Using metadata in creating offline views of e-learning content

Susanne Loidl-Reisinger[1], *Michael Sonntag*[2]

Institute for Information Processing and Microprocessor Technology (FIM)

Key words: *E-Learning, Metadata, Offline view, Learning Management System, Content management*

Abstract:

When creating learning content for online or offline viewing, metadata is an important part, so the Learning Management System can decide what to show whom in which form, or perform other functions (e. g. examinations, enrolment). For reusing content it must be possible to create offline versions (e. g. on CDs) from the same data to avoid inconsistencies and additional work. The problem is how to integrate the functions of metadata there without requiring another program to be installed locally. Beside general thoughts on the usefulness and problems of metadata in E-Learning we present a converter for creating offline views of CPS packages to be shown within web browsers. It employs metadata to show additional information, facilitate reuse of content by creating subsets and present additional derived navigational helps.

1 Introduction

Up to now learning environments and especially learning materials were mostly developed every time anew. Thereby many excellent learning materials are underused or were developed not only once, but several times. The reasons for these redevelopments are manifold, e.g. proprietary formats, lack of interoperability or simply because nobody knew that they already exist. This causes much stranded investment.

But the situation changes, people start thinking about integrating standards into their products and customers are already demanding better interoperability and reusability.

In this paper we discuss the advantages of using metadata in e-learning course material. First we present an overview about the "-abilities" (like interoperability or adaptability) of standards in general and some of today's metadata specifications and standards. To conclude this survey, we also discuss their usefulness and problems, which we face today.

In chapter 3 we introduce our Distance Education Framework – WeLearn - and talk about the specifications and standards used within. In chapter 4 we concentrate on one component of the WeLearn-Framework, the WeLearn Offline Converter and give three specific examples where and how to use metadata in creating offline views for e-learning content.

We conclude the paper by outlining ideas for our future work.

2 Metadata

Standards such as in the area of railroad tracks, light bulbs or the internet are used in everyday life and we take them for granted. The use of standards in e-Learning ensures developers and customers many “-abilities”. These are ([7], [13], [18]):

- Interoperability: Seamless exchange of data, using components developed in one location with one set of tools or platform in another location or with a different set of tools or platform
- Reusability: To reuse courseware (learning material) in other contexts and other environments and for other target groups
- Adaptability: Possibility to offer personalized learning
- Manageability: Tracking information about the learner's actions and the content.
- Accessibility: That a learner can access the appropriate content anytime and from everywhere.
- Durability: Durability in the sense that the technology evolves with the standards to avoid obsolescence (when technology changes, without redesign or recoding; evolveability, extensibility).
- Affordability: Increase learning effectiveness significantly while reducing time and costs for learning as well as for creating products (content, platforms, etc).

Having these “abilities” in mind, the use of metadata helps to provide learning material, fulfilling at least reusability and adaptability. In chapter 4 we will present several examples to prove this.

But before, we point out some important aspects concerning today’s metadata specifications and standards in the area of e-learning.

2.1 Metadata specifications and standards

Today many different organizations, consortiums, etc. like the Dublin Core Metadata Initiative (DCMI) [6], the Institute of Electronical and Electronic Engineering (IEEE) [11], the IMS Global Learning Consortium (IMS) [10], the Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE) [2], the Aviation Industry CBT Committee (AICC) [3], the Advanced Distributed Learning Initiative (ADL) [1], are working in various areas of e-Learning standards. Here we focus on the metadata specifications and standards these organizations provide and give a brief overview:

Dublin Core Metadata Initiative (DCMI): Today’s metadata standards and specifications e.g. IEEE´s Learning Object Metadata (LOM), IMS Learning Resource Metadata, etc. are based on the Dublin Core (DC) specification for metadata. The use of DC can be advantageous for archives or libraries. Unfortunately it is not convenient for practical use within e-learning environments, especially when talking about course assembling or the search for suiting courses, because it consist of only 15 elements, which are all optional (none are mandatory).

Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE): The ARIADNE-Project was established by the European Union and the Swiss Federal Office for Education and Science. Among other things (like an international system of knowledge pools - KPS), ARIADNE has developed a guideline for metadata. Later, this guideline was harmonized with the IMS metadata specification and submitted jointly to IEEE, where it became the basis for IEEE´s 1484.12.1 - 2002 Learning Object Metadata (LOM [8]).

IMS Global Learning Consortium (IMS): IMS was funded in 1997 by the members of EDUCOM (now EDUCAUSE National Learning Infrastructure Initiative). Especially in the area of metadata IMS cooperated with ARIADNE. Some time ago IMS, ARIADNE and IEEE worked together in the development of the metadata standard LOM. For further IMS specifications LOM (Version 6.1) is used as a basis, but within the new IMS metadata specification, some elements are added, some are redefined, etc. This means that currently their metadata specifications are departing from each other.

Institute of Electronical and Electronic Engineering (IEEE): The IEEE Computer Society Standards Activity Board chartered the Learning Technology Standards Committee (LTSC) in 1998 in order to develop accredited technical standards, recommended practices and guides for learning technology. One working group has already developed a metadata standard - 1484.12.1 - 2002 Learning Object Metadata (LOM). As mentioned before, LOM was developed in cooperation with ARIADNE and IMS, and it is built on the metadata specification Dublin Core. Consequently, LOM maps the DC and IMS elements, but also several other elements are added. Its main aim is to provide a classification that allows an easy way of searching, retrieving, using and evaluating learning objects. For each learning object a metadata file is added, which classifies the learning objects in LOM. Unfortunately, LOM does not specify a certain data format, protocol or a guideline for implementation. Therefore it can be interpreted and implemented in many different ways, which is counterproductive to the aim of interoperability.

Advanced Distributed Learning Initiative (ADL): Within ADL organizations like IMS, a consortium of several US government organizations, 1600 universities and more than 150 companies (Microsoft, Apple, General Motors, etc.) are working together since 1997. ADL´s main aims are to build a network for web-based e-learning and the development of reusable learning objects, to allow a faster development of dynamic and cheap software, to establish a broader market for e-learning and to give access to high-quality e-learning contents, which can be personalized. To be able to achieve these goals, ADL developed SCORM (Sharable Content Object Reference Model [16]) that separates learning contents and learning applications and specifies how they should work together. A major aim of SCORM is not to create more small standards, but to think and develop globally to establish a common base for the developments in the e-learning market. Consequently, SCORM combines various standards such as the IMS Learning Resource Meta-data Specification Version 1.2., itself based on the IEEE LTSC Learning Objects Metadata (LOM) Standard. Together (with some other specifications), these specifications form the SCORM Content Aggregation Model.

2.2 Usefulness and problems of today’s metadata specifications and standards in E-Learning

Undoubtedly, the use of standards and especially the integration of metadata make sense. E.g. the development of appropriate e-learning material is very cost-intensive and time-consuming. When including metadata in courses and in the individual resources, one advantage is flexibility gained. Multiple courses can be assembled just by tracing the integrated metadata. E.g. general parts of a course in handheld programming could be reused in special courses like PocketPC, Palm or Psion programming.

In addition the same material can be re-purposed as well, because parsing the metadata allows adapting the material to various target groups (e.g. a beginners course in computer science, in schools, etc.) and courses can be personalized to individual preferences. Once the resources are tagged (metadata is included) one can differentiate between material with the same content, but provided in different formats (text files, audio, video, etc.).

So why should one add and use metadata, which is obviously additional effort and costly? Answers for this question could be:

- Developers and customers gain flexibility.
- Learning material can be assembled individually, which means that personalization, but also mass-customization is possible without immense additional expenditure.
- Reusability is ensured, as course material can be reassembled, adopted, re-purposed, etc.
- Last, but not least, the advantages mentioned above also result in a better return on investment.

This sounds very good and promising, but unfortunately there is another side of the coin [12]. As already mentioned in chapter 2.1 today more than one specification/standard for metadata in e-Learning exists. Fact is that there is no international agreed metadata specification/standard. Various groups are working in this area and it will take time to finally agree on one standard or one to emerge as the leading one through widespread use. Just to get an overview about the different specifications and standards is time-consuming and therefore it is a cost argument in developing software for Distance Education. Furthermore, appropriate tools and support are missing and therefore most of the specifications/standards are too complex for practical use. Content/Course developers focus on developing content, adding metadata takes too long and is too complicated at the moment and often the necessity of including metadata is not always obvious.

But, on the other hand, as developers and customers we cannot neglect metadata any longer. In consequence this means that we (as developers) have to support at least the global players (IEEE and IMS) and it is on us to develop tools for our customers, in order to simplify adding and using metadata.

3 The WeLearn Framework

FIM (Institute for Information Processing and Microprocessor Technology, University Linz) has been working for a long time in the area of Distance Education and within the last 3 years we developed the WeLearn (Web environment for Learning) Framework.

At the moment the WeLearn-Framework ([5, 14]) consists of 4 components:

- The WeLearn-System: An open Distance Teaching/Coaching/Learning platform
- Didactical templates for universities, schools and adult continuing education
- Course material, especially created for e-Learning
- The WeLearn Offline Converter: To allow an offline presentation of course material

WeLearn is in use at several universities (University of Linz, University of Zurich, etc.) various high schools in Austria and in the area of adult continuing education. The feedback we receive from the various users shows that we have reached our main goals, namely to provide an e-learning environment, which provides the possibility to create a specialized environment living up to the expectations and needs of the course providers and learners, which is additionally free and open (GNU-philosophy), easily and universally applicable, and provides possibilities for adapting and scaling.

One reason why this is possible is that we adhere to standards. For WeLearn we have chosen the supported specifications/standards very carefully and we are continuously monitoring the specifications/standards market.

Within the 4 WeLearn components at the moment we employ the following specifications/standards:

- The WeLearn-System (platform): The Content Packaging Specification of IMS (SCORM), the IMS Metadata specification, LOM by IEEE LTSC and the metadata specification for schools in Austria [4] published by the Federal Ministry for Education, Science and Culture (BMBWK) are integrated and supported.
- Didactical templates: At the moment no standards or specifications are included.
- Course material: The IMS Metadata specification, LOM by IEEE LTSC and the metadata specification for schools in Austria are included.
- The WeLearn Offline Converter: The Content Packaging Specification of IMS (SCORM), the IMS Metadata specification, LOM by IEEE LTSC and the metadata specification for schools in Austria published by the Federal Ministry for Education, Science and Culture (BMBWK) are integrated and supported.

For the next version of WeLearn others will be integrated and supported as well, because then intelligent agents, personalization and a workflow module will be integrated into the system.

3.1 Specifications/Standards within the WeLearn Framework

3.1.1 Content Packaging Specification (CPS)

Before we are continuing to talk about what kind of metadata we use and how we use it, we give a short description of the Content Packaging Specification [9] of IMS to show where the metadata can be included.

The IMS Content Packaging Specification consists of two major components: A so-called "Manifest File" and the resources (the physical files) as such. Figure 1 illustrates these components.

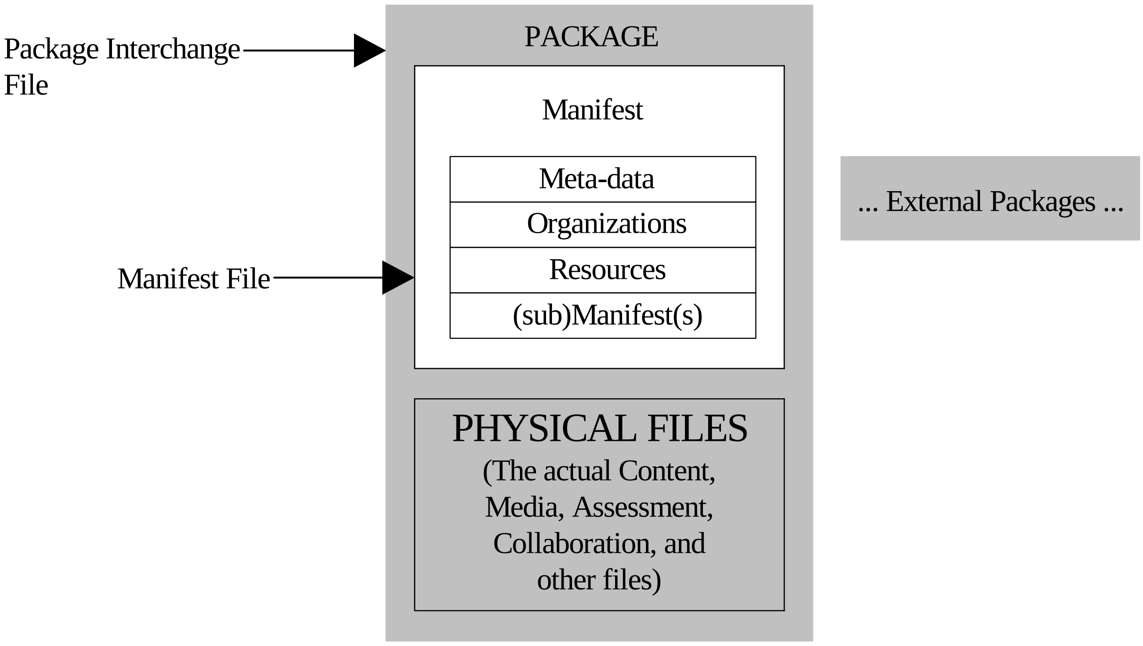

Figure 1: IMS Content Packaging scope

The Manifest File is an xml file (imsmanifest.xml), which includes at least one manifest. The so-called top-level manifest describes the package itself. Each manifest consists of a metadata section (information which describes the manifest as a whole), an organizations section (the structure of the course), a resource section (references to the actual files) and optional (sub)manifests. So the IMS Content Packaging Specification separates physical learning resources from their actual use or organization, allowing more than one use within different contexts or uses, e. g. in several courses.

Within a CPS manifest, metadata can be added to describe the course as such and in addition to that, metadata can also be part of the individual resources and items, which allows a much more detailed description.

3.1.2 Metadata specification of IMS and LOM

The latest metadata specification of IMS and the LOM standard of IEEE are similar, but not equal at the moment. Because of that we are supporting both within WeLearn. As mentioned earlier, LOM is based on the IMS specification and therefore both organizations use nearly the same base schema, which consists of nine data element categories [8]:

a) "The *General* category groups the general information that describes the learning object as a whole.

b) The *Lifecycle* category groups the features related to the history and current state of this learning object and those who have affected this learning object during its evolution.

c) The *Meta-Metadata* category groups information about the metadata instance itself (rather than the learning object that the metadata instance describes).

d) The *Technical* category groups the technical requirements and technical characteristics of the learning object.

e) The *Educational* category groups the educational and pedagogic characteristics of the learning object.

f) The *Rights* category groups the intellectual property rights and conditions of use for the learning object.

g) The *Relation* category groups features that define the relationship between the learning object and other related learning objects.

h) The *Annotation* category provides comments on the educational use of the learning object and provides information on when and by whom the comments were created.

i) The *Classification* category describes this learning object in relation to a particular classification system."

The elements are organized hierarchically and each element in the meta-data hierarchy has a specific definition, datatype, and specified range of values.

4 The WeLearn Offline Converter

WeLearn courses such as Propaedeutics in Computer Science, JAVA programming, etc. and their course material have been enhanced with metadata compliant to the specifications/standards and mentioned. The strict rule to create only standard compliant metadata allows us to use the courses and the individual course material not only within the (online) WeLearn Framework but also with other tools if desired or needed. One such tool is the Offline Converter used to create a completely offline view suitable for creating CDs to be distributed to students.

The converter is written in Java and is therefore platform-independent. It takes a manifest and a template and produces a complete set of webpages, including metadata, navigation, etc. For the user interface, see Figure 2.

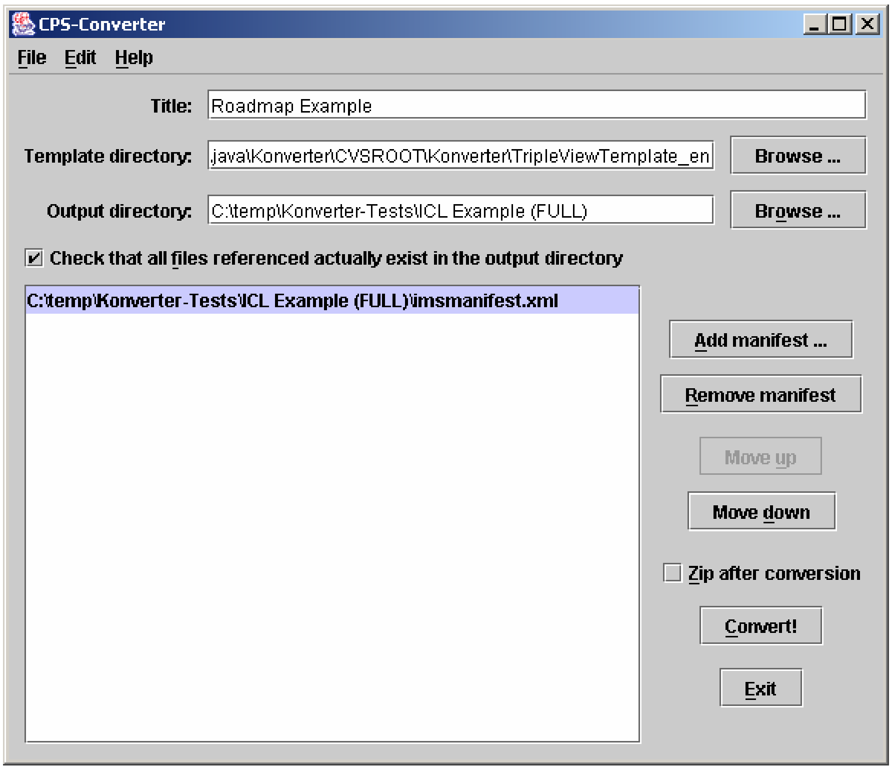

Figure 2: User interface of the WeLearn Converter

4.1 Metadata view

A concrete example of a course enhanced with metadata is Propaedeutics in Computer Science. See the following (very brief, the full metadata is rather long) snippet from its manifest. There we added metadata conformant to LOM, the metadata specification of IMS and the metadata specification for schools published by the Austrian Federal Ministry for Education, Science and Culture.

```
........
<metadata>
<schema>IMS Content</schema>
<schemaversion>1.1</schemaversion>
<imsmd:lom>
<imsmd:general>
 <imsmd:title>
  <imsmd:langstring xml:lang="en">Propaedeutics</imsmd:langstring>
 </imsmd:title>
 <imsmd:language>de</imsmd:language>
 <imsmd:language>en</imsmd:language>
 <imsmd:description>
  <imsmd:langstring xml:lang="en">Overview of information science, its
         methods, tools, applications in real life, and distinguished sci-
         entists. Recommendation of basic literature with excerpts of the
         table of contents and the preface. Additional material on learning
```

```
         theory and tips for increasing learning efficiency. Curriculum of
         computer science studies at the Johannes Kepler University in
         Linz.
  </imsmd:langstring>
 </imsmd:description>
 <imsmd:keyword>
   <imsmd:langstring xml:lang="en">propaedeutics</imsmd:langstring>
 </imsmd:keyword>
 <imsmd:keyword>
 <imsmd:langstring xml:lang="en">computer science</imsmd:langstring>
 </imsmd:keyword>
 <imsmd:keyword>
 <imsmd:keyword>
   <imsmd:langstring xml:lang="en">information theory</imsmd:langstring>
 </imsmd:keyword>
 imsmd:keyword>
   <imsmd:langstring xml:lang="en">problem modelling</imsmd:langstring>
 </imsmd:keyword>
 <imsmd:keyword>
   <imsmd:langstring xml:lang="en">data structures</imsmd:langstring>
 </imsmd:keyword>
 <imsmd:keyword>
   <imsmd:langstring xml:lang="en">algorithms</imsmd:langstring>
 </imsmd:keyword>
 <imsmd:keyword>
   <imsmd:langstring xml:lang="en">recursion</imsmd:langstring>
 </imsmd:keyword>

........

<!-- Meta-data defined by the BMBWK - Austrian Federal Ministry for
      Education, Science and Culture -->
<amd:curriculum>
 <amd:schoolgrade>11-13</amd:schoolgrade>
 <amd:curriculumcoverage>50, 50, 50</amd:curriculumcoverage>
</amd:curriculum>
<amd:certifications>
 <amd:certification>Part of the curriculum of computer science studies at
                        the Johannes Kepler University, Linz
 </amd:certification>
 <amd:certificationauthority>BMBWK</amd:certificationauthority>
 <amd:certificationdate>2002-06-12</amd:certificationdate>
 <amd:statusofcertification>approbiert</amd:statusofcertification>
</amd:certifications>
........
```

The WeLearn Offline Converter employs this metadata to show additional information like a description of the course, its author, usage information, etc. (see Figure 3, lower right). In contrast to this full listing of all metadata, individual parts can be selected using a subset of XPath expressions [17]. On the same figure this is shown in the upper left, where only the description and the keywords are shown. Through this, additional templates with a freely defined subset of metadata can be created according to individual needs of the creator of a course.

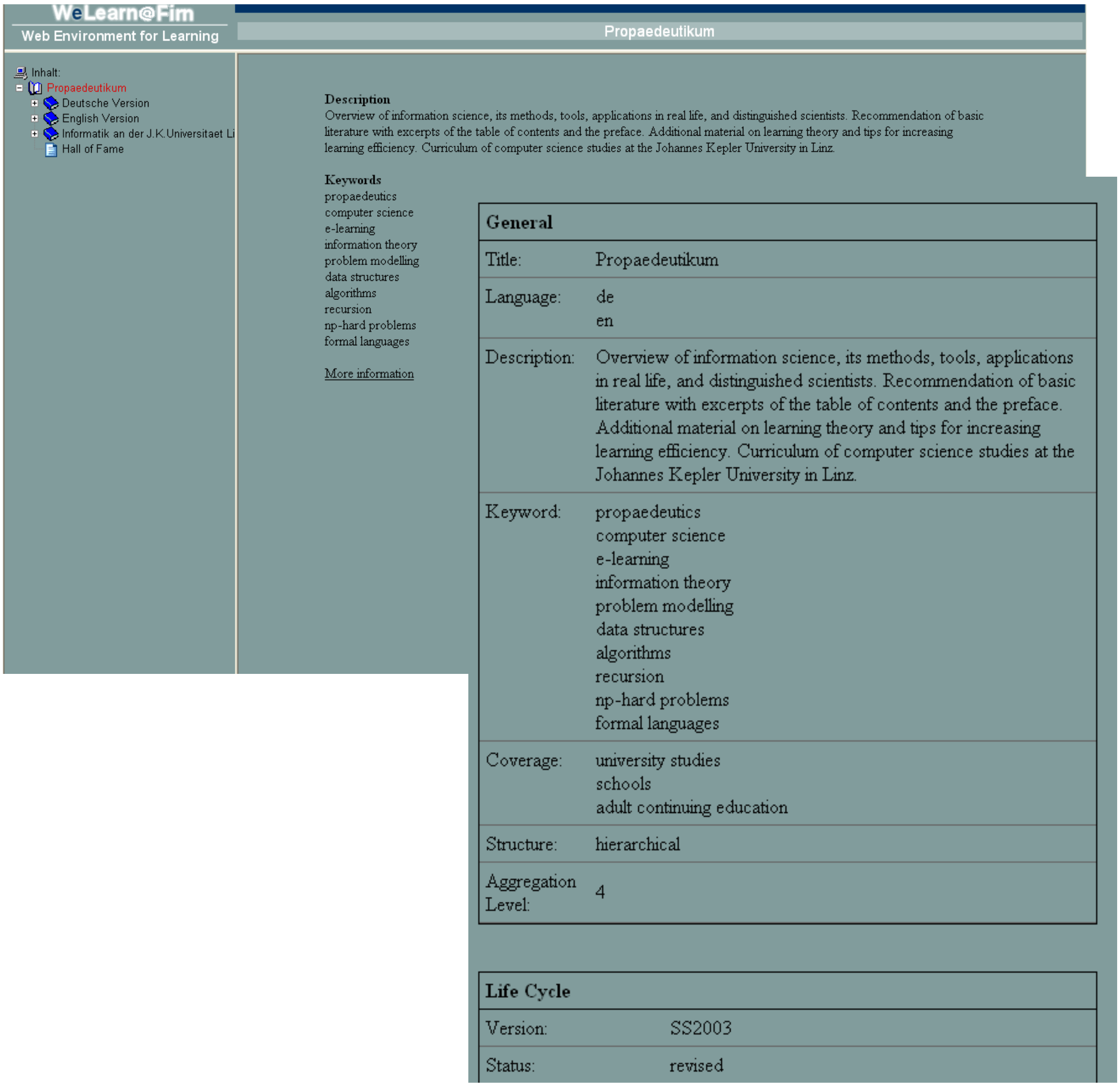

Figure 3: Metadata information as shown by the WeLearn Offline Converter

4.2 Roadmaps

By a “roadmap” we understand a high-level graphical representation of the general structure of the course content [15]. The concept of “roadmaps”, e.g. a railway or bus network, which is familiar to many people, is being used already in many courseware products as an alternative to the traditional standard decimal (or hierarchical) classification which we know from books and as it is implied by standard IMS manifests. A roadmap shows not every single item, but rather several individual parts are coalesced into one node, reducing complexity. Also, they represent the logical instead of the physical structure of the content. As an example, on traffic network maps towns might be a single dot, but there are several lines/stations/etc. hidden within. If all were shown, the map would be completely unusable because of too many details. How a roadmap looks like, as we use it, is shown in Figure 4.

Compared to a textual hierarchy, a graphical view can show much more information:

- The distance between nodes can be a measure of their relation: Similar topics can be drawn close together, regardless of their physical distance.
- The size of the node can be a sign of its importance (or duration, ….): All this information can hardly be included in a textual or hierarchical representation or is at least

extremely hard to compare and survey. Also the size of the labels could be used to signify another metric.

- Three-dimensional views are possible. Although they are much more complicated and navigation is not that easy, for large and highly structured content they can be a viable alternative. This is, however, left out here as it is a separate area of research.
- Coloring the edges can show typical "tracks", e. g. for beginners and advanced students or for specialists in different areas. Also nodes can be colored for signifying yet other data. It must be noted, that there could also be too much information, so not all possibilities should be used simultaneously. The user should have the possibility to choose from different presentations.
- Roadmaps also increase awareness: One look and location, progress, options for further navigation, etc. are clear.

4.2.1 Technical implementation

Roadmaps are currently implemented in the WeLearn Offline Converter and will be introduced to the next online version of the WeLearn system as well. Roadmap nodes are identified through the LOM metadata element "aggregation level", describing the logical size of an element. It ranges from 1 (individual parts) over 2 (collection of atoms, e. g. individual documents) and 3 (several level 2 items, e. g. a complete course) to 4 (e. g. a set of courses). Currently, all elements of level 2 are converted into a single node within the roadmap (although this can be changed easily). Additionally, all submanifests are also created as a separate node.

This information derived from the metadata of a manifest is used to derive a clickable image map for the offline HTML view. Two automatic layout algorithms are included. As they might not always produce the desired output (e. g. moving nodes together according to their content to signify their relation is not supported), the graph is also saved as an XML file.

4.2.2 Roadmap example

In Figure 4 you see a sample course on Java programming with its fully automatically created roadmap. Clicking on a node directly leads to the corresponding page. As can also be seen, compared to the hierarchical representation on the left, this is a much more obvious view of the different paths.

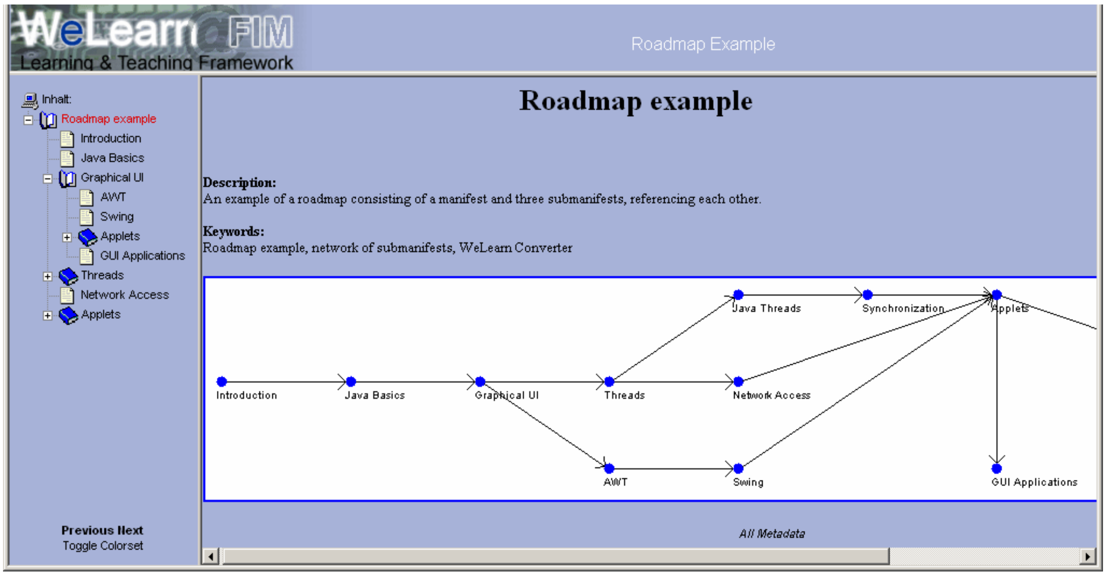

Figure 4: Roadmap example

4.3 Taxonomy filtering

Another kind of metadata, the taxonomy, is also especially supported by the converter. It is used for deriving different courses from the same manifest. This acts like a filter, showing only those items in the output (and the roadmap) which match certain criteria. Through this it is possible to create a single large course and derive several specific individual courses from it. The user interface for this is shown in Figure 5, where a certain course is derived from the total manifest. As the taxonomy can be defined freely, filtering can also be done according to complexity or topics (as long as the manifest contains appropriate metadata).

This functionality can also be seen as a precursor to personalized individual courses, where the result and the process is the same, only the decision function whether to include a part or not is not based on metadata alone but rather the combination of metadata and personal preferences and interests.

In Figure 6, exactly the same course as in the previous chapter is shown, this time however filtered according to the taxonomy for a single course. As can be seen, the roadmap is automatically adapted to leave out those parts no longer contained.

This ability to filter content has one main consequence, reusability. This is the result of being able to take smaller subparts with their associated metadata (e. g. submanifests) and easily integrate them into a larger unit. From this complete view, separate individual parts can be derived easily. If changes must be made, they all happen in a single location and getting different results (various courses derived from one manifest) simply requires a new conversion.

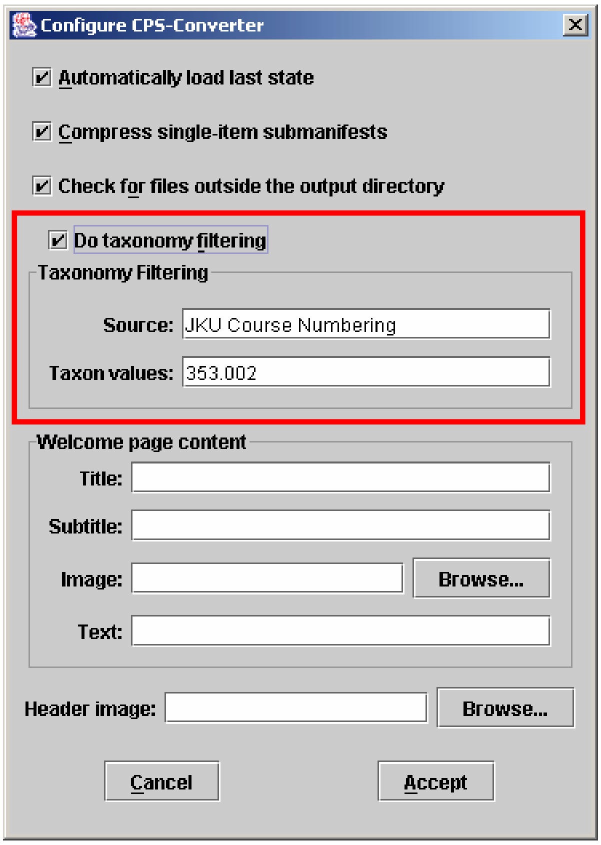

Figure 5: Advanced configuration highlighting taxonomy filtering

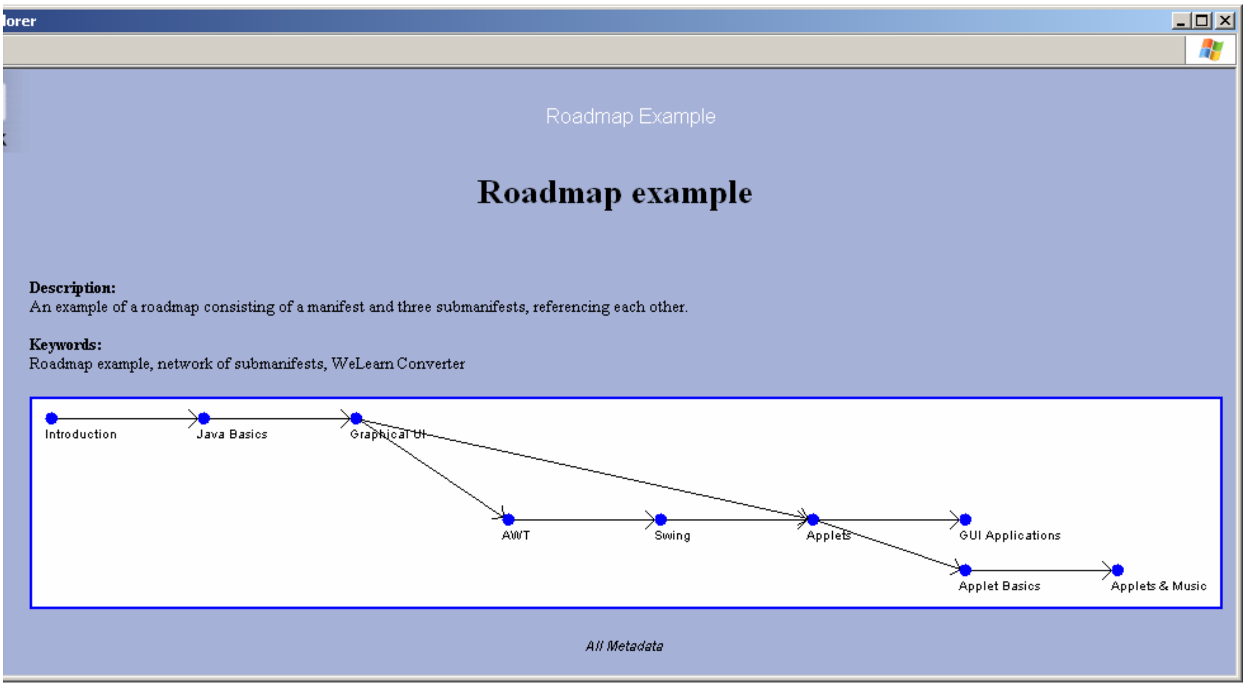

Figure 6: Filtered output (same manifest as Figure 4) according to taxonomy

5 Future Work

Being honest, adding metadata is not a trivial task. On the one hand information about the content is required, about prerequisites, didactical models, etc. And on the other hand, creating metadata takes time and must be done by hand at the moment.

Currently appropriate tools for adding, editing and updating metadata are missing. An author has to know how to write the course metadata compliant to the standards. Therefore he/she has to know how the elements are called and in which structure they must be written. Also their meaning must be known and ranges of values must be adhered to.

To relieve authors from this burden and to ensure that they get the possibility to concentrate on their major task – the creation of metadata – we are going to implement a WeLearn metadata editor.

This editor will (above others) provide the functionality to add metadata to courses and course material. We are planning to implement this modularly. This means, that the authors will be able to choose one or more metadata modules, where each module represents a specific metadata specification/standard. Once a module is chosen, the manifest will be parsed and metadata will be generated automatically. This information can be edited, changed and completed afterwards. When the author releases the metadata information, it will be stored again within the manifest.

6 Conclusions

In this paper we presented a brief overview of today's metadata specifications and standards and discussed possible advantages and disadvantages.

Furthermore we discussed the need of using metadata in general: increase of reusability, gain of flexibility, possibility to assemble course material individually, allow adaptation and personalization, etc.

In addition we gave three specific examples where metadata is added to courses and their use leads to better results, such as the possibility not only to show the metadata, but to use it for searching, for navigating and for assembling special (personalized) courses.

We are confident, that the use of metadata can improve e-Learning, environments and courses, leading to a more widespread acceptance and allowing a more efficient and easier usage (adaptation, personalization, etc.) of e-learning material.

Acknowledgement

This paper is a result of the project "Integrating Agents into Teleteaching-Webportals" sponsored by the FWF of Austria (Fund for the support of scientific research; Project number P15947-N04).

References

[1] Advanced Distributed Learning Initiative (ADL), http://www.adlnet.org

[2] Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE), http://www-ariadne-eu.org

[3] Aviation Industry CBT Committee (AICC), http://www.aicc.org

[4] Bundesministerium für Bildung, Wissenschaft und Kultur (BMBWK): Metadatenspezifikation für elektronische Lehrmaterialien, Stand: 2002-12-03

[5] Divotkey Roman, Mühlbacher Jörg R., Loidl Susanne, Remplbauer Doris: The WeLearn Distance Teaching Framework. EDEN (European Distance Education Network), 2002 Eden Annual Conference, Open and Distance Learning in Europe and Beyond Rethinking International Co-operation, Conference Proceedings, 2002, 308-314

[6] Dublin Core Metadata Initiative, http://www.dublincore.org

[7] E-Learningsite: Standards – Why Important http://www.e-learningsite.com/standards/importan.htm (July 2003)

[8] IEEE P1484.12 Learning Object Metadata (LOM) Standard, http://ltsc.ieee.org/wg12/

[9] IMS Content Packaging Specification, Version 1.1.2 Final Specification, http://www.imsproject.org

[10] IMS Global Learning Consortium (IMS), http://www.imsproject.org

[11] Institute of Electronical and Electronic Engineering (IEEE) Learning Technology Standards Committee (LTSC), http://ltsc.ieee.org

[12] Loidl Susanne, Paramythis Alexandros: Distance Education – A Battlefield for Standards. In: András Szücs, Erwin Wagner, Costas Tsolakidis: The Quality Dialogue. Integrating Quality Cultures in Flexible, Distance and eLearning. Proceedings of the 2003 EDEN Annual Conference, Rhodes, 15-18.6.2003

[13] Mats Svensson: e-Learning standards and technical specifications. Available at: http://www.centre-inffo.fr/v2/pdf/adapt/adapt2001_chap4_angl.pdf (July 2003)

[14] Mühlbacher Jörg. R., Mühlbacher Stephan C., Loidl Susanne: Learning Arrangements and Settings for Distance Teaching/Coaching/Learning: Best practice report. In: Hofer Christian, Chroust Gerhard (Ed.): IDIMT-2002. 10th Interdisciplinary Information Management Talks. Linz: Universitätsverlag Rudolf Trauner 2002, 205-215

[15] Mühlbacher Jörg R., Sonntag Michael: Roadmaps - Navigational Aids and Tools for Reusing Content in Distance Education. In: András Szücs, Erwin Wagner, Costas Tsolakidis: The Quality Dialogue. Integrating Quality Cultures in Flexible, Distance and eLearning. Proceedings of the 2003 EDEN Annual Conference, Rhodes, 16-18.6.2003, 73-78

[16] SCORM (Sharable Content Reference Model), Version 1.2. Available at: http://www.adlnet.org

[17] Simpson, John: XPath and XPointer, O´Reilly, 2002

[18] The MASIE Center e-Learning Consortium: Making Sense of Learning Specifications & Standards: A Decision Maker's Guide to their Adoption. http://www.masie.com/standards/S3_Guide.pdf (July 2003)

Authors:

Susanne Loidl-Reisinger, Dipl.-Ing. Dr.
Institute for Information Processing and Microprocessor Technology (FIM)
Johannes Kepler University Linz
Altenbergerstr. 69, 4040 Linz, Austria
loidl@fim.uni-linz.ac.at

Michael Sonntag, Mag. Dipl.-Ing. Dr.
Institute for Information Processing and Microprocessor Technology (FIM)
Johannes Kepler University Linz
Altenbergerstr. 69, 4040 Linz, Austria
sonntag@fim.uni-linz.ac.at