Open educational resources (OER) inspire teaching and learning

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Abstract—**Open educational resources (OER) can significantly reduce the time required to prepare lectures. The prerequisites are that a desired resource can be found quickly and that its adequacy for the intended purpose can be estimated easily. Eventually, the resource should also be suitable for modification. In the first part we outline the requirements for the sourcing, storing, retrieval and exchange of open educational resources considering technical and legal aspects. In the second part we present a case study focusing on the user level perspective. We describe the searching for a particular OER (an online Moodle tutorial), the analysis of the resource found, its modification and the publishing of the modified resource on a repository.**

Keywords-open educational resources; repositories; metadata; learning objects; learning design frameworks; open access; community of practice;

I. INTRODUCTION

Imagine the following situation: A university teacher is preparing his next week's lecture. The topic is the visualization of multivariate data with scatter plots and parallel coordinate plots. He has already held this lecture one year ago. His memo of that lecture indicates that the students had some difficulties with the sketching of a parallel coordinate plot. Our teacher would like to improve his lecture with elements that involve students directly and actively in the learning process, thereby promoting understanding by doing. He has some instructive simulations in mind, exercises, perhaps an assignment. However, our teacher has neither the time nor the budget to develop the required material. Certainly, hundreds of teachers all over the world must have the same or similar needs. Probably, one or more persons have already developed an easy to use software the students could experiment with in order to better understand the use of parallel coordinate plots for the analysis of multivariate data. Let us suppose that a free Microsoft Excel add-in would satisfy the needs of our teacher. How can he find this software? In case he finds it[1], how can he quickly compile an accompanying worksheet for the students?

[1] Such an MS-Excel add-in would be Visulab® - Interactive data visualisation in Microsoft Excel (http://www.inf.ethz.ch/personal/hinterbe/Visulab/)

The amount of work to develop educational resources (e.g. documents, graphics, images, videos, laboratory exercises, compatible learning units) is high. Moreover, all these resources have to be maintained and to be developed further as technologies or curricula change. Unlike scientists, teachers are all too often "lone fighters". They do not have many opportunities to discuss their lectures and materials with colleagues, to exchange ideas or even to develop materials in a team.

This is where open educational resources (OER) come into play. OER can help teachers to reduce their amount of work for the preparation of the lectures. Open educational resources can be modified to suit the specific didactical needs of a lecture and the "producers" and "consumers" can contact each other in order to discuss modifications and extensions to existing OER.

II. WHAT ARE OPEN EDUCATIONAL RESOURCES?

The OER movement aims to break down barriers – such as teaching material locked up behind passwords within proprietary systems or filed in personal drawers – and enable sharing content freely [1].

The *openness* of OER refers to [2]:

- The freedom to use the work and enjoy the benefits of using it.
- The freedom to study the work and to apply knowledge acquired from it.
- The freedom to make and redistribute copies, in whole or in part, of the information or expression.
- The freedom to make changes and improvements, and to distribute derivative works.

Educational means that the material is produced for use in formal educational settings, although open educational resources can well be used for informal or non-formal learning outside formal educational settings [1].

Open educational resources are digitized materials offered freely and openly for educators, students and self-learners to use and reuse for teaching, learning and research [1]. An open educational resource can be:

- *Learning content* (e.g. courses, modules, learning objects, exercises, references to collections and archives).
- *Software* (e.g. development tools, tools for organizing content, simulation tools)
- *Hardware* (e.g. electronics prototyping platforms such as Arduino [3]).
- *An implementation resource* (e.g. creative common licenses, best practice design principles).
- *An interoperability standard* (e.g. the sharable content object reference model SCORM [4], the IMS content packaging specification [5]).
- *Media* (e.g. images, audio recordings, videos).

III. INSTITUTIONAL AND NATIONAL REPOSITORIES

In order to be accessible from all over the world, open educational resources must be made available on servers connected to the internet, so-called repositories. Repositories can be provided by universities, libraries, communities, national bodies or other institutions. An exemplary collection of open e-learning content repositories can be found on the website of the Open eLearning Content Observatory Services OLCOS [6].

OER repositories must comply with standards. Otherwise, only local searches on the distinct servers can reveal the "hidden treasures". The repositories must exchange the descriptions (metadata) of the educational resources stored in their databases. In this way, searching on a specific repository yields the list of relevant records from all the connected repositories. The exchange of the metadata records is accomplished by means of the open archives initiative protocol for metadata harvesting OAI-PMH [7].

A central access to all OER repositories would simplify the task of searching for a needed resource. Such a central access already exists: The OAIster® database [8]. OAIster boasts more than 23 million records representing digital resources (digitized books and journal articles, digital text, audio files, video files, photographic images, data sets with statistical information, theses and research papers) from more than 1,100 contributors. OAIster records are freely available through WorldCat [9], the world's largest network of library content and services.

Figure 1. Search box providing access to WorldCat from within the OAIster website.

OAIster is intended to be a collection of open access resources. Open access resources are primarily library resources. Nevertheless, OER repositories incorporating the standardized OAI-PMH harvesting protocol could deliver their metadata to the OAIster database and thus make open educational resources accessible through a "single-point-of-search". The resources on existing repositories that do not support OAI-PMH cannot be retrieved through searches initiated on a repository supporting the OAI-PMH harvesting protocol. What should be done with such repositories? Their technical infrastructure could be upgraded with a suitable implementation of the OAI-PMH, provided that the metadata are already present or newly entered. Alternatively, the resources could be transferred to a repository supporting the OAI-PMH. In any case, new repositories should be based on the aforementioned standards.

Furthermore, all OER repositories should internally provide their metadata in a format that allows search engines such as google, yahoo or cuil to index them. In this way, teachers, students and self-learners can find open educational resources by using their preferred search engine.

IV. METADATA AND FORMATS

If we want to find open educational resources on other repositories than the one we are logged in, our repository must provide access to the metadata of the resources on the other repositories. As depicted above, this is done through metadata harvesting. In other words, we do not have access to the full text of those resources. And when we think of multimedia resources such as images, audio or video, it is obvious that we need metadata in order to be able to find appropriate content. Which metadata standard is suitable?

The Dublin Core metadata standard or a subset of it is a candidate for the description of open educational resources [10]. In the OAIster database, for instance, the simple Dublin Core metadata format is used. The Dublin Core provides general fields such as <title>, <creator>, <description> and <language> as well as fields specifically useful for educational resources (e.g. <audience>, <instructionalMethod>, <educationLevel>). With respect to complex educational resources such as courses or modules, there are important fields missing. For instance, no metadata fields exist for the specification of "educational objectives" or "typical learning time".

```
<rdf:Description>
  <dc:creator>Peter Noeller</dc:creator>
  <dc:title>Algebra</dc:title>
  <dc:subject>mathematics</dc:subject>
  <dc:date>2008-04-23</dc:date>
  <dc:language>EN</dc:language>
  <dc:description>
     An Introduction to Algebra
  </dc:description>
</rdf:Description>
```

Figure 2. Dublin Core metadata example (extract).

Another candidate for the description of open educational resources is the IMS metadata specification which is now aligned to the IEEE Standard for Learning Object Metadata (LOM) [11] [12]. The IMS Global Learning Consortium has specified these "data about data" in order to make the process of finding and using a learning resource more efficient. With the fields provided by the IMS / LOM metadata specification a learning resource can be described in more detail than it can be done with the elements of the Dublin Core.

Discussions with practitioners indicate that either metadata format will not be used extensively by teachers because of a significant lack of time to fill in the fields accordingly [13]. Eventually, the use of folksonomies (collaborative tagging) could improve the situation [14]. An author only provides a minimal set of descriptive fields with the educational resource when she or he publishes it on the repository. Users add appropriate tags when they find the resource. The more tags are added with time, the more relevant the results of a search for an OER will become.

```
technical.requirement.type = browser
educational.difficulty = low
educational.typicallearningtime = 00:00:10
educational.description = Explains who Frank
   Lloyd Wright was, in the context of recent
   American History. It has a portrait
   photograph and links to further resources.
educational.language = en-US
classification.keyword = architecture, chicago
school, modernist, prarie
```

Figure 3. IMS metadata example (extract).

The reuse of open educational resources further depends on reusable document formats. Material created on a Macintosh must be usable on a MS-Windows computer as well. The following formats can be recommended for reusable documents:

- Plain text: Unicode
- Images: TIFF (Tagged Image File Format)
- Audio: MP3 (MPEG-1, Layer 3)
- Video: MPEG-4

The Portable Document Format (PDF) is widely used for documents incorporating text, graphics images and even audio and video. A PDF-document can be read on every computer system, but it cannot be modified. Thus, PDF is not a suitable format for reusable learning objects. Open Office documents should be used instead.

What about HTML? HTML pages can be modified. It is relatively easy to add or remove content and to change the layout (as long as cascading style sheets are used to style the pages). Using a free Web authoring tool (e.g. KompoZer), the pages and styles can be modified even without a sound knowledge of HTML [15]. If the HTML pages and style sheets along with the images and further media should be packaged into a SCORM or IMS content package that could be imported into a learning management system, a so-called manifest file would be needed. Although the manifest is a text file written in XML, it is not easy to hand-code it. In this case, an appropriate authoring framework could be used, e.g. the ReCourse Learning Design Editor [16].

Complex educational resources such as courses and modules could be authored in XML. XML has several advantages:

- The sources are text files and can be written and modified using a simple text editor.
- XML is also the basis for the manifest file.
- Using XSL (eXtensible Stylesheet Language) transformations, the resources can be produced and published in different formats, such as HTML, SCORM, or PDF.
- The XML sources can also be written and modified using open source authoring frameworks, e.g. the Firedocs eLesson Markup Language (eLML) Editor [17].

Unfortunately, the eLesson Markup Language is not a standardized language. Educational resources written in a different XML-based learning design language cannot be edited with the Firedocs eLML editor, and vice versa.

V. REUSE OF EDUCATIONAL RESOURCES

Before they can be reused, open educational resources must be found. (We talk about reuse because we defined OER as materials produced for use in formal educational settings. Thus, the publication of the resources on repositories allows their reuse.) We already discussed the respective prerequisites (repositories, metadata exchange, search engine indexing, reusable document formats).

Anyway, who is interested in reusing educational resources? The intention of open educational resources is the reuse by other teachers. The promise is that the teachers can significantly reduce the time required to prepare lectures. The resulting variety of materials (and didactical concepts) also stimulates students. However, according to [18] only 15.3% of the users of MIT open course ware content are educators. 31.4% are students and 48.2% are self-learners. Why do only few educators reuse open educational resources?

The granularity of the resources could be a reason. It could be harder to integrate resources with coarse granularity (e.g. complete courses) into ones lectures. An expressive graphic or a table with significant data can be reused more easily than a complete online course or the recording of a two-hours lecture. The findings of [17], however, indicate that resources with fine granularity (e.g. images) are not reused more often than resources with coarse granularity. The determining factor for reuse with respect to granularity seems to be the *reuse context*. Resources with a slightly lower granularity than the object that has to be developed are easier to integrate than resources with much finer granularity. For the development of a course, for instance, the integration of a complete lesson is more convenient than the reuse of a single image.

Several teachers do not often reuse open educational resources because of technical barriers (e.g. no access to the repository, wrong document format). The most important obstacle is the difficulty to find the needed resources. This is mainly due to the lack of appropriate metadata. Eventually, a teacher, who is searching for a video with experiments regarding the psychology of human perception, really finds one. The duration of the video is 47 minutes and there are no descriptions of the individual scenes and no specifications of their beginnings and endings. The teacher does not have time to inspect the whole video and resigns the reuse of that resource.

First of all, teachers must make their own resources available. Otherwise, the OER movement will not be successful. Many teachers express certain reserves towards the publication of their own material. Some of them fear the criticism of the colleagues. Others complain that it would not be fair to freely reuse their material which they have worked very hard for. Some teachers worry about the time required and the cost of obtaining permission for using assets in their material (mainly graphics and images, audio and video content) for which a third party owns the copyright. On the other hand, teachers get personal satisfaction when they make their materials publicly available. They gain reputation. Authors of open content would like being personally rewarded through workplan, promotion, awards etc. for the use of their material and being acknowledged as the creator, especially when the resource is adapted or changed [1]. In any case, teachers must be encouraged to supply their materials and the institutions must setup the accompanying measures in order to support the authors of open content.

VI. CASE STUDY

At the University of Applied Sciences *HTW Chur* we currently use Claroline (Classroom Online) as learning management system [20]. In autumn 2010 we will introduce Moodle for the first-year students in the master program in information science [21]. The students enrolled in the further programs (business administration, tourism, civil engineering, electrical and electronics engineering, and media engineering) will follow in 2011. The faculty involved in the master program in information science has to become acquainted with the basic concepts and the efficient handling of Moodle's functions before the beginning of the new academic year in September 2010. During the first week of the fall semester, the students have to learn how to work with the Moodle platform. The respective introductory courses have to be repeated every year. Therefore, a blended learning course would be adequate. With two face-to-face lessons we could shortly summarize the concepts of Moodle and the peculiarities of the configuration at the *HTW Chur*. We could go through an exercise so that the participants could get to know the relevant functions. Consequently, the exercise would be different for the faculty and the students. Afterwards, an online course for the faculty and another one for the students could give them the opportunity to further study the effective use of Moodle for teaching and learning. The online course would also allow the faculty and students to have a look at individual topics at anytime whatsoever and to become acquainted with them on own accord.

The planning and realization of such an online course is both, time-consuming and costly. However, Moodle is widely used at universities all over the world. Thus, we expected that at least one adequate Moodle online tutorial would be available as an open educational resource.

A. Finding resources

The prerequisites were that the language of the educational content was German and that the online course was suitable for the training of both teaching staff and first-year students, or that the content should at leat be suitable for modification. Thus, we first searched the Swiss national learning object repository SWITCHcollection [22]. Unfortunately, we did not find a Moodle tutorial there. SWITCHcollection is a relatively new repository and does not yet contain many resources. In a second step we used the phrases "open educational resource" and "online tutorial" to search for pages in german with google. The search yielded 3 hits only! We changed the phrase search into a separated keyword search ("open educational resource online tutorial") and found at the first place among 15'300 pages the Moodle online tutorial on the web site of the institute for research in open, distance, and e-learning (IFeL) at Brig, Switzerland [23].

B. Analyzing the resource

The Moodle tutorial is hosted on the Moodle server of the institute IFeL. It is freely accessible over the web and the learners also get a free user account in order to work on the exercises and assignments.

Figure 4. Online Moodle tutorial (introductory page)

The tutorial comprises eight modules: Basic concepts, course configuration, content distribution, communication with students, collaboration, exercises & assignments, reflections, user administration. The intended audience is the faculty. Although the Moodle tutorial has not been published on a repository yet, its sources are available under the creative commons licenses BY (attribution) and SA (share alike) on the corresponding website. (The authors intend to publish the Moodle tutorial on SWITCHcollection in due time.) We downloaded the sources and inspected them. Unexpectedly,

there was also a tutorial for students included in the download package.

Does this resource suit our needs?

- The language of the educational content is German.
- There are two different tutorials, one for the faculty and the other for students as intended audience.
- The modules of the tutorials follow an intelligible didactical concept. The front page of every module lists concisely formulated objectives and the approximate time needed to complete the module. The content is structured according to the ECLASS model [24]. An ECLASS module is partitioned into five (eventually six) sections: Explain (overview), clarify (requirements, recommendations), look (review examples or samples), act (practice what has being taught), share (student interaction), self evaluate/ submit (self-evaluation and submission of completed work); eventually, a summary concludes the module.

E xplain
C larify
L ook
A ct
Share
S elf evaluate / **S**ubmit
(**S**ummary)

Figure 5. The ECLASS model (modified).

The tutorials come up to our expectations. Metadata would have been desirable in order to get a quick glance at the objectives and the overall time needed to complete the tutorials. These metadata should be added to the resource when transferring it to the SWITCHcollection repository.

C. *Modifying the resource*

The tutorials have been developed on the basis of eLML, the e-Lesson Markup Language [25]. The sources are written in XML and can be modified with any ordinary text editor. Structure, content and form of the tutorials are separated from each other. Using XSL transformations, the content can be published either as HTML pages, as SCORM-compatible content package or even as a PDF document. Besides the XML sources, the download package also contains the HTML derivatives.

We already had some experiences with learning resources based on eLML, but we were unsure whether or not the modifications of the eLML sources of the Moodle tutorials could be modified easily. We wanted to know more about it and contacted one of the authors. This was possible because the e-mail addresses of the team members who developed the tutorials were published on the entry page. The discussion with that person revealed the pitfalls of the eLML technology. At least one member of the development team must be a technician who is familiar with the eclipse development framework. Otherwise, the modifications of the sources (content, cascading style sheets, XSL-transformations etc.) would be rather complicated.

```
<unit label="goals" title="Ziele und Inhalt"
<learningObject title="">
   <clarify>
      <paragraph>In diesem Tutorial ...
      </paragraph>
      <list listStyle="ordered">
          <item><link targetLesson="moodle1">
          Grundaufbau und Basiseinstellungen
          </link></item>
          <item><link targetLesson="moodle2">
          Organisation und Administration
          </link></item>
      </list>
      <paragraph title="Aufbau">Das Tutorial ...
      </paragraph>
   </clarify>
</learningObject>
```

Figure 6. eLML source text (extract).

We had three options to proceed:

- The faculty could use the existing online tutorial hosted on the Moodle server of the institute IFeL. We would provide additional material with explanations of the specifics of our own Moodle configuration. The tutorial modules for the students could be published on our own web server.
- We could modify the existing HTML pages of both tutorials and publish them on our own web server.
- We could plunge into the technical details of eLML and the eclipse framework and modify the XML sources and XSL transformations according to our specific needs.

We decided not to alter the XML sources but to modify the HTML derivatives and publish both tutorials on our own web server. In this way, we do not need to modify the XSL transformations which would be needed to generate the HTML pages from the XML sources. Modifying the HTML pages is the easier approach but its drawback is that our modifications cannot be directly fed back into the original.

What were the modifications to be carried out?

- There were some typing errors on various pages of the tutorial. Correcting them was easy.
- The layout should reflect the corporate design of our university. Thus, the cascading style sheets had to be modified accordingly.
- The entry page of the tutorial should summarize the content and let the users select the faculty part or the students' part. It had to be designed from scratch.

- A presentation of the didactical concepts that can be supported through the configuration of a Moodle course is missing. It has yet to be developed.

To modify the HTML pages and the cascading style sheets was quite easy. However, to understand the structure of the pages and the navigation mechanisms was cumbersome. We had to inspect every single file and to sketch the relations between the HTML files and the style sheets in order to find the position for a particular modification. A concise documentation of that structure and the individual files would have been very useful.

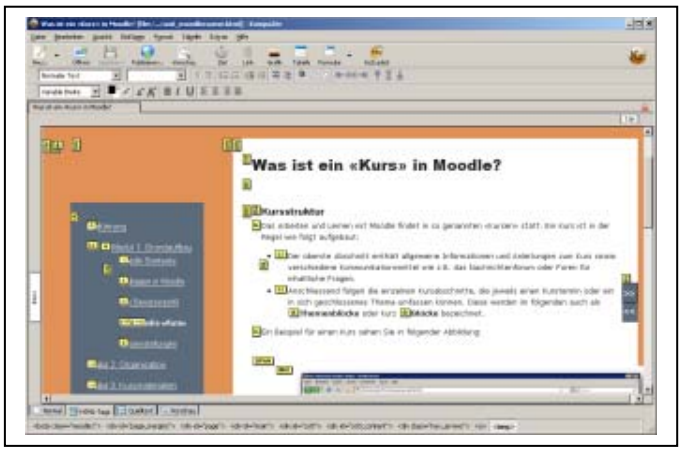

Figure 7. Modification of an HTML page using the free web authoring tool KompoZer [24].

Figure 8. New Moodle tutorial entry page.

D. Publishing the new resource

In order to give our work back to the community, we have to publish it on an institutional or other repository. We decided to publish our open educational resources on the SWITCHcollection repository.

The publication of an educational resource should be as easy as the download of a resource from the repository. Thus, we implemented the harvesting interface between our learning management system Claroline and the SWITCHcollection repository. Our faculty can transfer resources from Claroline with the "click on a button" [26]. It is most convenient to package the content (e.g. the HTML pages and stylesheets) along with the metadata file and the documentation into a zip-archive. Alternatively, the resources could be arranged in a SCORM or an IMS content package. In this way, only a single file has to be transferred to the repository. Before transferring the resource, a metadata form must be filled in. It is most important to precisely describe the resource in detail. Otherwise, it would be difficult to find it in the repository as the individual contents of a zip-archive, a SCORM, or an IMS package cannot be found by the repository's search engine.

The SWITCHcollection development group is working on the refinement of the metadata fields and the definition of their meanings. We are contributing to this work because meaningful metadata are crucial for the enduring success of open educational resources.

VII. CONCLUSIONS

In order to be found and widely reused, open educational resources must include three elements: The content itself, appropriate metadata, and a documentation (at least a sketch) that points out the structure of the resource from a didactical and a technical point of view. The resources must be published on servers that comply with open access standards (such as the Open Archives Initiative Protocol for Metadata Harvesting) and include Web 2.0 functionalities (such as comments). Educational institutions must support their faculty in the production and publication of open educational resources and last but not least the establishment of a community of practice would be of great value within and amongst institutions.

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