A Constructivist Content Exploration based on a Hypermedia eLearning Object System

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Abstract:

eLearning systems open up new perspectives on knowledge transfer. Providing valuable content and elaborate interactivity structures could encourage the learner to discover knowlegde on one's own initiative in a constructivist fashion. Applying semantic web technologies to eLearning systems will facilitate a new generation of eLearning systems.

In the present paper we introduce aspects and opportunities of a constructivist access to content structures and interactivity schemes from semantic notions of components along the Hypermedia Learning Objects System (HyLOs), our prototypical implementation of an eLearning content management system. A transition from standard educational annotation to semantic statements of hyperlinks is discussed. Our paper focuses on demonstrating how the online learning system Hylos will benefit from sematic web technologies, allowing for self-explorative knowledge discorvery.

HyLOs is built upon the more general Media Information Repository (MIR) and the MIR adaptive context linking environment (MIRaCLE), its linking extension. MIR is an open system supporting the standard XML, CORBA and JNDI. HyLOs benefits from manageable information structures, sophisticated access logic and high-level authoring tools like the eLO editor responsible for the semi-manual creation of meta data and WYSIWYG like content editing allowing for rapid distributed content development.

1 Introduction

Content in the academic education deserves dedicated treatment: As created by specialised experts, the quality of the presented knowledge needs to be complemented by an online learning application of equivalent quality. Building educational content thereby significantly depends on the target media: In writing a book we create an unchangeable, monolithic block of strict linear order. Setting up a collection of HTML documents results in a mesh of easily changeable content elements, which show a strict page orientation. The relational mesh itself, when fixed with the rather rigid HTML linking scheme, withstands any seamless

modification. Most of the learning platform environments on the market today follow the latter framework, thereby inhereting its severe shortcomings. Authors as well as consumers thus are forced to cope with material inherently shaped by the publication method.

In the field of education the task of content preparation for hypermedia use has been addressed recently with the standards Learning Object Meta data (LOM) [9] and Sharable Content Object Reference Model (SCORM) [10]. LOM introduces the notion of learning objects as a collection of content components together with its meta data. LOM's eLearning Objects (eLOs) revitalise the idea of rich, coherent information entities, subject to an appropriate processing for presentation. Up until now applications operating eLOs in their full potentials, thereby exploring capabilities as well as shortcomings of the model, are rarely seen.

In the present paper we introduce our prototypic solution of an eLO based open hypermedia system, the Hypermedia Learning Object System HYLOS [3], donating special focus to its variable content access options. A self-explorative content navigator following a constructivist approach is part of the system, as well as an efficient authoring tool for eLOs.

This paper is organised as follows. In section 2 we discuss aspects and the reception of the eLearning Object concepts. Section 3 presents the HYLOS system and highlights its special features. Finally, section 4 gives a conclusion and an outlook on the ongoing work.

2 eLearning Objects - A Hypermedia Way To Hinder Learning?

Several years of online learning experiments and debates have brought up a standardised container for educational content: the eLearning Objects (eLOs). eLOs denote the smallest, atomic learning units covering a single, self-consistent subject.

Following the IEEE LOM [9] standard eLOs are composed of

- a possibly composite content element, which is intended to be suitable for online display. No rigid restrictions on scale or media types are placed;

- a meta data set, describing educational, technical and administrative properties of the object in a standardised vocabulary, thereby giving rise to automated semantic processing;

- an option for named interrelations to express content information structures and their educational semantic. Structures may form nonlinear and non-hierarchical meshes. Note that eLO provide self-typed pointers by means of which large learning repositories of agglomerated eLOs may be constructed in a self-similar, intermittent fashion.

The creation of such rich educational 'information cells' was mainly motivated from three perspectives:

Modularisation: Courses and lectures commonly cover a variety of topics and aspects. Content material is considered more valuable, if split up into distinct 'minimal units' of well identified subjects. Modular online material not only promises ease for rearrangement and re-use, but also may enhance clearness to the learner on the subject presented. Decomposing content into consistent parts of manageable size is, in addition, a vital step towards its use in hypermedia: Besides the obvious need for digestible portions at online displays, any segmentation requires a rule set of glues, giving rise to the second perspective.

Structural transparency: Complex knowledge clearly carries a large variety of interrelations, which in general form an open mesh of references *and* reference context descriptions. Along with the separation of content into distinct parts eLearning Objects provide a reference set for defining those interrelations. In this way content structures are made transparent to eLearning applications and may be processed for hyper-referential displays. Additionally, references may carry its context information in a standardised, simplified manner (e.g. *IsPartOf, IsBasedOn*...), which can be offered to the learner by applications, as well.

Re-use and exchange: Well prepared eLOs cover a specific topic in a self-consistent manner, provide meta information on its coverage and the intended context of use. It is the idea that such generally shaped content blocks are much more suitable for re-use or exchange between teachers than commonly used documents. Each eLO is also meant to be an accessible Web resource (equipped with URI), so that access and exchange of these units, available in partly standardised formats, can be promoted to global ease.

Even though there has been very limited effort to explore online capabilities of eLO based educational content management to its full potentials, a harsh and controversial debate arose on this issue. The principle feasibility of these information objects as well as of meta data annotations is questioned in a surging pedagogical dispute [6], [7], [8], of which three focal points can be identified:

Modularisation versus Contextualisation

The production of modular, self-consistent learning content objects places the need of cutting borders in between related subjects. Any author experiences this matter from the initial shaping of objects until writing the last sentence, which must not reference any subsequent object in mind ("As we will see in the next presentation ..."). The critics start here with the argument, that de-contextualisation will diminish major parts of the content. Chopping up a continuous discourse into pieces will reduce learning merely to a trivial enumeration of facts.

On the contrary position it is stressed that contexts are to be expressed by means of (hyper-) references and the more relevant aspect lies in an efficient employment of this narrative technique. Stating learning content precise and confined in well defined, transparent contextual relations is also seen as an improvement over an only linear discourse, e.g. taken in a book.

Didactic Taxonomies and Standardisation - Producers of Artefacts?

The IEEE LOM [9] standard includes a meta data set of intermediate richness to encode didactic contexts and further educational properties. As is vital for exchanging and automated processing of these semantic features, the standard determines the categories of classification *and* the vocabulary of possible values, as well. Such rigid scheme of expressiveness is heavily criticised not only for being insufficient, but foremost for annotating nonexistent phenomena. Didactic context descriptors s.a. *LearningContext, TypicalAgeRange, Difficulty,* serve as key examples for this argument, since contextual properties appear not inherent to the content, but relate to both, the content and the learning situation.

On the counter position it is mainly pointed out that contextual information is not uniquely defined for an eLO. Instead any learning resource may carry a collection of advisable contexts without any normative claims. In general standardisation calls for always insufficient compromises, but is the only feasible path to interoperability and international understanding.

Commercial Interests

A somewhat foreign line of arguments spring from monetary visions, which occur too frequent to be ignored: Buying an appropriately large collection of eLOs might give rise to a Web offer of valuable courses, which can be sold independent of significant teaching efforts. The business model of students paying for degrees only earned by following online presentations seems too tempting to be disregarded. This vision also includes active markets for buying and selling eLOs.

The economic advantage of teacherless teaching is of course criticised to conflict with qualitative input from personal teaching interaction. To the best knowledge of the authors a successful story of (almost) fully automated teaching remains to be seen. Nevertheless, self-explorative learning aided by educational applications or supplementary online material in blended learning environments seem to successfully enter every day's teaching and learning programs.

To conclude this discursive section we want to point out two aspects on our perspective. Firstly, to our ears many of the controversial arguments on both sides seem to interchange educational application resp. content management and the teaching resp. learning itself. The subject of eLO employment is rather the question on media support of teaching and learning than the entire process. In other words: If disadvantageous in certain areas, eLearning Objects or online learning need not be used.

Secondly, the production and employment of teaching material cannot be viewed independent of its media. We all are well accustomed to books; most of us did spoil their view of online media by experiencing the insufficiencies of HTML-based presentations. The above sketched debate seems to reflect on this. However, the concepts of eLearning Objects are targeting the hypermedia world beyond HTML capabilities and should be judged from this. As of today this field is newly opened on the ground of XML frameworks and technologies [2] and brings us back to the early remarks of Landow [1], who had the pleasure of working with the pioneering hypermedia system Intermedia.

3 The Hypermedia Learning Object System HYLOS

3.1 Managing eLO Content

In this section we want to introduce HYLOS, our model and prototypic implementation of an educational content management solely built on eLearning Objects. Operating on a base of eLOs HYLOS pre-processes content for variable views: Each component can be displayed as comprehensive slide or detailed descriptive information. According to LOM attributes the learning complexity and the semantic density of all presentations may be adjusted. Different access structures are provided according to the didactic model in use. Figure 1 shows the hierarchical instruction path representing a behaviouristic approach, a set of individualised tools in constructivist fashion for searching, navigation and interactively aided overviews on completeness and learning success is under way. HTML and PDF currently are supported as presentation formats, where other types of preparation may be added easily.
Hyper referential relations within these applications are adaptable by authors as well as by users on a semantic layer. In HyLOS an author can define contexts of hyperlinks, representing the rhetoric of his choices. Learners may opt for the link context in use for their navigation. These capabilities are the outcome of the MIR adaptive Context Linking Environment described below, which is part of hypermedia learning system [12].
As proposed by the LOM standard eLOs in our system are simultaneously formed from content entities and Meta descriptors. Content is built from XML paragraph objects, as is the

standard cellular content concept within the underlying MIR system [3]. Meta data are selected as a conformal subset of the LOM standard. Additional information such as taxonomies according to external categorisation schemes, glossaries, bibliographies or organisational data have been modelled within the system and become accessible to eLOs by reference identifiers.
Our practical implementations of the HYLOS system rank around XML formats and processing technologies. They rely on the more general storage and runtime platform Multimedia Information Repository (MIR) [3]. Grounded on a powerful media object model MIR was designed as a universal fundament for ease in modelling and implementing complex multimedia applications. All data residing in the adaptable MIR data store are published in XML format, such that individual views and user interface behaviour can be reached by lightweight style sheet programming.

Built on a three-tiered architecture MIR provides general support of media data handling, authentication, user and connection handling. Its core is formed by a media object database, implementing a duality of object oriented information model and relational structure. The system offers a free layer for application specific modelling of information and structures, the latter being twofold as passive structures and 'active' references, where traversal is accompanied by underlying code execution. A generic web authoring allows for immediate editing of the modelled information and structures. MIR is built as an open hypermedia system and currently supports the standards XML, Corba and JNDI. For further reading we refer the reader to [4] and [5].

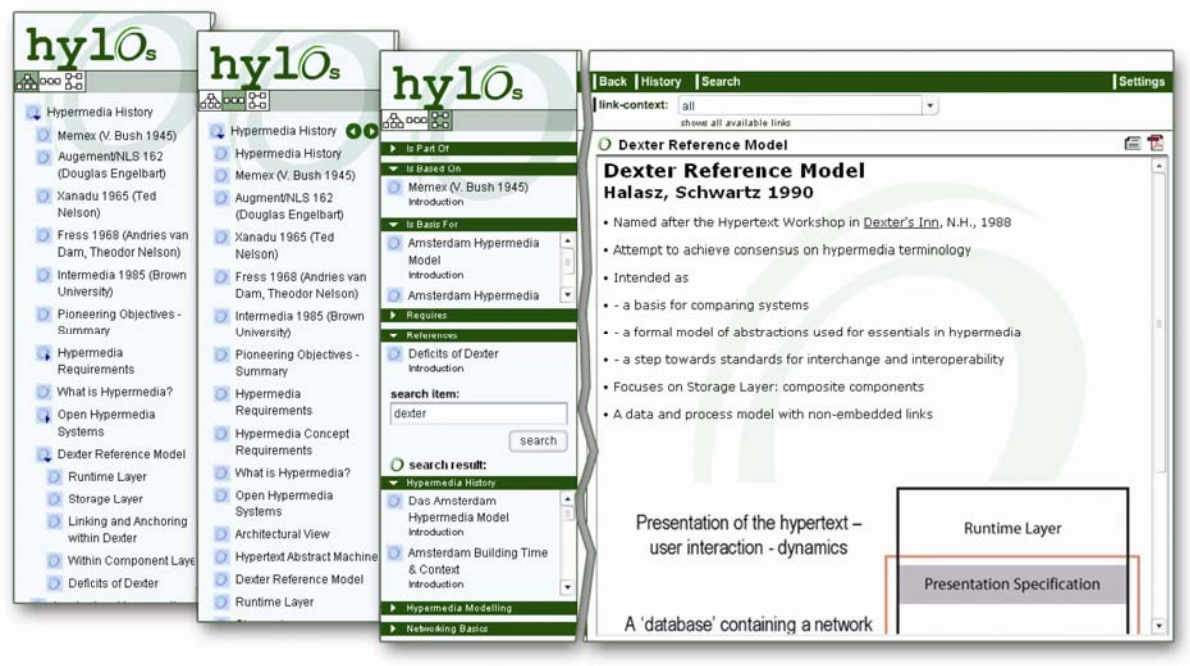

Figure 1: Three content access views within hylOs.

3.2 Exploring Content with HYLOS

The HyLOs learner front-end (s. fig. 1) provides three different views to the student. Each view presents the content of underlying eLOs according to a certain learning methodology. The first one is based on a linear learning paths, one instructional design as defined by a teacher. Those learning paths may be composed by choosing different eLOs from the knowledge repository. The second view is formed by the primary content structure the eLOs are embedded in. This hierarchical content organization is visualized as a tree. The root of the

tree could be viewed as the most common description of the subject, whereas the leaves are the most detailed information. In contrast to the different possible path views the hierarchical presentation is unique to the content, its arrangement defined within the authoring process. The third view provides a set of constructivist tools supportingr self-explorative learning. In contrast to the preceding ones which more focused on a collection of eLOs the perspective is switched to an eLO centered view. Starting from the current context node qualified relations to other eLOs are displayed. Those relations are taken from the LOM meta data “relation” section. Part of his constructivist access approach is an powerful search tool acting context sensitive across the entire repository.

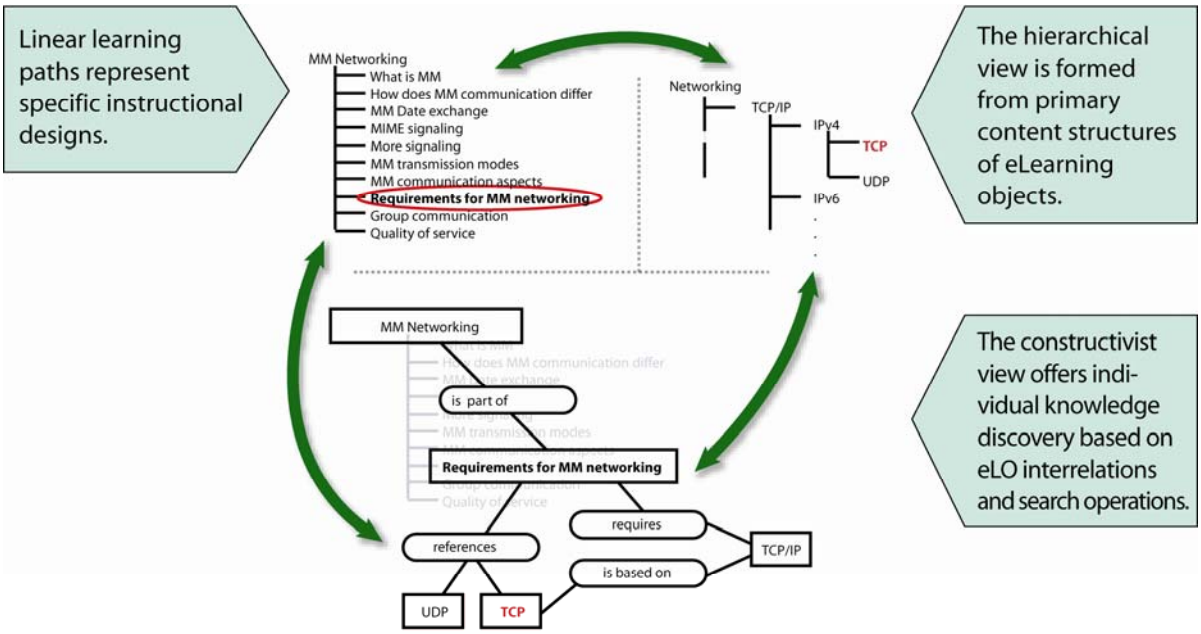

Figure 2: Use Scenarios for the HYLOS Naviagtor.

Imagine a learner, a bachelor student, is working on a unit covering the issues of “Multimedia Networking” providing by his professor within an introductory class on "Networking". At some time he is reaching the subject “Quality of Service”. It introduces aspects of QoS in networking. The student is not satisfied by the introductory content given in this course and wants to acquire background knowledge. For this task he switches the perspective to the constructivist view, where related topics of his present subject (eLO) are offered. By navigating along the relations or searching for similar 'knowledge nuggets' the learner may find a new learning path called “Internet Technologies”. Here the student switches back to this newly discovered instructional path and works along this course, intended for masters students. After studying the whole QoS lecture, the student wants to know, if there is more about networking and changes to the hierarchical view. Thereby the system will show the complete structure of networking related objects of that author to him.

3.3 Efficient ELO Authoring

Authoring Learning Objects is not a simple task: Content has to be comprehensively shaped for covering a single, self-consistent subject. Meta data, in a certain amount, are inevitably needed. It is a necessary but ambitious challenge to provide an authoring tool for seamless production of ELOs.

The HYLOS eLO editor (s. fig. 3) allows for a coherent authoring of complete learning objects, i.e. content, meta data and referential relations can be developed within one application. The tool attains three main views: The content navigator, the content editor and the meta data builder.

The **content navigator** offers the traversal and modification of eLO structures, operating on the relational context paths described above. Note that, as the applicative ELO structure need not be hierarchical, the generated view of an object tree is in the case of object re-use a non-normalised representation of the content.

The **content editor** is dedicated to the production of the entire content, i.e. descriptive paragraphs and slides. The main information structure to be filled is the ParagraphContent, consisting of an XML-formatted free text paragraph (including images or other media) and descriptive elements s.a. title, headwords and sectional titles. The latter strings are recycled to automatically generate a 'standard' slide for every eLO for the 'quick and simple' slide production. For voluntary use HYLOS offers an unrestricted slide presentation layer within the SlideContent information object, which can be correspondingly authored with the XML paragraph editor.

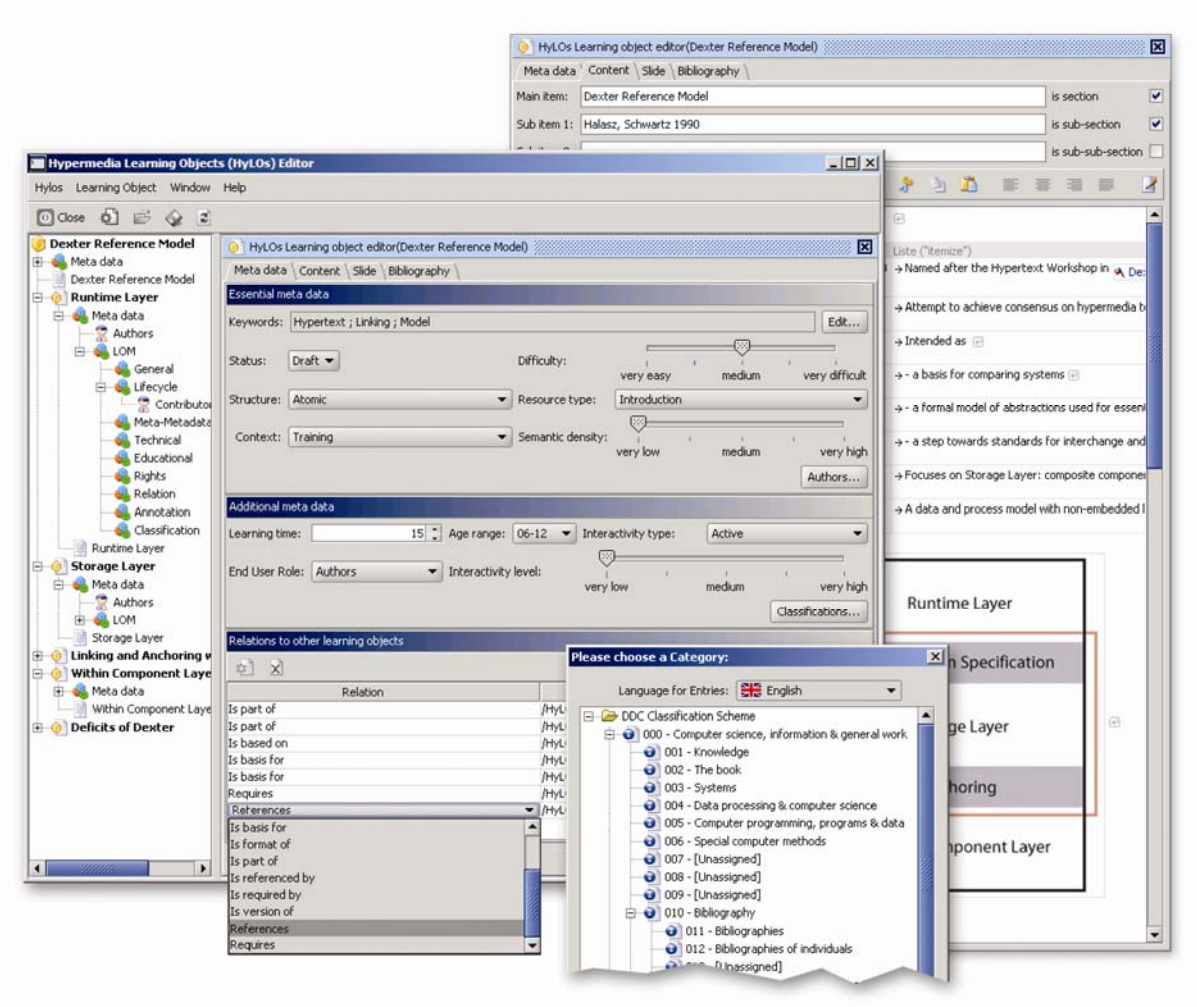

Figure 3: Authoring eLOs within HYLOS.

The **meta data builder** takes care of generating the ELO meta data set with minimised authoring effort. Relevant manual specifications are arranged on one sheet, where obligatory

data are reduced to seven fields at the upper part (s. fig. 3). The acquisition of meta data is essentially done in three ways:

Automatic Generation for most of the LOM attributes: All technical data (author, formats, sizes, dates, locations, aggregationLevel …) are directly provided by the MIR system. The content title is used as the LOM title, the sectional titles as coverage fields and as a description the (reformatted) first content paragraph. An additional set of faintly fluctuating data, e.g. language or intendedEndUserRole, are taken from user specific presets.

Obligatory manual provision for seven LOM attributes: Keywords, semanticDensity, difficulty, context, learningResourceType, structure and documentStatus require editing, if presets taken from previous editing do not apply.

Facultative manual provision for the remaining LOM attributes may be added either on the front sheet or by accessing the complete meta data tree.

Additional information structures s.a. glossary entries, taxonomic classifications, bibliography entries or persons can be accessed within the eLO editor through separate window sheets. Thus an author of eLOs is enabled to create or manipulate complex objects without distracting the focus from its destination in content.

4 Conclusions and Outlook

In this paper we discussed prospects and pitfalls of new educational content processing based on eLearning Objects, as derived from the IEEE standard LOM. Concepts and a practical solution for an open hypermedia eLO system were introduced. This adaptable system HYLOS offers variable generic views on eLO-based educational content, featuring a constructivist approach. New use scenarios combining those views in one navigational trail were presented.

A handsome editing system for authors is already provided within the system. Future work will concentrate on automatic content acquisition and analysis starting from records taken within lecture halls. Work also continues to make HYLOS available as a semantically aware Web service.

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