GO</string>
    </source>
    <taxon>
      <id>0006351</id>
      <entry><string language="en">transcription, DNA-dependent</string></entry>
    </taxon>
  </taxonPath>
</classification>

```

In this classification, the GO has been used as an external classification system and pointed to a concrete node in that system, with ID 0006351. This represents a “biological process” in GO and is defined as “The synthesis of RNA on a template of DNA,” and we can from this, identify specific classes of that process (for example, “mRNA transcription with identifier GO:009299”), parts of that process (for

¹¹<http://www.geneontology.org>.

environment and a true learning experience. Obviously, a semantic layer which establishes the appropriate relationships between resources and the learning process will be a first step toward maintaining such a social network. But the learning process in virtual learning environments is far from being completely and concisely described. Although the new EHEA paradigm focuses mainly on formal learning, bridging higher education and lifelong learning, some of the ideas behind it can be adopted to any educational level. The shift from a content-based curriculum to a competence-based one is one of the main methodological issues, calling for new technologies such as LORs, as aforementioned.

New learning theories such as connectivism (Siemens 2005) establishes that learning is produced during the process of establishing new relationships between contents and concepts, rather than in the already acquired knowledge. LORs are important elements in the network built by the learner during his or her learning process, as they store not only the learning resources but also all the details of the learning experience itself with respect to the learner, with the help of the appropriate ontological support. In fact, nowadays we live in an age of content abundance, as resources are easy to find, create, remix, and share; the main problems for learners now are quality assessment and the lack of feedback, which are informational competences that must also be acquired and developed as part of the learning process. This subject is deeply discussed in Chap. 5 of this book.

We have discussed that the shift promoted by the new EHEA paradigm also causes a shift from traditional CMS, aimed at storing and preserving digital content with unidirectional interaction (the producer–consumer model), to LORs, which provide users with a dynamic vision of content (e.g., infrastructure), promoting a higher degree of interactivity, framing interactions, and learning experiences. In this sense, content is not something static, it evolves multidirectionally from an initial source, as it is “used” by learners. Therefore, the concept of preservation is at stake and needs to be possibly redefined. On the other hand, LORs must offer content as infrastructure, but the learning process is performed everywhere else. The LOR is an important element of the virtual learning environment but it is not the only one and, of course, learners may search for resources outside the institutional “barriers.” This is one of the key elements in connectivism: learning happens anytime and anywhere; it is the learner (and not the institution) who decides and takes control over his or her learning process, going where his or her particular learning goals might be satisfied and at the same time combining multiple sources. This new landscape shapes new roles, as teachers and institutions must become guides, enablers, capacity builders, facilitators, more than just content creators and providers. Any learning management system based on a simple content management solution is, simply, condemned to death.

Therefore, LORs seem to be one of the basic elements of any virtual learning environment, but they must be built based upon these principles: they need to serve a community of users which share a common interest; they must allow users to store any kind of content, in any format, as well as to establish the appropriate relationships with other content already in the repository; users should be also allowed to add their own tags, ratings, or comments about the content; browsing and searching

should be semantically supported; personalized services should be provided according to each user profile; and, finally, system usage should be analyzed to discover any potential problem or improvement. All of these characteristics will be only possible when repositories will become a collection of semantic services being part of a semantic learning management system which operates at a higher level.

References

- Ade, J., Allegre, C., Arsenis, G., Bladh, A., Catenhusen, W.-M., Dowling, P. et al. (1999). The Bologna Declaration of 19 June 1999. Available at http://www.bologna-bergen2005.no/Docs/00-Main_doc/990719BOLOGNA_DECLARATION.PDF
- Akeroyd, J. (2005). Information management and e-learning. Some perspectives. *Aslib Proceedings: New Information Perspectives*, 57(2), 157–167.
- Berners-Lee, T., Hendler, J., & Lassila, O. (2001). The semantic Web. *Scientific American*, 284(5), 28–37.
- Bloom, B. S. (1956). *Taxonomy of educational objectives, the classification of educational goals – Handbook I: Cognitive domain*. New York: McKay.
- Boiko, B. (2001). *Content management bible*. New York: Wiley.
- Conway, P. (2008). Modeling the digital content landscape in universities. *Library Hi Tech*, 26(3), 342–354.
- Downes, S. (2001). Learning objects: Resources for distance education worldwide. *International Review of Research in Open and Distance Learning*, 2, 1.
- Dreher, H., Krottmaier H., & Maurer, H. (2004). What we expect from digital libraries. *Journal of Universal Computer Science*, 10(9), 1110–1122.
- Ferran, N., Casadesús, J., Krakowska, M., & Minguillón, J. (2007). Enriching e-learning metadata through digital library usage analysis. *The Electronic Library*, 25(2), 148–165.
- Gagné, R., Briggs, L., & Wager, W. (1992). *Principles of instructional design* (4th ed.). Boston: Wadsworth Publishing.
- Gašević, D., Jovanovic, J., & Devedžić, V. (2007). Ontology-based annotation of learning object content. *Interactive Learning Environments*, 15(1), 1–26.
- Gruber, T. R. (1993). A translation approach to portable ontologies. *Knowledge Acquisition*, 5(2), 199–220.
- Heery, R., & Anderson, S. (2005). *Digital repositories review*. Bath: UKOLN and Arts and Humanities Data Service. Retrieved November 15, 2007, from http://www.jisc.ac.uk/uploaded_documents/digital-repositories-review-2005.pdf
- Herlocker, J. L., Konstan, J. A., Terveen, L. G., & Riedl, J. T. (2004). Evaluating collaborative filtering recommender systems. *ACM Transactions on Information Systems*, 22(1), 5–53.
- Holmes, B., & Gardner, J. (2006). *E-learning: Concepts and practice*. Thousand Oaks: Pine Forge Press.
- Konstan, J., Miller, B., Maltz, D., Herlocker, J., Gordon, L., & Riedl, J. (1997). GroupLens: Applying collaborative filtering to Usenet News. *Communications of the ACM*, 40(3), 77–87.
- Littlejohn, A., & Margaryan, A. (2006). Cultural issues in the sharing and reuse of resources for learning. *Research and Practice in Technology-Enhanced Learning*, 1(3), 269–284.
- McGreal, R. (2004). Learning Objects: A practical definition. *International Journal of Instructional Technology and Distance Learning*, 1(9), pp. 21–32.
- McNaught, C. (2006). *Are learning repositories likely to become mainstream in education? Proceedings of the 2nd International Conference on Web Information Systems and Technologies, Setubal, Portugal, April 11–13, 2006* (pp. IS9–IS17). Keynote address.
- Monge, S., Ovelar, R., & Azpeitia, I. (2008). Repository 2.0: Social dynamics to support community building in learning object repositories. *Interdisciplinary Journal of E-Learning and Learning Objects* (formerly the *Interdisciplinary Journal of Knowledge and Learning Objects*), 4.

- Nash, S. S. (2005). Learning objects, learning object repositories, and learning theory: Preliminary best practices for online courses. *Interdisciplinary Journal of Knowledge and Learning Objects*, 1. Retrieved May 15, 2006, from <http://ijklo.org/Volume1/v1p217228Nash.pdf>
- Peters, T. A. (2002). Digital repositories: Individual, discipline-based, institutional, consortial or national? *Journal of Academic Librarianship*, 28(6), 414–417.
- Reigeluth, C. M. (Ed.). (1999). *Instructional-design theories and models, volume II: A new paradigm of instructional theory*. Mahwah, NJ: Lawrence Erlbaum Assoc.
- Rosenberg, M. J. (2002). *E-Learning: Strategies for delivering knowledge in the digital age*. New York: McGraw-Hill.
- Sicilia, M. A. (2007). Beyond content: Sharing the design of open educational resources In: Open educational resources [on-line monograph]. *Revista de Universidad y Sociedad del Conocimiento (RUSC)*. 4(1). UOC. <http://www.uoc.edu/rusc/4/1/dt/esp/sicilia.pdf>.
- Sicilia, M. A., García-Barriocanal, E., Sánchez-Alonso, S., & Soto, J. (2005). A semantic lifecycle approach to learning object repositories. *Proceedings of the Advanced Industrial Conference on Telecommunications*, pp. 466–471.
- Siemens, G. (2005). Connectivism: A learning theory for the digital age. *International Journal of Instructional Technology and Distance Learning*, 2(1), 3–10.
- Sumner, T., & Marlino, M. (2004). Digital libraries and educational practice: A case for new models. *Proceedings of the 4th Joint Conference on Digital Libraries*, pp. 170–178.
- Taylor, J. C. (1999). Distance education: The fifth generation. *Proceedings of the 19th ICDE World Conference on Open Learning and Distance Education*, Vienna, Austria.
- Thomas, P., Carswell, L., & Price, B. (1998). A holistic approach to supporting distance learning using the internet: Transformation, not translation. *British Journal of Educational Technology*, 29(2), 149–161.
- Thomas, A., & Rothery, A. (2005). Online repositories for learning materials: The user perspective. *Ariadne*, 45, available at www.ariadne.ac.uk/issue45/thomas-rothery/.
- Wiley, D. (2000). *Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy*. In D. A. Wiley (Ed.), *The instructional use of learning objects: Online version*, <http://reusability.org/read/chapters/wiley.doc>.
- Wiley, D. (2007). Content is infrastructure. *Terra incognita* [online]. Available at <http://blog.worldcampus.psu.edu/index.php/2007/10/03/content-is-infrastructure/>.

Bibliography

- 2009 Horizon Report. (2009). Various authors. Retrieved February 19, 2009, from <http://wp.nmc.org.horizon2009>
- Alsagoff, Z. A. (2008). University learning = OCW + OER = Free! *ZaidLearn*. Retrieved February 19, 2009, from <http://zaidlearn.blogspot.com/2008/06/university-learning-ocw-oer-free.html>
- Downes, S. (2005). The fate of eduSource. *OLDaily*. Retrieved February 19, 2009, from <http://www.downes.ca/cgi-bin/page.cgi?post=15>
- Downes, S. (2008). The future of online learning: Ten years on. *Half an Hour*. Retrieved February 19, 2009, from http://halfanhour.blogspot.com/2008/11/future-of-online-learning-ten-years-on_16.html
- Ferran, N., Mor, E., & Minguillón, J. (2005). Towards personalization in digital libraries through ontologies. *Library Management*, 26(4/5), 206–217.
- Hirst, T. (2008). OER custom search engine. *OUseful Info*. Retrieved February 19, 2009, from <http://ouseful.open.ac.uk/blogarchive/014895.html>
- Leslie, S. (2008). Dynamic Wiki-driven OER search engine. *EdTechPost*. Retrieved February 19, 2009, from <http://www.edtechpost.ca/wordpress/2008/06/20/google-coop-on-the-fly/>
- Wiley, D. et al. (2004). Overcoming the limitations of learning objects. *Journal of Educational Multimedia and Hypermedia*, 13(4), 507–521.



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