

Building e-Learning Content Repositories to Support Content Reusability

Jacek Marciniak

Faculty of Mathematics and Computer Science, Adam Mickiewicz University, ul. Umultowska 87, 61-614 Poznań, Poland

Keywords: e-Learning Digital Libraries, Content Reusability, SCORM, Tools for e-Learning.

Abstract: The article presents the method and tools to build repositories of digitalized didactic materials to support their reusability. The method consists of a set of recommendations for the structuring of didactic materials and of a way to assign unambiguous didactic interpretation to sections of materials by means of UCTS. SCORM and dedicated software Content Repository are among tools used for this. SCORM is a popular specification which defines principles used to represent digitalized didactic content, which allows to create reusable materials. UCTS is a taxonomic system designed to situate contents in the didactic process. Using this system to mark portions of materials ensures that users will access materials that are cohesive and relevant without the risk of downloading incomplete contents. Content Repository is a dedicated software designed to create, store and process didactic content with the ability to reuse it. A repository of teaching materials on protection and management of archaeological heritage has been created based on the method and tools discussed (E-archaeology content repository). The repository contains approximately four thousand and five hundred Learning Objects in five languages and about eight hundred units of didactically useful knowledge, which have been described in the language UCTS.

1 INTRODUCTION

A repository of didactic materials is an IT solution used to digitally store, process and retrieve didactic contents. Repositories can be made in different ways, subject to form of materials, availability of technical infrastructure, or user habits and IT skills. A solution enabling digital storage of files can be considered a repository of didactic materials. Also, a dedicated IT system which requires materials structured according to a defined specification and recorded in a selected technical standard can be considered a repository. The type of technical solution used is correlated to didactic materials and their role in the process of distance learning.

Digitalized didactic content can be incorporated in the distance teaching process in various ways depending on the methodology used. It can be used as support and supplement to the didactic process or it can serve as core source of information which replaces the teacher. Notwithstanding its role, it is essential that the teacher should be able to adapt materials to the specificity and needs of target groups. Those adapted materials can differ to a lesser or higher extent from the canonical form of

the training programme. The materials modified may contain additional elements to expand certain themes, or parts of materials may be removed. For the canonical contents to be modified the teacher should have at his disposal a suitably flexible content repository. Usually, due to limited IT competences of teachers it is recommended that adaptation of contents should be done without advanced technological skills.

In order to construct flexible content repositories, it is essential for teaching materials to be constructed in such a way that they can be easily modified and repeatedly used. First of all they should have a form allowing for construction of larger structures with smaller units; also they should be saved in such a technical specification which will enable flexible processing. SCORM as well as division into Learning Objects meets this requirement. Another thing which is necessary is the mechanism of granting didactic interpretation to those sections of materials which are cohesive and useful didactically. Such sections are designed to be used in many various educational contexts, different from that in which they were initially placed. In the method presented here didactic interpretation is given by

means of UCTS nomenclature (Universal Curricular Taxonomy System).

2 FORM OF DIDACTIC MATERIALS

In order to be repeatedly used, didactic materials must have adequate form. A good solution is a form of so called e-learning courses. Known as 'e-books' or 'content', they have a method of recording contents that is suited to specific features of online teaching. An e-learning course has the following characteristics:

- It contains multimedia and interactive elements which improve the attractiveness of the contents and teaching efficiency;
- It has a hierarchical structure which follows the principle of dividing contents into independent units of knowledge, so called Learning Objects;
- It is suited to be placed in any system of distance learning by the fact that it has been recorded in a standard of didactic content such as SCORM.

Multimedia and interactive elements increase the efficiency of online learning. They should always complement and expand relevant contents and not be used as mere attraction (Horton, 2006). Division of the contents into Learning Objects is an approach that relates directly to the specificity of online teaching. Students are hardly able to master the entire content of a single session of an e-learning course. Thus, if Learning Objects are divided into sections that can be mastered within three to ten minutes than the entire work becomes more effective. Complexity and large amounts of contents may cause Learning Objects to be placed in larger structures, which present selected issues and subjects. Learning Objects will be placed hierarchically in aggregating structures on several levels, depending on how detailed the content is.

The underlying feature of SCORM specification is the fact that contents can be organized in such a way that will allow for its repeated use. SCORM philosophy is based on the fact that contents are divided into numerous components and as such they are transferred into technical form such as courses, SCOs or sets of SCOs. Other technical specifications (i.e. AICC, Tin Can) may also be used. They must only allow the division of content into smaller units.

3 DETERMINING DIDACTIC USEFULNESS OF CONTENT COMPONENT

Structuring materials as Learning Objects and saving them in a flexible standard such as SCORM is a good starting point to create reusable repositories. However, such an approach does not answer the following questions:

- Which sections of materials stored in a repository are of standard didactic value?
- Which components may function on their own, i.e. are relevantly cohesive and didactically useful?
- Is it possible to incorporate fragments of contents into new structures in such a way that they are relevantly cohesive and didactically useful?

These questions in practice boil down to one: Is it possible to download any component from a repository of didactic materials, for example one SCO or several SCOs, and use it in a didactic process?

For the components downloaded to be cohesive, didactically useful and devoid of purely technical character it is necessary to develop a method that will allow for interpretation of the components in the context of their didactic character. Thus, if the contents are saved in SCORM, it is not sufficient to relate to their structure because individual elements of this structure (SCO, set of SCOs, course) do not carry any information about the role of the materials in didactic process. SCORM shifts to the author the responsibility to indicate which elements of the structure are didactically useful and which have been introduced only for purely technical or organizational reasons, for example the component has been broken down into smaller units due to its volume, and in consequence individual components should not function independently.

However, to conceptualize contents so that their components may be reused many times may be a daunting task for the author. This stems from the fact that in the process of creating contents in a conventional way (e. g. while writing a book) it is not customary to consider multiple uses of its parts (chapters). It is taken for granted that the contents will be delivered to student in its totality. Therefore, in structuring contents meant for SCORM, where from a technical standpoint all methods of content structuring are possible and feasible (especially when it is regarded as a strictly technical job!) it is essential to develop and apply a more systematic approach which will enable an unambiguous

determination of contents usefulness.

SCORM is neutral about the complexity of content. It does not include any curricular taxonomy model that can be used to describe the role of content in the teaching process (Dodds, 2006). Within the method presented as suitable for interpretation of didactic contents a solution is suggested that does not refer to any particular educational context – it is UCTS.

UCTS (Universal Curricular Taxonomy System) is a taxonomic model, designed to interpret didactic content (Marciniak, 2012). This model provides a description language to structure didactic materials on several levels. The model can be used to describe materials in SCORM. It can also be used to structure materials in any other form or technical specification.

UCTS provides the following components that can be used to describe didactic content:

- Curriculum,
- Learning module (or: Module)
- Learning Unit (or: Unit)

The term Curriculum is used to define contents that can be deemed as a teaching program i.e. that contains a set of materials which present a given topic in an exhaustive way, and which fulfill certain didactic goals. A Curriculum is made up of any number of Module-type components. These components are arranged in a sequence in which they should be realized by student. A Curriculum can be supplemented by an element of Exam type, which will function as a final test for the entire teaching program.

A Module can be made up of several components of Unit type, or other modules. The entire set mutually complementing each other is meant to cover a given topic in an exhaustive fashion. This component should be supplemented with an exam type element which will verify how well student has mastered the module.

A Unit is the smallest section of materials, which introduces cohesive content and which contains elements to enable students to self verify their progress. A Unit is the smallest section of contents that cannot be divided any further. This reflects the idea that for any didactic material (book, script, PowerPoint presentation) there is a certain threshold below which further sectioning of materials is not possible, although divided contents may still be relevantly valuable. It is assumed that a Unit may be made up of the following smaller elements:

- Learning Object – a section of materials which introduces new contents organized as ‘knowledge capsules’. The contents may be

delivered as text, text with graphics (drawings, photographs, etc) or as multimedia and interactive content (non-linear graphs, dynamic diagrams and graphs, etc); this element may contain self verification and verification features.

- Exercise – a component designed only for self verification. This type of elements should be built in an interactive way i.e. it should contain elements of interactive testing (one-choice and multiple choice questions, drag and drop, puzzle, etc).
- Self assessment – a special type of exercise which enables students to verify their progress in a given section of contents. Questions in this component should have a cross-sectional character.
- Exam – a component to verify students’ progress. Questions in this component may be drawn at random from pools of questions, or given in a fixed set. The results should be sent to LMS/LCMS system and made available to teacher.
- References – a list of books or papers to expand on issues discussed,

4 CONTENT REPOSITORY TOOL

A Content Repository is a tool that allows for digital storage of didactic materials and for creation of new materials based on existing components (www.contentrepository.org). The tool was developed to solve the problem of electronic storage of large amounts of resources. A content repository is a piece of software working in WWW environment. It is designed to create content repositories in SCORM standard (version 1.2 and 2004). It can be used to create monographic or multi-topic repositories.

A basic function of Content Repository is to create new structures of knowledge based on existing components. The system enables this in an approach that is analogous to editing, in which editor selects interesting and relevant contents. In Content Repository this activity consists of finding materials in the system and incorporating them into existing structures. This tool allows for processing only those components that have been earmarked by the author as didactically useful. This is done in the tool by ascribing a didactic interpretation to the component and by creating an artifact called Processable Unit (PU).

Processable Unit (PU) is a structure of data isolated from Content Repository, and which serves

as a base on which processing of knowledge deemed by authors as didactically useful takes place. Processable Units are created by ascribing didactic interpretation to any SCORM component (Fig. 1). PU's created in this way are defined in the system as Basic PU's. UCTS-derived nomenclature or nomenclature derived from any other taxonomic model may be used for didactic interpretation. Content Repository is adapted to simultaneously serve numerous taxonomic models. If UCTS nomenclature is used, entitled users may ascribe one of the following values to a SCORM component (SCO, set of SCOs, course): Unit, Module, Curriculum. The system enables also creation of blank PU's, so-called System PU's. Their role is to aggregate other PU's stored in the system. It is possible to embed any base PU's or other system PU's in system PU's. What is important is that when a content is defined as PU, it determines whether it can be downloaded from the system. Only those content structures can be downloaded from Content Repository that have been defined as PU's in the system.



Figure 1: Ascribing didactic interpretation.

Processable Units are artifacts isolated from Content Repository which determine the level of content granularity in a repository. The system permits operations on contents only by referring to PU's. The tool does not permit to create new content components, i.e. it is not possible to create new SCO's nor is it possible to defragment PU's (that is to divide into smaller units). This also means that while downloading contents from repository it is not possible to download single SCO's isolated from the PU in which they have been embedded. So, only those content structures earmarked by the author as didactically cohesive and useful can be downloaded from Content Repository.

5 E-ARCHAEOLOGY CONTENT REPOSITORY

E-archaeology content repository is a repository of digitalized didactic contents in the area of protection and management of archaeological heritage. The repository was built using a Content Repository system. UCTS was used for didactic interpretation. The repository is available at: www.e-archaeology.org/contentrepository. The resources collected there are made up of multimedia and interactive e-learning courses.

All the contents in the repository have been developed by specialists in the area of protection and management of archaeological heritage within the framework of two European Leonardo da Vinci projects. The first project, resulted in developing contents for a learning program "Protection and management of archaeological heritage in contemporary Europe", and in building a set of e-learning courses based on this content. In the course of the second project the contents was expanded and supplemented.

Digitalized materials stored in E-archaeology content repository were built in a way suited for online teaching (Marciniak, 2009). The course components contain interactive and multimedia elements (Figure 2). Those elements introduce contents in a non-linear fashion and test students' progress in self-tests. The structure of those materials allows their reusability. The authors divided the contents into small cohesive units of knowledge which describe topics in an exhaustive way (Kok, 2009), then these materials were digitalized in this form. While implementing the contents in SCORM (version 1.2) it was decided that individual cohesive sections of materials were saved as SCO's. SCO's making up individual courses are organized hierarchically, using the Activity SCORM component. These structures were selected in the course of creating the contents, thus reflecting conceptualization of the subject in accordance to author's plan.

The repository contains didactic contents in five languages (English, German, Latvian, Polish and Spanish). There are about 4500 SCO's, in particular (approximate values for English version):

- Fifteen training programs (curricula)
- Sixty components of Module type
- One hundred seventy-five components of Unit type
- Seven hundred SCO's.

Authors of new learning programs and teachers using the repository content can take advantage of a

range of solutions supporting search process, such as LOM metadata and tags from wordnet-based ontology in the area of protection and management of archaeological heritage used to describe the contents.

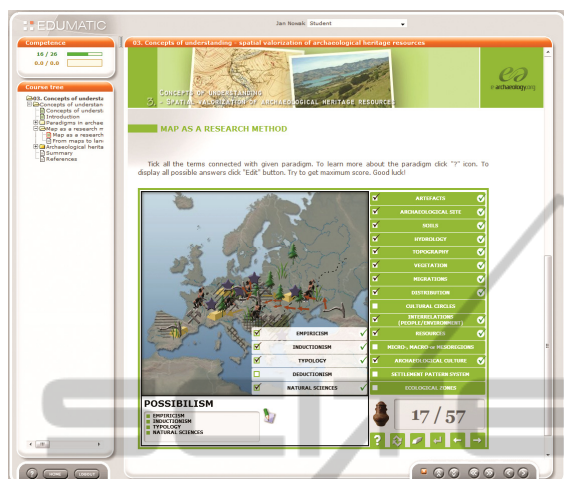


Figure 2: Element of an e-learning course.

The contents in E-archaeology Contents Repository can be used to conduct a didactic process in the area of protection and management of archaeological heritage. After downloading from the repository, they can be incorporated into teaching in the following ways:

- Materials may constitute basic training programs in assisted web-base training;
- They can supplement synchronized training sessions (for example videoconferences), or conventional courses.

In order to verify the method and usefulness of Content Repository tool, in the Leonardo da Vinci project nine pilot training courses were conducted in the area of protection and management of archaeological heritage. Contents for these trainings were created with E-archaeology repository resources. The teachers running the courses created their own training programs suited to the needs of target groups. From a technical standpoint training programs are system PU's defined in Content Repository as UCTS Curricula. The teachers reused content from the repository annotated as UCTS Modules and Units while creating Curricula.

6 CONCLUSIONS

To enable creation of repositories of reusable teaching materials it is essential for the materials to have a certain form, to be didactically interpreted

and to be described in such a way as to simplify search. A good solution is to save contents as SCORM and structure them as Learning Objects. It is necessary to ascribe didactic interpretation so that the repository could refer to didactic and not technical conceptualization. Use of SCORM enables division of contents in many different ways; however, not every type of division will ensure comprehensive delivery of a subject to students, nor will it ensure distance learning methodology. UCTS - compatible content conceptualization leaves room for additional didactic requirements. LOM metadata are of particular use in building SCORM contents because they allow comprehensive description of contents, and then effective repository search.

Content Repository enables creation of massive repositories of teaching materials. The system is run by SCORM and its all metadata. It permits loading e-learning courses and other types of knowledge structures, dividing them to suit the teaching needs, and building new teaching programs or other types of knowledge structures using components available. It is possible to download these components as SCORM packages. Thanks to these functionalities courses loaded into the system are not identical with what can be downloaded from it.

ACKNOWLEDGEMENTS

This research was partially supported by the Leonardo da Vinci project number 2010-1-PL1-LEO05-11465

REFERENCES

- Dodds, P., 2006. SCORM 2004, 3rd Edition, Overview, Advanced Distributed Learning.
- Horton W., 2006. *E-learning by design*, Pfeiffer.
- Kok M.S.M., 2009. Teaching by distance learning or face to face: the differences between direct and distance teaching, *van Londen H., Kok M. S.M., Marciniak A. (eds.) E-learning Archaeology, Theory and Practice*, University of Amsterdam, pp. 143-150.
- Marciniak J., 2009. Methodology and e-learning solutions in "Archaeological heritage in contemporary Europe" distance learning course, *van Londen H., Kok M. S.M., Marciniak A. (eds.) E-learning Archaeology, Theory and Practice*, University of Amsterdam, pp. 56-89.
- Marciniak J., 2012. Metody organizacji materiałów dydaktycznych w postaci elektronicznej zapisywanych w standardzie SCORM. *EduAkcja. Magazyn edukacji elektronicznej*, nr 1(3)/2012, pp. 79-92.