Meta-Information for Multimedia eLearning

Ralf Steinmetz and Cornelia Seeberg

KOM, Darmstadt University of Technology, Merckstr. 25, 64283 Darmstadt, Germany
http://www.kom.e-technik.tu-darmstadt.de
{Ralf.Steinmetz, Cornelia.Seeberg}@kom.tu-darmstadt.de

Abstract. The generation of multimedia learning objects are expansive and time consuming. Only by reusing them in many contexts, the effort becomes worth while. Reusing requires a flexible layout. Therefore content and format should be separated. Means for searching relevant learning object are of highest importance. Metainformation has to be added to the learning object. Metadata and especially learning metadata are a powerful instrument. Complemented by an ontology and relations between the learning object, the learning material become findable. For supporting the authors, tools like a metadata editor are necessary.

1 Introduction

The advantages of multimedia learning are widely discussed:

- complex procedures and algorithm can be depicted nicely by animations,
- dangerous experiences can be shown in a video,
- huge or tiny objects of consideration can be "tamed" by simulations,
- expansive procedures can be exercised virtually before doing it in reality.
- the motivating aspect of good and colorful learning material improves the performance of the learners and so on.

The price of these features is a high effort to generate this kind of learning material. Not only expert knowledge, but also expertise to record videos or to handle applications for creating animations etc. is needed. Skills in graphical designing are as necessary as ability to deal with a image processing programs. Teamwork with multimedia experts has to be practiced. New pedagogical concepts have to be developed.
In this paper some technical approaches to solve the problem of high effort are presented.

2 Reusability

To compensate the above listed expenditures, the multimedia learning objects have to be used more than just once, either by the same author or by others. If the learning objects can be reused, the extended effort at the generation becomes reasonable. There are several features of reusability:

- **Learning Scenario:** A learning object is normally used to teach the information for the first time. But it can be reused – probably slightly modified - for the repetition before exams or for looking up like in an encyclopedia. It can also serve as a test item either for self-controlling or for an exam.

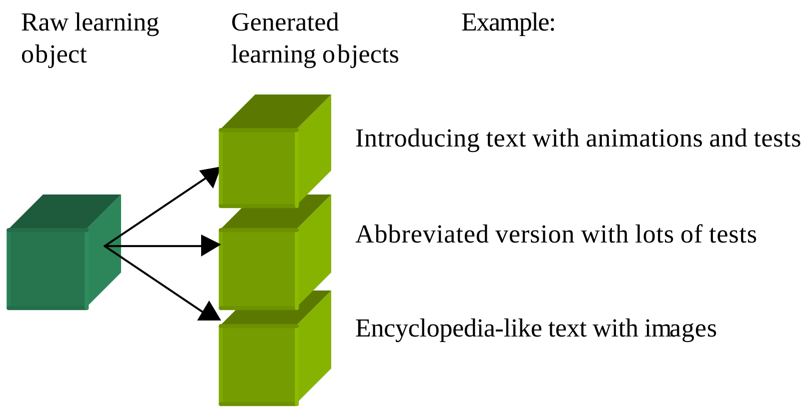

Fig. 1. Generating several learning objects out of a raw learning object

- **Output Medium:** A learning object can be viewed via a computer or – if it is not of a dynamic format – as a print out.
- **Context:** Learning objects can serve in different contexts. A learning object can be an example in one course and an introduction in another.
- **Technical Aspects:** The learning objects should be optimally used in all technical environments, no matter which operating system the learner prefers, which internet connections and screen size are available.
- **Personal Preferences:** Users have different personal preferences for using an electronic document. They differ in the font size, the number of windows in use etc. The learning objects should meet any of such preferences.

Reusability means that learning object can be easily found and used by other authors and learners in different pedagogical contexts. To facilitate these aspects of reusability, some requirements have to be fulfilled. Two of them are discussed in the following sections. The requirement of a formal description of the learning objects is in more details discussed in chapter 3.

2.1 Separation of Content and Format

The separation of content and format as it is possible by storing the learning objects as XML files and presenting them via XSL, allows for different characteristics of a raw learning object. Personal preferences, output medium and technical aspects can be adapted to users. Also different layout preferences of the authors can be considered. A raw learning module stored as XML can be presented as a PDF print out with print layout in a 12 pt Times Roman font or as a HTML page with web layout in a 14 pt Arial font. This flexible environment provides for different presentation forms of the learning objects.

2.2 Parametrizeable Modules

One possibility to generate different content from one raw multimedia learning object such as a simulation or a movie, is to parameterize the learning object. That means that a simulation has a set of starting parameters from which the suitable one for the specific learning context can be chosen (see [7]). Or the relevant section of a movie or an audio file can be selected.

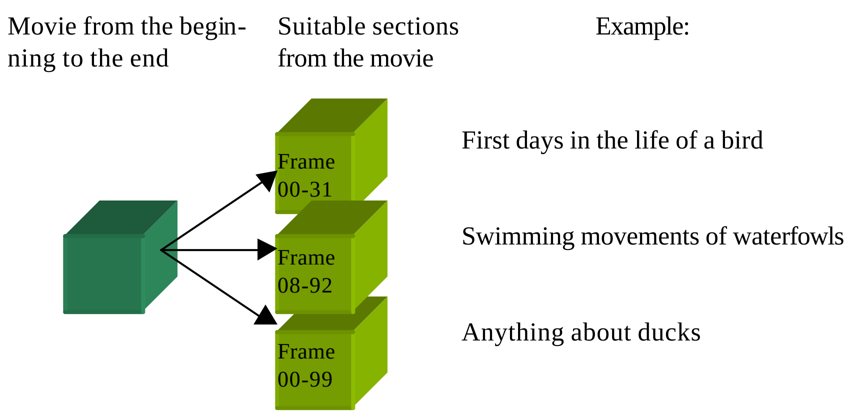

Fig. 2. Virtual learning objects by different starting parameters

So, from one raw learning object several virtual learning objects can be generated without much effort.

3 Metainformation

For an author to reuse his/her own learning objects or even learning objects of some other author, there has to be a powerful means for searching. Otherwise, the learning object cannot be found. Search engines usually offer thousands of hits to a user as a result of a query, if the keywords the user provided are very popular or generic. The problem is that it is not possible to describe the content of HTML pages, videos or animations in an adequate way. What is needed is information about information; also called metadata - labeling, cataloging and descriptive information structured in such a way that allows learning objects to be properly searched and processed [18]. With metadata users can describe much more accurately what kind of information they actually want to find.

3.1 Learning Object Metadata

One approach for metadata describing learning resources is the “Learning Object Metadata (LOM)” [5] scheme by the IEEE Working Group P1484.12. It is mainly influenced by the work of the IMS (Educom's Instructional Management Systems) [3] project and the ARIADNE Consortium (Alliance of Remote Instructional Authoring and Distribution Networks for Europe) [1]. The LOM scheme uses almost every category of the metadata scheme Dublin Core [2], which is used in the bibliographic world, and extends it with categories and attributes tailored to the need of learners and authors searching the web for material.
The LOM approach specifies the syntax and semantics of learning object’s metadata. In this standard, a learning object is defined as any entity, digital or non-digital, which can be used, reused or referenced during technology-supported learning. Examples of learning objects include multimedia content, instructional content, instructional software and software tools, referenced during technology supported learning. In a wider sense, learning objects could even include learning objectives, persons, organizations, or events. The IEEE LOM standard should be conform to, integrate with, or reference to existing open standards and existing work in related areas (see [17]).

Purpose
In the LOM specification [13], the following points are mentioned among others as the purpose of this standard:
“To enable learners or instructors to search, evaluate, acquire, and utilize learning objects.
To enable the sharing and exchange of learning objects across any technology supported leaming system.
To enable the development of learning objects in units that can be combined and decomposed in meaningful ways.
...”
The standard provides for extensions of the below listed categories. So, it is possible and LOM conform to add a category for parameters (see [7]). This way, to one physi-

cal raw learning object. may exist several metadata records with different starting parameters. And thus, another purpose of LOM can be to enable generating virtual learning object

Structure

The definition of LOM divides the descriptors of a learning object into nine categories:

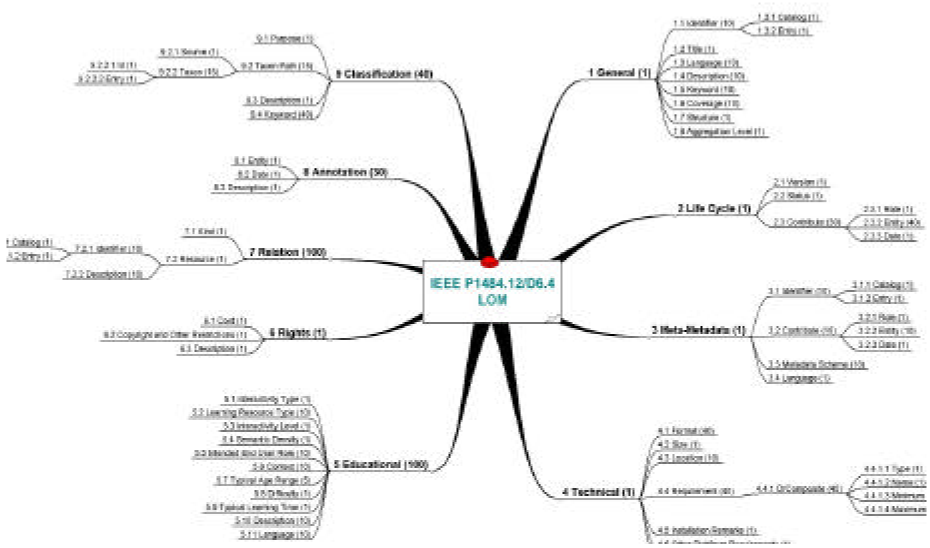

Fig. 3. The nine categories of LOM

Category 1: General, regroups all context-independent features of the resource.

Category 2: Lifecycle, regroups the features linked to the lifecycle of the resource.

Category 3: Meta-metadata, regroups the features of the description itself (rather than those of the resource being described).

Category 4: Technical, regroups the technical features of the resource.

Category 5: Educational, regroups the educational and pedagogic features of the resource.

Category 6: Rights, regroups the legal conditions of use of the resource.

Category 7: Relation, regroups features of the resource that link it to other resources.

Category 8: Annotation, allows for comments on the educational use of the resource.

Category 9: Classifications, allows for description of a characteristic of the resource by entries in classifications

Taken all together, these categories form what is called the "Base Scheme". Some elements like the description element of the general category allow free text as values, while for other elements the values are restricted to a limited vocabulary.
Following Dublin Core, all categories are optional in the LOM scheme. The reason for this is simple. If someone wants to use all categories and attributes from LOM, she/he has to fill out at least 60 fields. Entries like author, creation date or to some extent keywords can be filled automatically by an authoring system. But then there are still many entries left, which the author has to fill her-/himself. The time effort to describe all properties of a resource is considered as a hindrance to a wide distribution and usage of a metadata scheme. Using learning objects to build courses requires more information than the description of a single resource can provide. All categories are optional and the base scheme can easily be extended to fit particular needs (for how to use LOM for building courses, i.e. compositions of several learning objects, see [11]).

The values for the relation category of LOM are taken from Dublin Core. The values are.

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{isPartOf, HasPart, IsVersionOf, HasVersion, IsFormatOf,HasFormat, References IsReferencedBy, IsBasedOn, IsBasisFor, Requires, IsRequiredBy}
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Unfortunately, the bibliographical background of these relations is obvious. Furthermore the relations mix content-based and conceptual connections between the learning objects. The fact that a learning object is referencing an another one, is an indication that both learning objects contain information about the same topic. It is not enough information for a course author to decide, whether these connected learning modules can be presented in a certain order. The relations "isPartOf/hasPart" and "isVersionOf/hasVersion" are useful for organizing and managing generated lessons. To help assembling lessons they are not helpful. Adding two layers of metainformation to the metadata, the drawbacks of LOM can be compensated.

3.2 Ontology

As in traditional, printed books, an index of the keywords of the domain to be learnt, is very helpful to find quickly the wanted topic. An ontology contains the relevant keywords of the knowledge domain and it offers also relations between the keywords, both hierarchical and non-hierarchical.

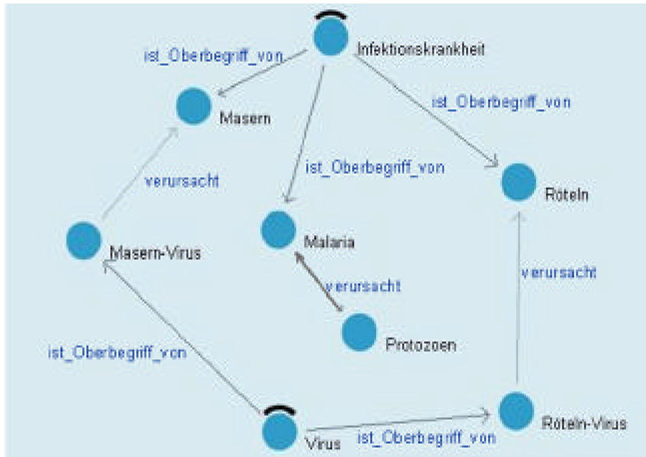

Fig. 4. An example for an ontology

The course author or the learner can get information about the available topics. The learners get an overview how the topics are connected. Together with the LOM information, learners can search for learning objects, they know nothing about. Example: learners can search in the ontology for bacteria causing diarrhea and the search the metadata files for a movie described by the result of the ontology search.

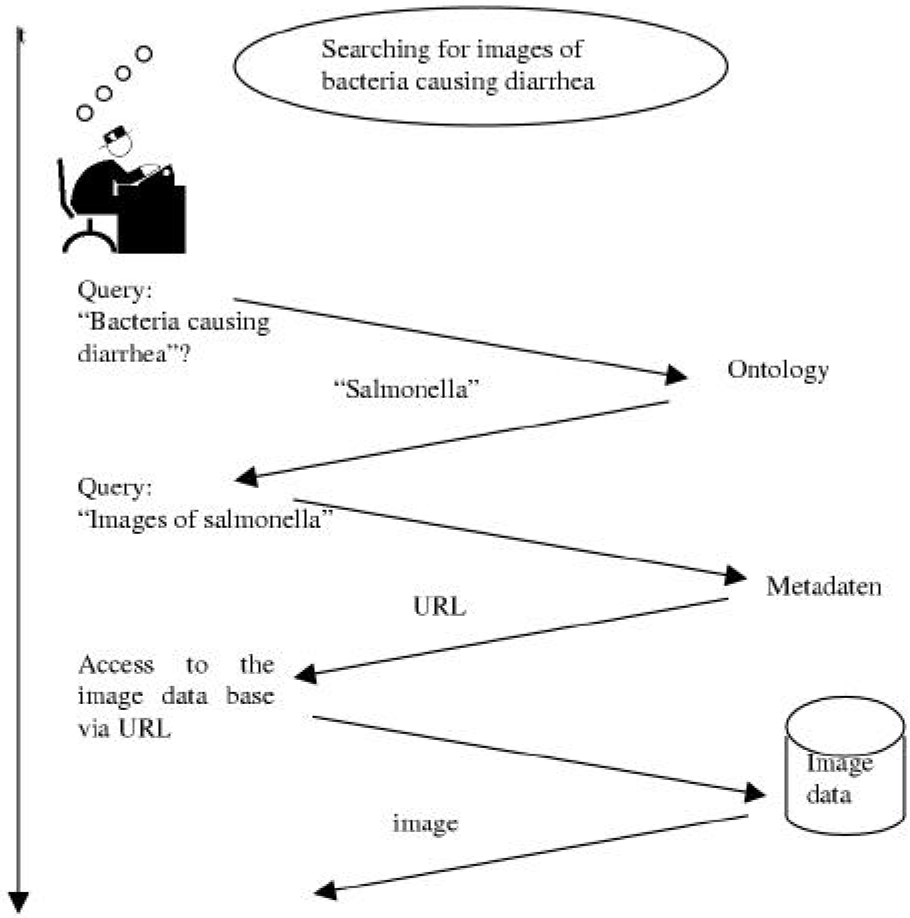

Fig. 5. Procedure of searching for learning objects with an ontology and metadata

3.3 Rhetorical-Didactic Relations

The second additional kind of metainformation are relations between learning objects. These relations can help the course authors or the learners to find clusters of learning modules.

The relations between single learning objects should be restricted to didactic relations. These are for both the course author and the learner useful to gain additional, more profound or explaining material.

Based on the Rhetorical Structure Theory of Mann and Thompson [14], a set of so-called rhetorical-didactic relations can be used to connect learning objects. Examples are "example" or "deepens". Also tests and exams can be added to informing learning objects by the relation "exercises" (see [15]).

4 Tools

For the authors, to describe their learning object is additional expenses, beside the fact that generating multimedia content is as such more costly than traditional text content. Additionally, the authors are domain experts and not normally knowledge engineers. Therefore, the authors have to be supported by comfortable tools. In the following sections, tools for composing and editing LOM files and for building up ontologies are sketched.

4.1 New Kinds of Tools

An optimal environment for authors is an integrative authoring suite consisting of both content and metainformation editors and a course builder (see [12]). An example for this scenario is the project *k*-MED [4]. Here, the medical ontology is called ConceptSpace.

ConceptSpace-Editor

With the ConceptSpace-Editor concepts of the knowledge domain can be set, deleted, renamed and modified. There are several applications for managing and enhancing the ontology and for navigating on it for searching concepts. The user interface has to be intuitive since in this project the content experts are medical specialist and not computer scientists. These tools can be operated cooperatively, both synchronously and asynchronously.

Since the modeling of the ontology is a complex and time consuming task, methods for enriching ontologies at least semi-automatically [8], [9] are extremely helpful.

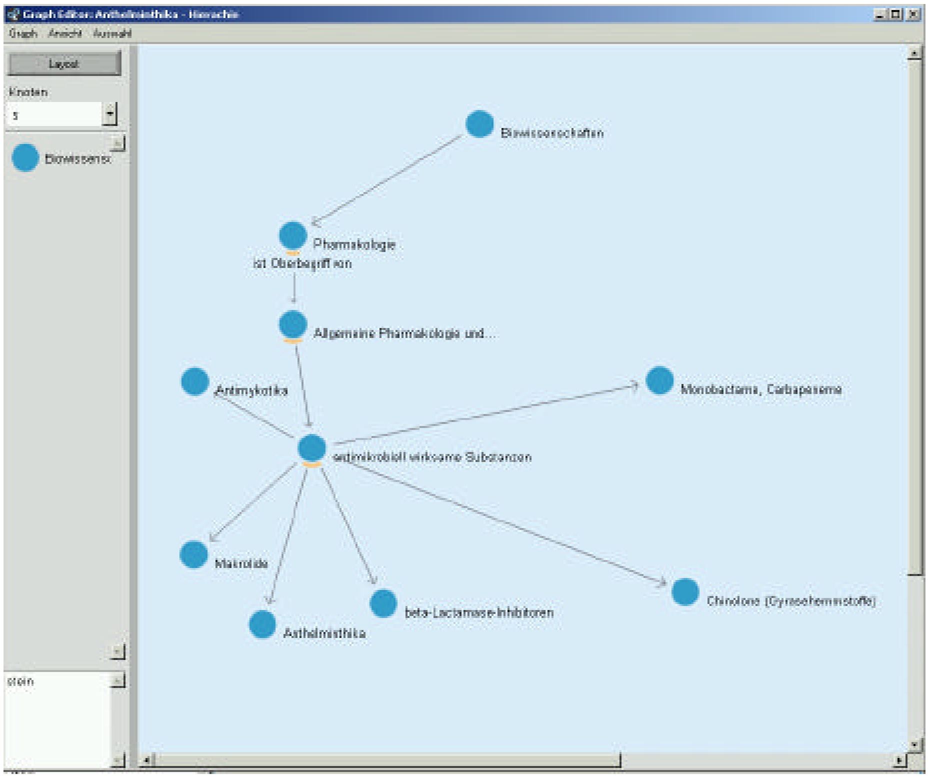

Fig. 6. ConceptSpace Editor (*k*-MED)

LOM-Editor

The LOM-Editor is the tool to generate the metadata record of a learning object, connect them to the concepts of the ontology and export the metadata as an XML description. The LOM base scheme consists of 60 fields. The willingness to describe the learning object by at least a minimum of metadata is related to the comfort of the tool. The LOM editor used in the *k*-MED project [16] compiles as much information as possible from the learning object themselves, like seize, creation date and format. Additionally, authors can employ personal templates.

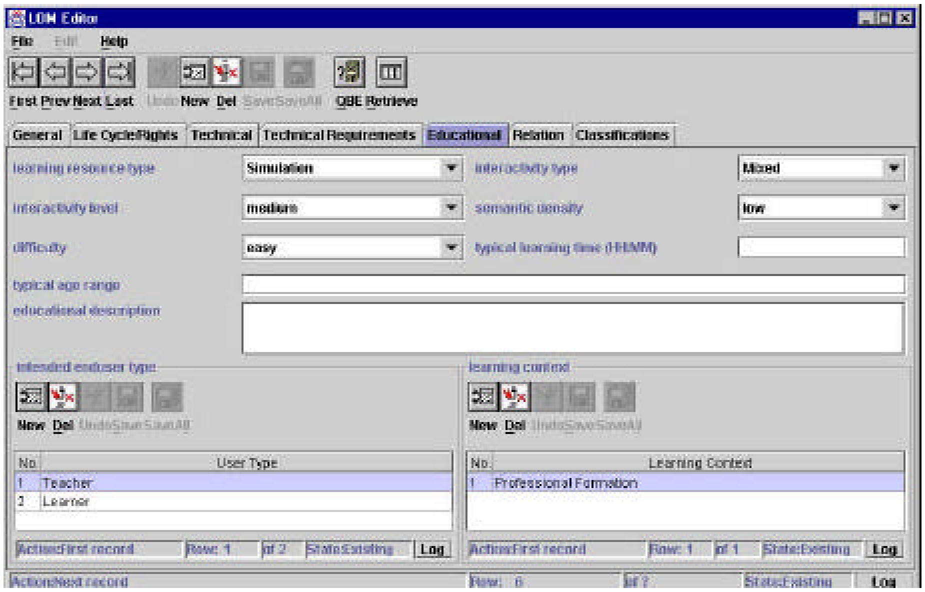

Fig. 7. KOMs LOMEditor

4.2 Feedback from Authors

In the following section, experiences with the k-MED authors are delineated.

The smaller the learning object are, the more predestinated they are for reuse. But not designing complete courses or at least chapter of courses is quite unaccustomed for the authors. Especially since the thread and the readability may suffer from the modularity of the learning object, the authors prefer to create bigger learning units.

Authors are ambivalent with the graphical design. They enjoy the professional layout, but do not like to be pressed to always follow it.

To model the ontology is surely the most unusual and difficult task. At the same time, the usefulness is quite indirect. Therefore, the authors are not enthusiastic about the ontology.

Metadata are known to every scientist, to anybody who has ever searched for a book in the library. Searching on the metadata is straightforward, and entering the metadata is comfortable. This point is no problem.

With the adequate training and support, the authors were very well able to handle the tools and to suggest improvements (see [10]).

We believe that the difficulties of the authors are the pain of the pioneers. After a period of familiarization, the metadata authors will be as adept with the new tools and tasks as they are now with word processing tools.

5 Outlook

The modularization of the learning material allows for more individualized learning. Due to the rapid development in scientific areas, the half-life of knowledge decreases rather fast. A permanent process of learning is required. That means, life-long learning conducted often by oneself is needed to remain up-to-date. The traditional way of teaching “once and for all” becomes obsolete. As it is planned by the LOM draft, descriptions of learning object shall be make it possible for machines to support learners finding the needed information. We have shown that metadata alone are not sufficient. Tim Berners-Lee suggests in [6] a structure combining a formal representation of the knowledge domain (e.g. an ontology) and metadata and calls this vision the semantic web.

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