

Instructional Models and Scenarios for an Open Learning Repository

Instructional Design and Metadata

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Abstract

In this paper we present the evolution of a metadata-based course portal, the Open Learning Repository (OLR for short). Different instructional models and principles are integrated in order to meet different learning and teaching strategies. To achieve this, different metadata models (domain model, instructional model, cooperative and structural model) are designed and mapped. In a scenario-based-evaluation of a former version designers, teachers and developers realized that the use which is focussed by implementation can differ from actual use by learners. Therefore, in OLR we do not only implement different instructional principles and theories but also help-files which address the learners reflection of their own learning strategies. Different learning strategies as well as organizational framework serve as relevant context which is addressed by scenarios written by all stakeholders. Scenarios furthermore serve as medium for communication between instructional designers, computer scientists and teaching staff.

Keywords: Metadata, Instructional Design, E-Learning, Scenario-Based-Evaluation, RDF/RDFS, LOM, Learning Repositories, Hypermedia

1 Motivation

Our Open Learning Repositories aim at metadata-based course portals, which structure and connect modularised course materials over the Web. The modular content can be distributed anywhere on the internet, and is integrated by explicit metadata information in order to build courses and connected sets of learning materials. Modules can be reused for other courses and in other contexts, leading to a course portal which integrates modules from different sources and authors. Semantic annotation is necessary for authors to help them choose modules and to connect them into course structures.

We use a relational database to store all metadata, but store no content in the database itself. We are currently using the OLR system in the context of two courses, one in artificial intelligence and one in software Engineering.

The focus in the first and second generation of our Open Learning Repositories [DHR01] was the technical infrastructure. So the main questions were, how to store the metadata, should we use O-Telos [O-Telos], XML or RDF [RDF99] etc. We have implemented also different navigation interfaces. Different views on a given course are possible, realized by different queries and page designs. A user has a choice between a classic hierarchical tree-like navigation, a trail navigation, where he can move forward and backward on a trail, and semantic (context) net navigation. We have experimented with these different navigation schemes in order to build an idea, which navigation the learner prefers.

There was a lack of pedagogical background in the first and second generation of OLRs. Thus we decided to design and implement a new prototype of OLRs, which we called OLR3. In a team of computer scientists and pedagogues we focused on, how can we use an open learning repository to enhance teaching and learning. We have implemented different instructional models and extended the Learning Object Metadata standard LOM [LOM02]. The results of the evaluation of the second generation of our Open Learning Repositories motivated us to address the general conditions that influence the use of an e-learning system in a given educational setting more explicitly in the further design process of the OLR3. The multidisciplinary of the project team made it necessary to find a medium for communication that allows to communicate domain specific ideas and theories beyond the different areas of expertise. We recommend a scenario-based design to handle this task.

2 OLR

In this first part of the paper, we will give an overview on the architecture of the 3rd generation of OLR, its current functionalities, and its web interface.

2.1 OLR architecture and technology

Our 3rd generation of our Open Learning Repository, OLR3, is implemented in Java and works as a JavaServlet, running on an Enhydra [ENHYDRA] Application Server (open source software). It is connected to an Oracle Database via JDBC, which is used to store the metadata entered by course authors and students. There are two types of metadata: structure-metadata and annotation-metadata. The structure metadata represent information about the structure of a given course or course unit, the navigation path within this course or course unit and the relations between different learning objects. Annotation metadata represent the information about the content itself. We are actually using the LOM metadata standard to annotate the learning objects. All metadata are defined in RDF and RDFS [RDFS00]. The RDF schemes, needed for either the annotation or the structure of learning materials can come from anywhere in the internet.

The database does only hold the metadata from RDF files, that are prepared to act as a data source for the courses metadata.

The central part of the system is a storage called "StatementPool". It holds all metadata that is known to the system at runtime. When an author starts working on a course, the pool is filled with the already existing data about that course from the database, and all statements from the used RDF schemes. Any referenced RDF schema will be parsed using the SiRPAC RDF parser [SiRPAC], whereas imported RDF files are parsed by a VRP RDF parser [VRP], which provides semantical checks against given RDF schema rules.

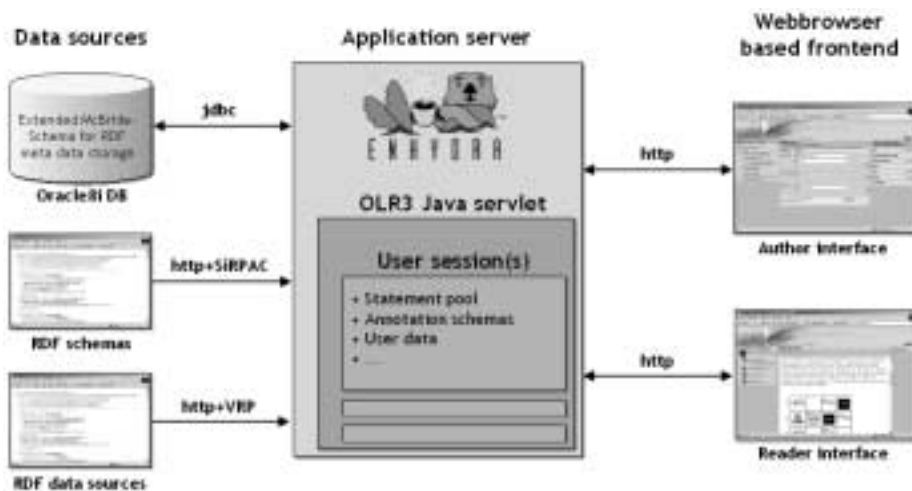


Figure 1 : OLR Architecture

2.2 OLR Web Interface

OLR3 provides a web-browser based metadata editor/viewer and provides two major user interfaces: One for readers with a more graphically oriented view and only minor functions for manipulation of the underlying metadata. The other one designed for authors to provide a schema-driven and browser-based metadata editor with flexible binding to different RDF schemes.

2.2.1 Learner Web Interface

Learner of a given course can navigate through an existing course structure, displayed as a tree and extended by additional, metadata-defined images for better understanding. As we will see in the third part of this paper we implemented two instructional models in our OLR3 prototype for the course "Introduction to Artificial Intelligence". Within that tree the user may select single course elements, whose content will be shown in the middle of the screen. A specific engine prepares and filters the content, and displays it based on a stored layout.

The reader interface also offer the reader the possibility of making minor additions to the metadata of a selected course element by providing functions like “add comment”, “add bookmark”, etc. All those additions can be made private or public to other course readers.

2.2.2 Author Web Interface

The second interface is the actual metadata editor which is intended for course authors, who can navigate through the structure tree of a course and select any sub-element. All existing editable metadata for this element are shown in the center of the screen, and the user can choose from a set of existing RDF properties, to add to the metadata, or to modify the existing data. The author can also bind RDF schemes (e.g. DC, DCQ, LOM) from anywhere in the Internet to extend the set of available properties for annotation, or unbind RDF schemes, that are not needed anymore. A “toolbar” holds those bound RDF schemes and offers the possibility of navigating through their structure by displaying an expandable tree view of any available property.

3 Three Different Views on Learning Materials

Learning management systems and learning environments as well as standards for metadata in the field of learning, often implement or address specific learning and teaching principles, theories and models. These learning theories are addressed either implicit or explicit. This means that neither teachers nor learners can choose a way of learning which is suitable best to their preferred learning strategy or learning style. Choosing from different learning principles or models of course requires reflection on ones own activities of learning or teaching. In live long learning, learners have to be able to decide on learning needs and choosing a preferred way of learning themselves:

“Dieses lebenslange Lernen soll und kann jedoch nicht lebenslang durch formale Verpflichtung und Kontrolle erzwungen werden, sondern es muss eine freie Entscheidung jedes mündigen Menschen sein, den eigenen Lernbedarf und die Lernform selbst zu bestimmen. In Zukunft wird es vermehrt Möglichkeiten geben, selbstbestimmt – im Sinne einer Selbststeuerung – zu lernen, unabhängig von bürokratischen Bedingungen, vorgeschriebenen Curricula und institutionellen Organisationsformen. [RAU2001, p.6]

We designed the Open Learning Repository [OLR3] open to different learning and teaching strategies. In order to be able implementing any learning model we separated domain model from instructional model. In order to face the different needs of novices and experts, we offer different navigational structures: guiding sequences (supporting learning processes) as well as links to related learning objects (supporting exploration)

Yet we implemented two different learning models which can be assigned to different paradigms/epistemologies: a learning sequence designed along Ausubel’s theory of Expository Teaching [AUS1968] which is derived from cognitivistic theory. And a PBL model (problem based learning) [WIE1992] which is associated with situated approaches.

Modeling different spaces or models means modeling different views on learning material. In OLR three different spaces are modelling different aspects/views: *Domain Model*, *Instructional Model*, *Structural* and *Cooperative Model*.

These different models can be structured by different experts in the different fields (experts in the subject domain and instructional designers e.g.)

3.1 Domain Model

In the *Domain Model* the domain/subject specific ontologies are specified, mainly including MatterOfFactRelations, both hierarchical as well as associative [cp. MED2000]. This knowledge space includes structuring of subject specific knowledge, subject specific skills and competencies.

3.2 Instructional Model

There is no unique instructional ontology but different approaches, theories and models. In the *Instructional Model* instructional phases and relations are specified. They are derived from different instructional models and learning theories. Furthermore learning processes are modelled along different instructional principles (PBL, case-based e.g.). In existing metadata standards learning processes are not addressed [ALL2002]. But Meder stresses, that learning objects should be defined

in six dimensions [MED2000]. One of these dimensions defines the position of an learning object within the process of knowledge acquisition.

„Ein didaktisches Objekt muss bestimmt sein (...) in der Dimension logisch-operativer Verlaufsformen, d.h. es gibt Methoden – im definierten Sinne – die den Verlauf der Aneignung von Wissen bestimmen können“ [MED2000]

Up to now we implemented two different instructional models derived from different principles and paradigms: Expository Teaching by Ausubel (cognitivism) and a problem-based-model (situated approach).

Phases we modelled along Expository Teaching [AUS1968] are:	Phases we modelled along the PBL model [WIE1992] are:
Phase	Phase
Advance Organizer (orientation)	Set Goal
Progressive Differentiation (conceptualization)	Specify Criteria
Practice	Acquire Knowledge
Integrating and Connecting	Generate Ideas
	Realize Implementation
	Reflect
	Generalize
Relations between them are „followed by“.	

Modelling learning processes and phases works as threads, guiding students as well as authors. We described instructional roles of each phase. The Expository model as well as the PBL model work as guidance to authors presenting learning material. The PBL model although guides students structuring their own project work.

The *Instructional Model* is transformed to guiding structures at the interface: called “learning sequence” (Expository model) and “problem solving path” (PBL model).

3.3 Structural and Cooperative Model:

Compatible to learning processes specified in the *Instructional Model* but also independent from specific theories, methodical and structural relations as well as cooperation-supporting relations and learner activities are specified. Examples for methodical and structural relations are:

- Theory generalizes example:

Entity	Relation	Entity
example	generalize	theory

- Exercise applies theory:

Entity	Relation	Entity
exercise	applying	theory

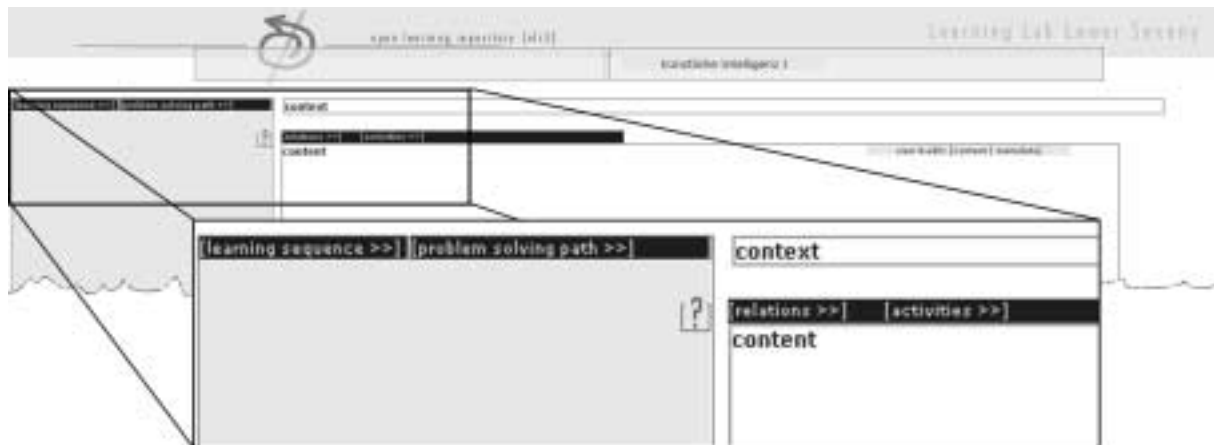
In order to model these relations, each learning object must be categorized methodically.

In this model also cooperative relations and learner activities are modelled. Examples for learner activities are:

Add keyword in metadata
Add relation
Add comment
...

Cooperative relations are modelled to guide students cooperative work. Next to the “problem solving path” e.g. relations are offered which motivate students comparing the progression of their project with others’ or to compare the organization and coordination of projects within teams. These relations are planned to be implemented in the OLR3.

Due to these models the new interface of the OLR3 will look like this. This new interface is based on results of the scenario-based-evaluation of the former version of OLR (OLR2):



4 Scenario-Based Evaluation and Design

In this section different aspects of an scenario-based evaluation and design of the OLR will be highlighted. After a short description of the evaluation of a former version of the OLR the meaning of contextual conditions for the design of a new e-learning system like the OLR3 will be discussed. Furthermore the relevance of scenarios as a medium for communication will be stressed.

4.1 Evaluation of a former version of the OLR

One substantial starting point for the planning of the design process of the OLR3 has been a scenario-based¹ evaluation of a former version. In this evaluation survey 20 students which had attended an introductory course on artificial intelligence were interviewed using a semi structured guideline. The lecture notes of this course on artificial intelligence had been provided to the students using a former version of the OLR. The aim of this survey was to find out on the one hand how the lecture notes and on the other how the OLR can be improved. On the basis of these interviews a scenario-of-actual-use was written. In addition the designers, teachers and developers of the lecture notes and the OLR were asked to write scenarios-of-intended-use where they should express their ideas of how the material should be used by the students. The comparison of the scenario-of-actual-use and the scenarios-of-intended-use revealed that the OLR had been used in a very restricted way by the students. Much of the functionality implemented in the OLR had not been used or has been seen as not useful for the students to reach their objectives. The survey is described in more detail in a technical report [RIC2002]. One reasonable explanation of the mismatch between the use made by the students and the functionality provided by the OLR is that the learning activities of the students are oriented to objectives determined by the course and its embedding in the organizational structure of an university and characteristics of the learner.

One consequence of this result that could only be mentioned briefly in this context is that we do not only implement different learning principles and modules but also help-files, which address the learners' reflection of learning strategies. By doing so we face the fact that choosing from different learning modules requires reflection on ones own activities of learning. We are going to create the help-files on the basis of scenarios that describe the different underlying educational ideas on the level of concrete human activities.

4.2 The meaning of contextual conditions for the design of the OLR3

Another consequence of the evaluation mentioned above is that in the further design process of the OLR-3 general conditions and characteristics of the learner should be addressed more explicitly. With the term general conditions we refer to characteristics of the educational setting in which the learning material is embedded. The most important characteristic of the educational setting that may influence the use of a certain learning material are the implicit and explicit learning objectives. While in many educational settings some learning objectives as the acquisition of domain specific knowledge are named explicitly, other possible learning objectives as the acquisition of social and scientific

¹ We use the term scenario to refer to a narrative description situation of use. [CAR2000] states that a scenario is characterized by a setting, includes agents and actors with individual goals or objectives and describes in contrast to Use-Cases more complex sequences of human action. We apply situations of use in a very broad sense. For example, attending a lecture by a student is a situation of use.

competencies stay more or less implicit. It seems reasonable that these learning objectives propagated by an educational setting have an impact on the selection of the students individual learning activities.

A clear description of the implicit and explicit learning objectives within a given educational setting and its possible influences on students behaviour will be very important to make comprehensible design decisions. Only if possible conflicts between the learning objectives within a given educational setting and the learning objectives of the developed learning material can be anticipated it will be possible to decide if the learning material should be adapted to the educational setting or vice versa. This problem will be even more important if the learning material is constructed on a special educational model with explicit learning objectives and a certain conception of the learner. We assume that focussed changes in learning can only be fruitful in interaction with organizational changes (lecture and exams) – it will not change by simply offering a new e-learning system to the students.

In other words, we assume that the use of a learning environment as the OLR3 could only be understood adequately as a part of more complex and longer lasting students learning activities.

The educational setting with its implicit and explicit learning objectives and their possible impacts on the students behaviour will constitute the context, which is addressed by scenarios written by all stakeholders. Scenarios of use appear to be an adequate way to describe the possible impacts of the context, because they force the writer to think about the concrete behaviour of the user.

4.3 Scenarios as a medium for communication

Beside the fact that scenarios seem to be an adequate way of describing the use of a certain artefact on different levels of abstraction and to highlight different perspectives on one task they furthermore serve as a medium for communication between all involved stakeholders. A collective base for communication is very necessary because of the interdisciplinary design team involved in the design of the OLR3 and the integrated learning modules that consists of instructional designers, computer scientists and teaching staff. On the one hand in the development of any kind of educational material many different variables like the learning content, the underlying pedagogical models, characteristics of the learner, contextual conditions and technological requirements have to be taken into consideration (cp. TER2000). On the other hand it is unrealistic to recommend that every stakeholder has expertise in all the addressed topics. While the cooperation of an interdisciplinary design team allows addressing all the relevant topics it keeps still necessary to find a way to communicate the different ideas, concerns etc. within the design team. Scenarios seem to provide such a collective base for communication within the project. The necessity to formulate the possible consequences of certain variables, theories etc. on the concrete behaviour of an actor shall assure that the necessary information to make decisions on the design, can be communicated in the whole team. An adequate medium for communication is also an important condition to understand made design decisions at a later point of time and to receive starting point for further evaluation procedures.

5 Further Work

We are currently extending OLR functionality by a new user-interface as mentioned before. On the one hand the design of the new user-interface as well as the help files will be based on the results of the evaluation of the second generation of OLR. On the other hand the design will be guided by new scenarios-of-use that will address pedagogical theories and general conditions of the educational setting explicit. We also will vary the educational setting in which the OLR3 will be used in the next year to support a broader use of the OLR3 and the embedded learning materials. Good structured learning materials are very important for learning and teaching, but appropriate and well structured learning materials for e-learning are absolutely crucial. Thus new learning materials for the course "Introduction to Artificial Intelligence" will be produced and already existing materials will be restructured and annotated based on the different models described above.

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