ENRICHING A COURSE SYLLABUS WITH OPEN EDUCATIONAL RESOURCES

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Abstract

Recently a considerable amount of reusable open educational resources covering all grades of education has been developed, many of which come from official university programmes. These resources can be used as additional educational material by instructors and students. The questions are how can we take advantage of all this wealth? How can we design and build a graduate course using existing open educational resources? In this paper we shall tackle this problem focusing on higher education, using a Computer Networks course as a case study. Key issues and problems will be presented; a concise methodology will be proposed. We shall also present a supplementary experimental tool called LO Finder.

Introduction

Learning Objects

In general, a learning object is any digital resource that can be (re)used for facilitating intended learning outcomes. Learning objects are reusable, that is, they can be extracted and reused in multiple learning environments (Mills, 2002).

Learning objects have arisen to satisfy the faculty need for reusable instructional materials. A learning object may be a tutorial, an assignment, a test, a quiz, a drill or even a complete online course. As far as the format is concerned, LOs may come in the form of PDF/text files, websites, simulations, Java applets, Flash content, etc. De Salas and Ellis refer to the benefits of learning objects to both learners and instructors (2006, p. 4).

To successfully customise and enhance modules, courses and curricula, learning objects must have several attributes (Metros & Bennett, 2002; Mills, 2002; de Salas & Ellis, 2006):

- Portability and interoperability: learning objects should work across various platforms, browsers and course management systems.

- Searchability: instructors and learners should be able to easily locate LOs.

- Accessibility: learning objects can be located and delivered to the learner efficiently.

- Durability: learning objects remains stable and reusable even if operating systems and software packages change; for this purpose, they have to be updated as needed.

To facilitate these goals, learning objects must use standard formats (e.g., pdf, mp3/4, flv) and must be tagged with metadata, i.e., information required to fully or adequately describe their content. Typical metadata information may be author, institution, file size, location, time of creation, language, culture, etc.

This information is important for the recall of learning objects and their appropriateness regarding specific uses and tasks and their quality (Zens & Baumgartner, 2008). Metadata can be either a priori or a posteriori. A priori metadata are created in advance by the authors of learning objects and professional indexers. A posteriori metadata, in contrast, are created after usage by the users themselves or by automatic means (Juzna, Kavcic, & Divjak, 2007 as cited in Zens & Baumgartner, 2008).

One form of metadata added by users is social tags or folksonomies. Various schemes for automatic metadata generation using combinations of author indexing, expert indexing, peer review, automatic metadata generation and/or collaborative social tagging have been proposed (Zens & Baumgartner, 2008).

Potential users of learning objects will estimate the value of metadata when they will be confronted with the problem of selecting appropriate LOs for their needs from huge search results.

During the past years various standardisation initiatives of learning objects have appeared. Commonly used standards are the SCORM (Shareable Content Object Reference Model) and the LRE LOM standard (by the Institute of Electrical and Electronics Engineers, IEEE) which defines a structure for interoperable descriptions of learning objects (Metros & Bennett, 2002, p. 5; Zens & Baumgartner, 2008, p. 2).

Because search engines return too many results, most of which are not prepared for education or may not maintain adequate quality, learning objects are often kept in specific sites, called learning object repositories. There, the materials are

organised under majors and are easier to find. Databases are employed to host the digital objects themselves as well as the metadata describing the objects; however, in some implementations, databases host only the metadata along with links to the LOs, in which case they are called "referatories" (Metros & Bennett, 2002, p. 4). In some repositories the materials are peer reviewed and assessed, ensuring a minimal quality control (Metros & Bennett, 2002, p. 8). In the following, we shall use the term "repository" to describe both repositories and referatories.

Historically, the first practical LO repository for higher education was MERLOT (Multimedia Educational Resource for Learning and Online Teaching project). MERLOT (www.merlot.org) was initially funded in part by the National Science Foundation and sustained by higher education members. Today, it is an international cooperative referatory of high quality, peer reviewed online resources, containing more than 18,000 learning objects (Ochoa & Duval, 2008). Table 1 lists some of the most famous contemporary repositories; Table 2 lists some of the most famous contemporary referatories.

Table 1: Some of the Most Famous Repositories

Rank	Repository	Size (LO)	Rank	Repository	Size (LO)
1	HEAL	22,347	14	Apple Interchange	938
2	Exploratorium Digital Library	13,886	15	Explore Learning with Gismos	420
3	PBS Teacher Source	11,942	16	Science WebLinks	335
4	BioDiTRL	8,949	17	Free-ed Net	126
5	Curriki	8,201	18	Fathom archive	96
6	CITIDEL	5,992	19	LOLA Exchange: Wesleyan U	84
7	Connexions	4,872	20	Exploratories	71
8	ARIADNE	4,798	21	PhET U. of Colorado	67
9	LearnNC	3,138	22	General Physics Java Applets	59
10	Wisconsin Online Resource Center	2,445	23	ESCOT	44
11	National Learning Network UK	1,825	24	UC Berkeley Interactive University	36
12	Illumina	1,755	25	Harvey Project	31
13	Maricopa Learning Exchange	1,609			

Table 1: Rank and Size of the 25 Repositories studied

(Source: Ochoa & Duval, 2008)

Table 2: Some of the Most Famous Referatories

Rank	Referatory	Size (LO)	Rank	Referatory	Size (LO)
1	Intute	120,278	8	Internet Mathematics Library	10,482
2	Edna	36,530	9	Nime-Glad	8,879
3	GEM Exchange Gateway	34,946	10	AT&T Blue Web´n	6,371
4	MERLOT	18,106	11	Ideas	5,622
5	AMSER	16,666	12	FerlFirst	3,938
6	SMETE	14,251	13	EducaNext	760
7	DLESE	13,530	14	Learning about Learning Objects	250

Table 2: Rank and Size of the 14 referatories studied

(Source: Ochoa & Duval, 2008)

Open Educational Resources

Open educational resources (abbreviated as OER) are "digitised materials offered freely and openly for educators, students and self-learners to use and reuse for teaching and learning" (Hylén, 2007, p. 10).

OER include various kinds of digital products such as content, tools and methods, implementation resources, best practices, techniques, processes, incentives, licenses, etc. (Wikipedia: Open educational resources). In this paper we are interested in learning content, which includes courses, course materials, content modules, learning objects, collections and journals. In this work we shall use the term open educational resources to denote open learning content. Also, we shall use the term LOs as a synonym to open learning content — although the latter is a superset of (open) LOs.

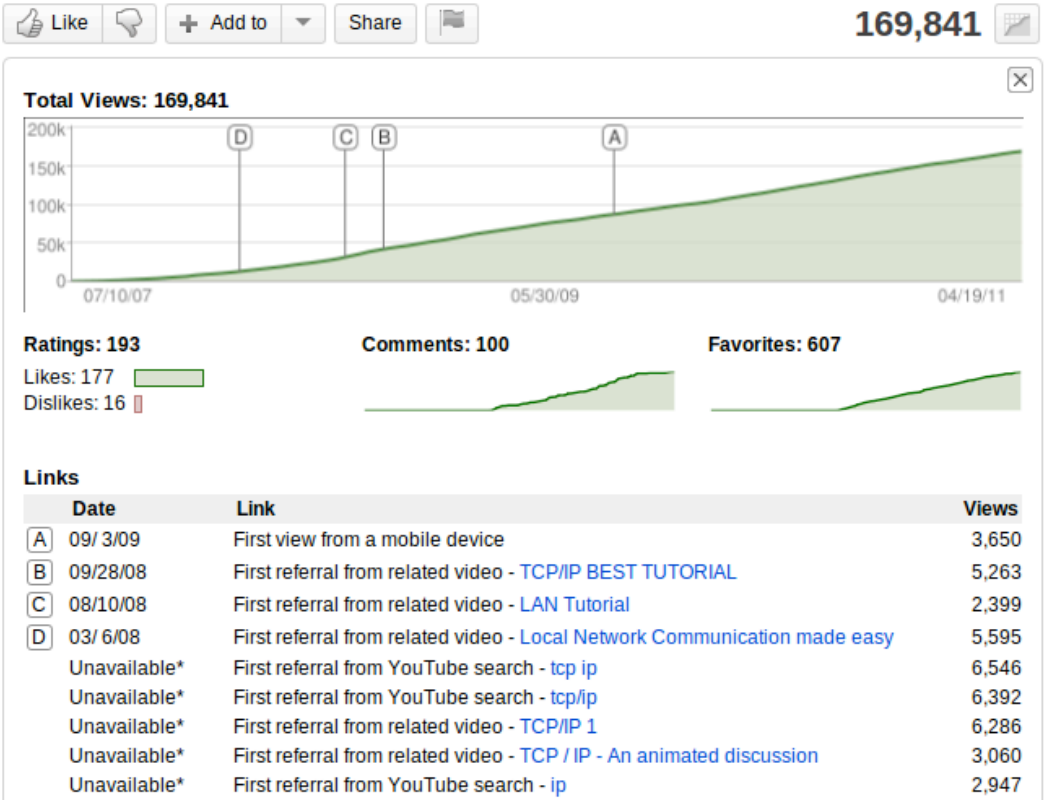
Open educational resources may be stored in various kinds of sites. Many universities have posted their courses on line, starting with MIT (MIT OpenCourseWare), Stanford (Stanford Engineering Everywhere), etc. Course materials in various formats may be found there, including pod casts (e.g., www.apple.com/education/itunes-u). Many sites host articles, presentations, howto's, animations, etc. A large collection of presentations, many of which are educational, is hosted in www.slideshow.com.

YouTube contains a lot of educational videos and many university professors maintain their own channels there, although there are also specific sites hosting exclusively educational videos such as SciVee (www.scivee.tv) and LabAction (www.labaction.com) (Snelson, 2009).

The reason probably is that YouTube is the most widely known source of videos. In fact, as of March 28, 2011, there were found 5,020 results for the key phrase "computer networking tutorial," some of which have been viewed over 100,000 times! Similarly, the key phrase "local area networks" returned about 5,420 videos.

The problem with educational resources stored in places other than repositories is that they may lack metadata, making their educational reuse difficult. Often, OER producers get involved in social media to increase the visibility and reputation of their educational content. Some sites like YouTube however, allow authors to tag their products, hence to add useful a priori metadata information; also, statistics and social tagging (likes and dislikes) may be used as a quality indicator (Figure 1).

Figure 1: YouTube Statistics and Social Tagging Constitute Useful Metadata



Education is Changing

Knowledge is growing exponentially today. The amount of knowledge in the world has doubled during the past 10 years and is now doubling every 18 months. In many fields the life of knowledge is now measured in months and years instead of decades, as it used to be 50–80 years ago. While new knowledge appears, half-life of knowledge is continuously shrinking (Bonikos, 1994; Ley at al., 2008). For instance, in 1994, half-life of knowledge was estimated to be five to seven years in engineering, five to eight years in business administration, five to six years in biotechnology, three to five years in medicine and one to two years (!) in information science (Bonikos, 1994). Since knowledge is outdated so fast nowadays, higher education syllabuses continually evolve, while new courses appear. As a result, new textbooks are needed, while the existing ones have to continually get updated. This makes the use of open learning content even more important.

Book authors strive to make new editions every 2–3 years, in order to cover new knowledge. However, old media such as books are evolving at a slow pace in relation to new media. In most cases, however, a gap remains — usually filled by journal articles, papers, as well as Internet-published material in various new

media formats such as pdf, videos, flash animations, presentations, etc. Part of these resources may be OER.

Another issue is the multimedia advantage: images, videos, pod casts, etc. help make teaching more pleasant and help students perceive new concepts more easily, being at the same time portable, reproducible anywhere, any time; simulations and animations facilitate understanding of difficult issues and misconceptions (Boyle et al., 2003; Snelson, 2009).

Another issue is that of additional textbooks and materials (readers). In higher education, the single textbook practice has been abandoned; instructors today suggest additional bibliography and multimedia resources in various formats.

A final issue is availability, cost and openness; open educational resources are freely available, facilitating education in all regions of the planet. Several movements and declarations have appeared, such as the *World Declaration on Education for All* and *The Cape Town Open Education Declaration*. For more information the reader may refer to the links of Lemma "Open educational resources" of Wikipedia.

Faculty Scenarios. Possible ways of using LOs in education are:

- to illustrate or clarify challenging concept that students usually have a hard time understanding;
- to update a course by instilling recent knowledge, research results and current trends;
- to convert a course for online delivery (even as guidelines or templates);
- to enhance the learning process use multimedia LOs such as videos, simulations, animations; and
- as main learning materials (i.e., exclusively, instead of textbooks, etc.) as an effective way to minimise cost (for instance, in developing countries).

The research question is "how can we design and build a graduate course using existing open educational resources?" This paper will examine and propose ways and methods for finding open educational resources and using them as main or supplemental materials to support current and future higher education courses.

Putting LOs Together

LOs are reusable learning materials by definition; however, putting together related LOs requires some conditions to be met, since two (or more) LOs may not fit together for various reasons, such as:

- two LOs are comparable and thus there is no reason to use both;
- one LO is a superset of another and thus there is no reason to use both;
- one LO is incompatible with the set gathered so far (in the sense that it is too simplistic or too advanced, or uses concepts which have not yet been defined).

Some pedagogical issues that arise here are:

- What is the background required to attend each LO? Is the level appropriate for my students?
- Is the quality acceptable?
- How is the quality of various LOs compared?
- Will my students be able to understand the LO?
- Do my students have the necessary background?
- Will my students like the LO or will they be bored?

It comes out that the instructors have to spend some time in order to carefully examine LOs and select the most appropriate:

- Will my students like the idea of studying additional materials? Or will they hate it because they will have to study more resources?
- How can I force my students study the resources? Perhaps by assigning some activities or assignments based on those materials.

We expect students interested in the course to like studying additional materials because the latter provide different perspectives and interesting view which enhance the learning process; besides, students usually prefer watching videos, animations and presentations to reading text (de Salas & Ellis, 2006, p. 20). In any case, the practice of studying from many sources rather than a single textbook is considered as the most appropriate pedagogically.

How can we combine all this heterogeneous materials in one unique formal course? Will the materials cover the entire syllabus? Shall we be able to cover all

aspects without gaps? How shall we avoid overlapping or controversies? How can we check the validity of the material? Will the result be acceptable? Will the students be happy or will they be lost?

Answering all these questions is out of the scope of this paper; however, the instructor's engagement is perhaps the most crucial factor. Assembly or enhancement of a course from/with LOs requires expertise and design strategies for best functionality (Metros & Bennett, 2002, p. 4).

Research Questions

- Can we design courses based on open educational resources exclusively?
- How can we design courses based on open educational resources?
- Are there any advantages in using open educational resources?
- How shall we be able to locate the proper materials? How shall we assess them?

Propositions and Solutions

In order for instructors to select LOs for their course, some questions have first to be answered, such as: What are the aims of the course? What are the expected knowledge, skills and attitudes that students must gained have in the end of the course? Typical solved problems, activities and assessment guidelines could be used to clarify the above. Course orientation (i.e., theoretical or practical) should also be known.

We shall use our case study to illustrate the above issues. A Computer Networking course could be purely theoretical, purely practical, or a mixture of both (e.g., 60%–40%). Two incompatible approaches exist in the bibliography: the bottom-up approach and the top-down approach, regarding the order in which network layers are being presented.

Solutions to Pedagogical Issues

Not all LOs are of good quality; nor are all able to fit in a particular syllabus; thus

- Some criteria have to be specified, including quality, duration, required background, validity, etc.
- The required background should be specified in the LO metadata.

- The instructor has to previously check and carefully select the proper LOs.

- The instructor has to prepare a study guide or a reflective action guide. This will also function as a platform that will glue together the various materials.

Learning Object Metadata is a data model, usually encoded in XML, used to describe a learning object and similar digital resources used to support learning. The purpose of learning object metadata is to support the reusability of learning objects, to aid searchability, and to facilitate their interoperability, usually in the context of online learning management systems (LMS).

A Study Guide is a special text accompanying a course, describing:

- the goals of the course, the learning targets in terms of knowledge, skills and attitudes;

- the approach followed and the orientation of the course (theoretical, practical, etc.);

- since formal education means a change in behaviour, where is this change and how can it be observed or even measured;

- the detailed course syllabus (e.g., in 4–5 pages);

- examples, typical problems with their solutions, self-evaluation questions, activities;

- links to LOs and external educational resources, as well as, related software that will enable the students to practice and drill;

- how to read the textbooks, notes and in general all the materials accompanying the course;

- special guidelines for students and instructors on how to study the materials; and

- additional readings, bibliography, etc. i.e., where to find more information on the various topics presented.

Advanced LO metadata greatly facilitate the instructor's task of finding, classifying and selecting the most appropriate LOs to enhance a course. Our proposition is to describe the course syllabuses as hierarchical trees, i.e., as a set of metadata similar to the LO metadata. Then by examining advanced LO

metadata (such as educational grade, preferred ways of teaching and learning, prerequisite concepts, etc.), instructors may decide whether a LO is possibly appropriate for their course before studying it. In our Computer Networking case study, the teaching approach (i.e., bottom-up or top-down) would be an important detail to be included in the metadata.

As a case study let us consider a Computer Networking course syllabus. What the instructor has to do is (*proposed methodology*):

Table 3: The Proposed 10-Step Methodology of Enriching a Syllabus with LOs

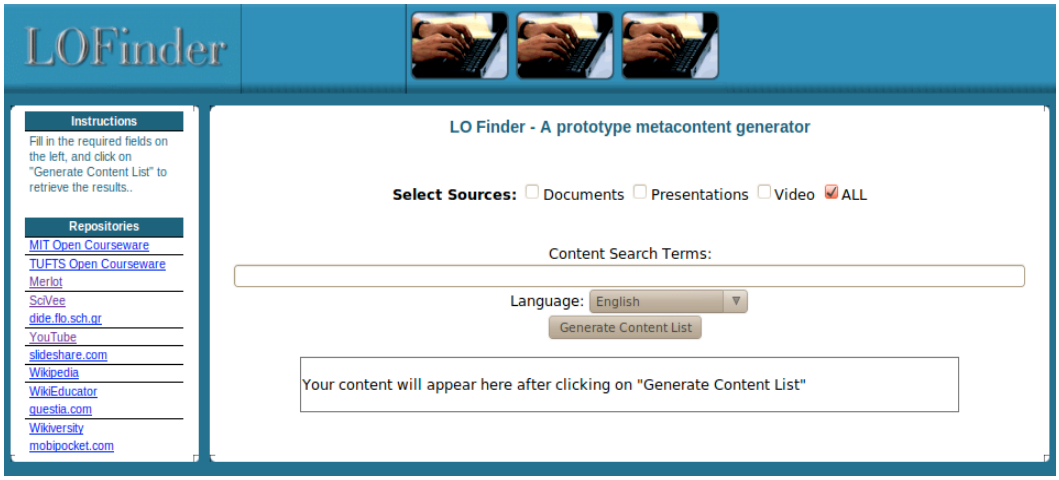
1. Define the course orientation (theoretical-practical) and teaching approach (bottom up or top down).
2. Define the course aims and expected results.
3. Design a detailed course syllabus.
4. Come out with the format/ type of OER needed to enrich (or create from start) the detailed course syllabus.
5. Define a limited set of appropriate repositories and sources of OER for search.
6. Perform a set of searches to collect the relative resources, based on specific quality criteria such as metadata, peer reviews, folksonomies, etc. Use of tools greatly facilitates this process.
7. Examine collected resources and select those which best fit the criteria.
8. Update LO metadata, provide feedback (reviews, social tagging) for future personal use, as well as, for other users.
9. Link selected resources to the detailed course syllabus.
10. Prepare a study guide.

A Tool Supporting the Selection of LOs

In order to facilitate this process, we have developed a tool called “LO Finder”. Technically, LO Finder is a meta-search engine, programmed to search for specific types of LOs (doc, pdf, videos and presentations) in specific repositories and sites which host educational materials. Technical details about this tool fall out of the scope of this paper. LO Finder provides a form for the instructors where

they can enter a keyword, desired language of the LOs and select the form of materials and the repositories (Figure 2).

Figure 2: LO Finder Initial Screen



Then, by pressing the "Generate Content List" button, LO Finder returns a list of the findings (Figure 3). Readers can test the tool themselves using the URL: http://www.securexpance.com/metacontent. Authors will welcome their feedback.

Figure 3: Part of Results Provided by LO Finder

Finally, after selecting a proper list of resources (possibly by trying several searches using additional keywords and techniques to better filter the results, e.g. (Multiplexing and Demultiplexing + "Transport Layer"), we end up with a

minimum set of LOs which the instructor has to examine 'manually' for quality, compatibility, broken links, etc. The result in our case study looks like Figure 4.

Figure 4: Part of Computer Networking syllabus linked to selected OER

Chapter 4 – The Transport Layer

4.1 Transport layer service models: HTML1 HTML2 PDF1 DOC1 PPT1 PPT2 VIDEO1
4.2 Multiplexing and demultiplexing: HTML1 PDF1 DOC1 PPT1 PPT2 VIDEO1
4.3 Connectionless data transfer with UDP: HTML1 HTML2 PDF1 DOC1 PPT1 VIDEO1
4.4 Introduction to reliable data transfer: HTML1 HTML2 PDF1 DOC1 PPT1 PPT2 VIDEO1
4.5 Reliable data transfer with TCP: HTML1 HTML2 PDF1 DOC1 PPT1 PPT2 VIDEO1
4.6 Congestion Control with TCP: HTML1 HTML2 PDF1 DOC1 PPT1 PPT2 VIDEO1
4.7 Summary and further reading
4.8 Practice and Drill (activities, questions, problems, labs)

Conclusion

Use of open educational resources in various formats can greatly enhance a course; they also present the student with different perspectives of various authors and make study independent of instructors, authors and textbooks, which is pedagogically correct.

Detailed LO metadata will greatly facilitate the instructor's task of finding, selecting and putting together LOs. LOs which have been peer reviewed or are suggested by many instructors assure a minimum quality. Special techniques and personal help instructors assemble courses from reusable LOs.

In this paper we have proposed a methodology for populating a detailed course syllabus with OER. This methodology enables instructors to build a course syllabus based on completely open materials.

We have also presented a research tool called LO Finder. This may be used to collect LOs in multimedia formats such as texts, presentations, videos and podcasts. Using this tool and a detailed Computer Networking course syllabus, we have demonstrated a way of constructing a hypertext document linking together all selected LOs across the syllabus. In this way we may even build a course using exclusively open educational resources.

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