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DESIGN OF LITHUANIAN DIGITAL LIBRARY OF EDUCATIONAL RESOURCES AND SERVICES: THE PROBLEM OF INTEROPERABILITY

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Abstract. Currently digital library of educational resources and services (DLE) for general education and vocational training systems is under active implementation in Lithuania. Its design is based on the idea of partition of digital learning resources to two separate parts (learning objects (content) and units of learning (learning methods/scenarios/designs)) which have clear different functions, and investigation of reusability and interoperability of these two separate parts within the system and DLE as a whole on European level. The article aims to analyse several aspects of interoperability of these main DLE components.

Keywords: digital library, repositories, interoperability, standards, learning objects, units of learning, reusability.

1. The Concepts of DLE and its Main Components

1.1. DLE

Lithuanian concept of digital library of educational resources and services (DLE) proposed by us is based on the following notions:

We consider DLEs to be the aggregates of "knowledge repositories, and services, organized as complex information systems" [Digital Libraries…, 2003].

The notion 'knowledge' is used here as the synonym of 'digital learning resource' (LR). Further the notion 'digital learning resource' will be used here as an 'umbrella' notion for different kinds of LRs such as so called 'learning objects', 'learning assets', 'units of learning', etc.

DLEs are a set of LRs and associated technical capabilities for creating, searching, and using information; they are an extension and enhancement of information storage and retrieval systems that manipulate digital data in any medium [Borgman, 1999].

DLEs are the core of networks of learning environments and resources, that is (1) designed to meet the needs of learners, in both individual and collaborative settings; (2) constructed to enable dynamic use of a broad array of materials for learning, primarily in digital formats; (3) managed actively to promote reliable anytime, anywhere access to quality collections and services, available both within and outside the network [Lee L. Zia, 2001].

DLE must not be seen as merely a digitized collection of information objects plus related management tools, but as an environment bringing together collections, services, and people to support the full cycle of creation, dissemination, discussion, collaboration, use, new authoring, and preservation of data, information, and knowledge. The challenges and opportunities that motivate advanced DLE initiatives are associated with this view of the digital library environment. Work on DLEs aims to help in generating, sharing, and using knowledge so that communities become more efficient and productive and the benefits of collaboration are maximized [Digital Libraries…, 2003].

The main components of DLE are LRs (i.e. learning objects and units of learning), their repositories, and appropriate services / tools (such as virtual learning environments (VLEs)) to use them.

1.2. Learning Objects (LOs)

There is a lot of LO's definitions coming from various sources. We consider the following LO definition the most suitable: "LO is any digital resource that can be reused to support learning" [Wiley, 2000].

A LR truly becomes a LO (a resource, reusable within another learning context) when it is associated with self–describing information – metadata. Metadata is used to implement LO repositories, to search for LOs in the repository, to share LOs, to import LOs into or export them from VLEs, to combine them with other LOs (using them as building blocks to build lessons, courses, etc.) [Jevsikova, Kurilovas, 2006].

Reusability of LO is considered: (1) as is; (2) by de and re composition (lego model); (3) adapted to fit a specific context; (4) as an example; (5) by modification; (6) by localisation.

1.3. Units of Learning (UoLs)

Unit of Learning (UoL) itself and all its components are embedded LOs, including learning objectives, prerequisites, learners' or trainers' roles, activity assignment, information objects, communication objects, tools and questionnaire objects [Paquette, 2004].

1.4. Virtual Learning Environments (VLEs)

There are different kinds of ICT tools and systems to support various pedagogies – so-called e-Learning platforms, VLEs, Learning Management Systems, Content Management Systems, etc.

The term VLE is used here as "a single piece of software, accessed via standard Web browser, which provides an integrated online learning environment" [Virtual Learning…, 2003].

VLEs usually include the following functions: (1) controlled access; (2) student tracking; (3) resources and materials; (4) communications; (5) links; (6) customisation [Kurilovas, 2006a].

2. Hypothesis

The main goal here is evaluation of possibility to create in principle pedagogically and organizationally flexible cost effective DLE model providing learning customisation possibilities for its users.

The main hypothesis is the idea that ultimate increase of the main DLE components' (i.e. LRs) reusability could ensure these DLE characteristics, and there is the possibility to warrant stable interoperable working of system's components.

The main factor here is the idea of partition of LRs to two separate parts (LOs and UoLs) which have clear different functions, and investigation of reusability and interoperability of these two separate parts within the system and DLE as a whole.

LOs here are considered to be reusable pedagogically decontextualised LRs (so called ‚content') which are not directly interconnected with particular pedagogical methods / scenarios / designs, and therefore it's possible to reuse the same LOs to implement different learning designs.

UoLs here are conversely considered to be LRs containing learning designs reusable for different subjects and different LOs.

This kind of "reusable" DLE design seems to be one of the best possible e-learning solutions from technologic, educational, organizational and socioeconomic points of view. The detailed evidence of this statement is out of scope of the article, but shortly it ensures DLE's pedagogical and organizational flexibility as well as the better financial and economic efficiency indicators such as less investment into LRs for one probable user, major financial benefit, less time to buy off, etc.

In this case: (1) major reusability of main DLEs components is achieved; (2) more users can benefit from such system; (3) content and learning design creators have the possibility not to reinvent the wheel but use and improve already created LRs; (4) better conditions are created for various content / design creators to improve the quality of existing LRs by their permanent (collaborative) modification.

The need for reusability of LRs has at least three elements: (1) interoperability: LR is interoperable and can be used in different platforms; (2) flexibility in terms of pedagogic situations: LR (here LO) can fit into a variety of pedagogic situations; (3) LR modifiability to suit a particular teacher's or student's needs: LR can be made more appropriate to a pedagogic situation by modifying it to suit a particular teacher's or student's needs.

The article aims to analyse several aspects of interoperability of learning objects and units of learning.

3. Interoperability Concept

A critical success factor for e-learning is the possibility to share, collaborate, twin, and move people and resources within a country or region and across Europe. The sharing of education related data and services makes them less costly, increases the supply, enhances the quality through incremental improvements, and allows a shorter time delivery. However, sharing of data, content, tools and services can only be achieved when clear agreements are made between all parties concerned. The more global this agreement, the greater the benefit.

The practical implementation of this is interoperability in different areas, such as learning content and repositories, accessibility, assessment, administration, learner information, quality, and learning activity. However, interoperability is not only about technology and standards. As practitioners find out, putting standards to use by, for instance through application profiles, and the learning and political dimensions are of equal importance [Roadmap to Interoperability…, 2006].

Standardisation is about coordinating technology, and e-learning interoperability initiatives are more or less coordinated explorations of various ways of achieving more effective applications of ICT in education.

3.1. Different Layers of Interoperability

Interoperability is the ability of two systems to operate. There are different aspects of interoperability: (1) Physical layer: the physical appearance, the media and amount of contact available; (2) Empirical layer:

the entropy, variety and equivocation encountered; (3) Syntactical layer: the language, the structure and the logic used; (4) Semantical layer: the meaning and validity of what is expressed; (5) Pragmatic layer: the intensions, responsibilities and consequences behind the expressed statements; (6) Social layer: the interests, beliefs and commitments shared as a result.

The Syntactic layer which is a part of technical layers deals with Technical interoperability; the Semantic layer deals with Semantic interoperability; the Pragmatic layer deals with Pragmatic interoperability.

3.2. Technical Interoperability of Services

Complex ICT systems are today often built following a service known technically how to interoperate with the other services by means of a well-defined interface. The major advantage is that system builders can make use of services from different service providers given that they obey the service interface specifications.

A LR repository could be accessed easily if it has implemented for example the Simple Query Interface (SQI). Service developers from their part can develop their service the way they want as long as they obey the interface specifications. Obviously, the more these interface specifications are shared among service developers, the greater the interoperability.

3.3. Semantic Interoperability

Semantic interoperability is achieved to the extent that users of interoperable services give the same or compatible meaning to information exchanged between the services. Semantic interoperability relates to information being exchanged between services and is achieved through several means.

First, it requires a common conceptual model. Standards such as the IEEE LOM and specifications such as various IMS specifications typically make use of a conceptual model or an information model and separate the what from the how; i.e. the conceptual model describes what information is exchanged in terms of concepts, their properties, and relationships between these concepts while a so-called binding expresses how this information is exchanged.

Second, the concept properties may have values that require a common understanding. The values being exchanged are on the lexical level while semantics is at the conceptual level. Semantic interoperability is therefore also concerned with questions such as different terms (possibly from different languages) express the same concept and does a specific term used by different users induce the same semantics? Therefore in order to achieve a higher degree of semantic interoperability, controlled vocabularies (used here in broad sense, referring to value lists, classifications, taxonomies, glossaries, dictionaries, ontologies, and thesauri) are often used. The meaning of a term is not only determined by its definition but also by its relationships to other terms such as in taxonomy or thesaurus [Roadmap to Interoperability…, 2006].

The Semantic layer addresses the interoperability of meaning (semantic interoperability); i.e. will information given by one actor in an educational system be understood correctly by another actor. This might involve terminology aspects (homonyms, synonyms, scope) as well as human language aspects.

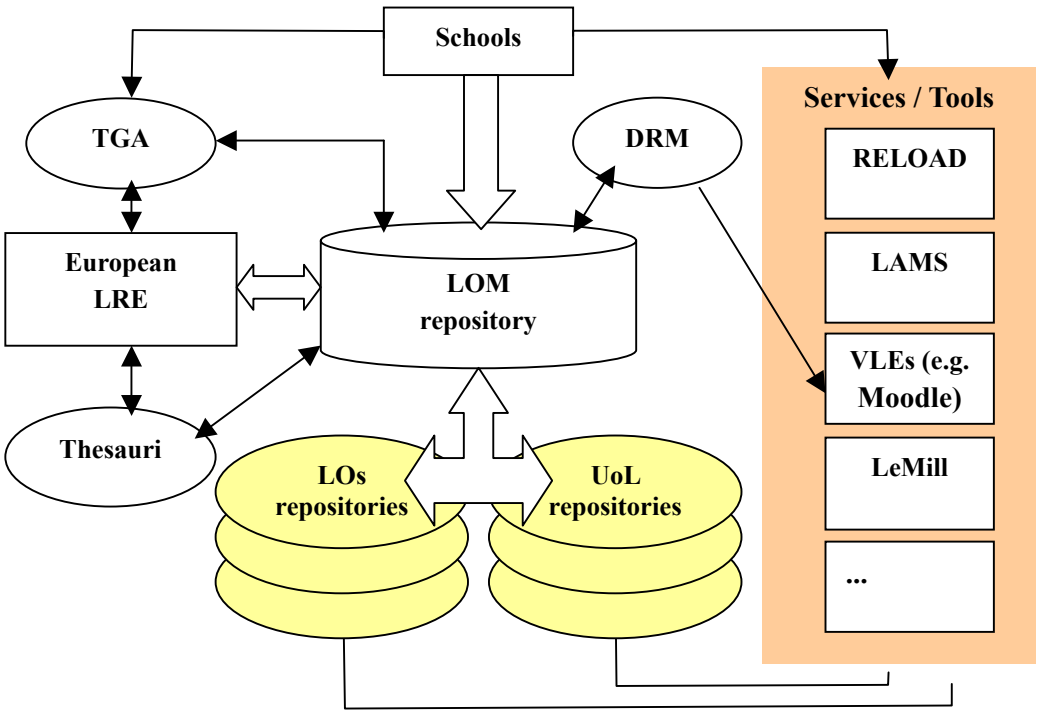

Figure 1. Scheme of Lithuanian DLE

4. Implementation of DLE in Lithuania

Currently national DLE for general education and vocational training systems is under active implementation in Lithuania.

The core players in the field are the Centre for Information Technologies in Education (ITC) under the Ministry of Education and Science, and Institute of Mathematics and Informatics (IMI).

The scheme of Lithuanian DLE under implementation is shown in Figure 1.

4.1. Main Components of Lithuanian DLE

The first Lithuanian decisions in LRs interoperability field were: (1) to localize and embed EUN LOM AP 2.0, (2) to implement LOM repository, (3) to connect Lithuanian LOM repository to European LRE, and (4) to implement TGA ontology-based curricula mapping to search for LRs in their repositories and VLEs.

It is planned that the main components of future Lithuanian DLE will be learning objects and units of learning, their repositories, LOs and UoLs metadata (LOM) repository, and appropriate IMS content Package and LD compliant services / tools.

4.1.1. Contemporary LOM repository

IEEE LO metadata (LOM) standard application profile (AP 2.0) has been prepared by European Schoolnet (EUN, URL: http://www.eun.org) to describe LOs.

The following activities were implemented by ITC while implementing FP6 IST CALIBRATE (Calibrating e-Learning in Schools) project (URL: *http://calibrate.eun.org/ww/en/pub/calibrate_project/home_page.htm*):

- EUN LOM AP 2.0 was localised to Lithuanian.
- More than 1000 Lithuanian LRs were described in conformity with this AP by specially trained LRs indexers.
- LOM repository based on MySQL database management system as well as PHP software package (internet programs handling environment) and Java technology was created (URL: *http://lom.emokykla.lt/public/search.php*). ITC Apache web server and Linux operating system were used for LOM repository.
- User–friendly interface to aggregate LOs metadata into LOM repository was created.
- All these LOs metadata were tested against the compliancy with European thesaurus and filled into LOM repository.
- Several distance learning courses were disaggregated to LOs level and introduced as SCORM packages to reuse in different VLEs.
- LOM repository was connected to European learning resource exchange (LRE) system with the help of SQI technology and Brokerage system.

4.1.2. Contemporary Services / Tools

VLEs

Scientific research results [Kurilovas, 2005] had shown clearly that the best open source VLEs are not less quality on module level than the best proprietary products while being more attractive for educational institutions from financial point of view. Therefore it was proposed Lithuanian educational institutions to widely implement open source VLEs such as Moodle and ATutor.

It was also investigated that VLEs are not neutral in their impact on pedagogical methods and scenarios. We could divide VLEs to more 'content centred' and more 'learner centred' systems. Course design will involve moving from 'content centred' to a 'learner centred' system. Course material in content centred systems is aggregated into 'courses' to which learners are assigned, coupling the learner closely to the content. Learner centred systems organise students into groups [Kurilovas, 2006a]. The more VLEs are 'learner centred', the more they fit the aims of schools as e-Learning communities [Kurilovas, 2006b].

VLE Moodle was evaluated against well-developed pedagogical, organisational and technical criteria as the most suitable VLE for wide implementation in Lithuanian general education and vocational training institutions, as well as for teacher in-service training system. Its fundamental advantages in comparison with the other open source systems are: (1) clear social constructivist philosophy and design; (2) modular, extensible architecture; (3) wide and lively developer and user community [Kurilovas, 2005].

Moodle version 1.6.3 was fully localised by IMI and at the moment is downloadable from ITC server (URL: *http://vma.emokykla.lt*) for installation in educational institutions. ATutor VLE was also localised and enriched by several functions while implementing Education Development Programme, and at the moment is also downloadable from ITC server via the same URL. Decentralised way of VLEs implementation was chosen in Lithuania to strengthen schools as e-Learning communities.

LeMill

LeMill learning toolbox in under development in CALIBRATE to provide teachers the possibility of collaborative learning and creation of LOM compliant LOs. Its interface is localised, and training is provided to target group of Lithuanian CALIBRATE teachers.

5. Interoperability of Learning Resources

5.1. European Learning Resource Exchange (LRE) Policy

European LRs implementation in education policy is based on LRE. Lithuanian DLE is a part of LRE.

Here are the main principles of this policy: (1) LRs are described using open LOM standard for expressing metadata about LRs; (2) federated search engine to search for LRs is implemented (to run search in all LR repositories, connected to each other).

The LRs term here includes LOs and smaller parts (pieces) they can be combined of – learning assets [Kurilovas, 2006b].

The LRE is a service that provides the means to unlock the educational content hidden in digital repositories across Europe and share it among all partners of the LRE and their users. The service is offered to actors providing digital content: Ministries of Education, regional educational authorities, commercial publishers, broadcasters, cultural institutions and other non-profit organisations who are offering extensive but heterogeneous catalogues and repositories of online content to schools.

Exchange system is implemented by connecting national LR repositories of various countries to the federation system – an infrastructure for discovering and exchanging LRs, where each partner remains in control of LRs and their metadata.

Core services provided by the LRE system are:

- LR discovery.
- LR exchange (including digital rights management (DRM)).
- LRs semantic interoperability [Jevsikova, Kurilovas, 2006].

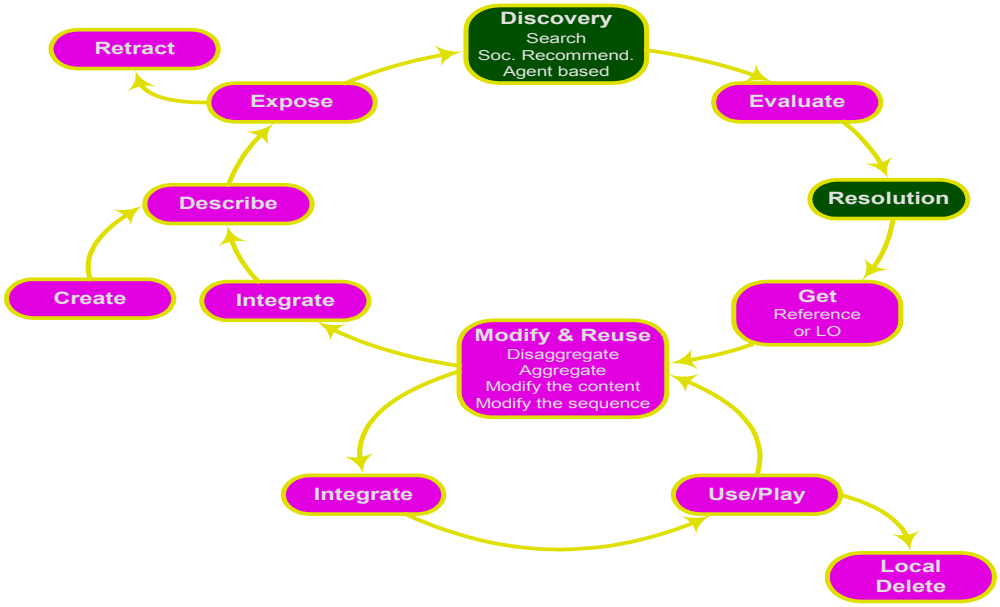

Figure 2. General scheme of LRE working

The quality of the former two services depends on implementation of the latter service – semantic interoperability of LRs. Therefore a lot of attention is channelled to research and practical solutions forming in this domain.

Semantic interoperability problems appear when users can't find a relevant LR, find irrelevant LR, misinterpret or don't understand LR itself, or don't understand the metadata (e.g. purpose, copyright, technical requirements, intended audience) and/or evaluate the LR wrongly.

It is being looked for the best solutions of the semantic interoperability problems. For example, some of proposed solutions might be: development of controlled multilingual vocabularies (terms and their meanings, as well as context), multilingual thesauri (currently 14 languages and about 1200 terms are included into European thesaurus), terminology and curriculum mappings, tracking of end user tagging, using of machine translation, developing LRs with future localisation in mind, localisation of the LRs, resources metadata automatic production from observation of user behaviour.

One of LRs semantic interoperability issues is design of truly multilingual service. This includes all possible solutions mentioned above concerning learning content, and properly internationalised and then localised interface of service implementation, e.g. portal [Jevsikova, Kurilovas, 2006].

5.2. TGA Ontology and Curricula Mapping

Semantic interoperability could be ensured if we could provide mechanisms where a meaningful entity

in a country's curricula can be mapped to a meaningful entity in the other countries' curricula.

CALIBRATE approach is an ontology covering a common set of features for LRs and curricula. This is a three aspect classification model describing topic, goal and activity features (TGA). For curriculum analysis:

- the "T" refers to the topic of a part of the curriculum;
- the "G" refers to the desired level or competence that learners should obtain;
- the "A" refers to intended and prescribed learning activities by the pupils as part of the competence descriptions.

The descriptions of pupils' learning activities, "A", are integrated parts of the goal/competence statements in the curricula. In general the "A's" are described by nouns expressions, e.g. to measure, to construct, to illustrate etc.

To capture the semantic of curricula cross Europe, it is necessary to classify them according to at least T, G and A. Other contextual factors to avoid ambiguity would be purposeful to present in LOM profile.

It is suggested to use topic and its sub- and related topics (e.g. mathematics, algebra, geometry) to conceptually map a national curriculum. However, this is not enough. While analysing the different national curricula CALIBRATE researchers have discovered that they also have competencies embedded and these are connected to certain learning activities. For the knowledge organisation system to represent a precise meaning of the curricula it must take into consideration both competencies and their implicit learning activities.

Four main concepts for describing goals in the curricula were identified. These are: Acquire, Apply, Create and Participate. For each of the main concepts there are 4-9 concepts that are narrower in definition.

One could use TopicMap as a tool for navigating in the document structure, based on the semantic information contained in the document. Based on the tagging, the systems could perform different types of queries based on the classification, and/or based on the different tagged information elements within a part of the document.

CALIBRATE researchers have chosen to represent the curricula document in XML, which also gives the possibility to use a vast amount of tools and applications for navigating and processing this information. There is a number of XML standards that would be useful. Since all the XML tools and the different formats for processing the curricula, and the curricula are in XML format, it will give an advantage of reuse of tools and methodologies between the different "systems", since both TopicMap, RDF, SKOS and the curriculum have the same format.

When the users browse the curriculum using Topic Map, and select a node, based on the semantic tagging of that part of the document, they should get a list of "Goal oriented words" and a list of "Topic oriented words" – based on the combination of this information and the TGA classification, a set of LOs should be provided.

Identification of Goal oriented words could facilitate:

- semantic enrichment for automatic searches in keyword, classification and description of LOs;
- communities to annotate directly to Competency/ Goal placeholders in the curriculum.

Identification of topic related words could facilitate:

- communities to annotate relevant learning resources directly to the curriculum;
- more advanced searches;
- more advanced browsing [Specifications…, 2006].

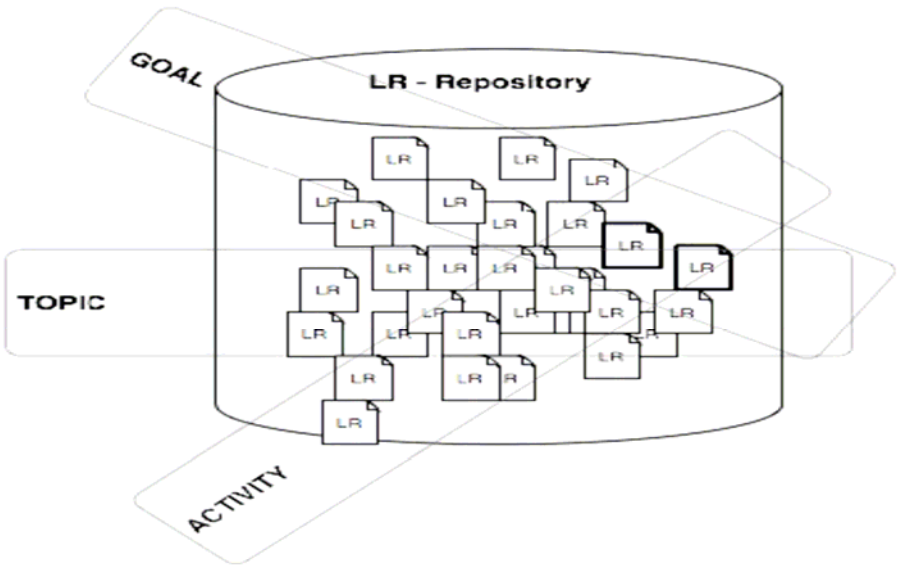

Figure 3. Search in LOs repository using TGA ontology

Lithuanian Mathematics curriculum for secondary level was chosen as pilot for mapping in CALIBRATE, and at the moment it is already mapped against learning goals.

6. Learning Design: Interoperability of Learning Methods and Scenarios

The work on Educational Modelling Languages (EMLs), and their subsequent integration in the IMS Learning Design Specification [IMS-LD, 2002], is the most important initiative to date, to integrate Instructional Design preoccupations in the international e-Learning Standards movement.

The EML concept challenges the over importance devoted to LOs seen solely as information packages [Paquette, 2004].

6.1. Units of Learning and IMS Learning Design

A lot of learning does not come from knowledge resources at all, but stems from the activities of learners solving problems, interacting with real devices, interacting in their social and work situation. A lot of research about learning processes provides an evidence that learning doesn't come from the provision of knowledge solely, but that it is the activities of the learners into the learning environment which are accountable for the learning. The emphasis on learning designs is also justified from a reusability perspective [Paquette, 2004].

One of the basic aims of IMS Learning Design (LD) specification is to enable the abstraction of different learning design approaches into a meta-language that will represent and allow the interchange of practically any learning scenario. The meta-language, when designing LOs, is an important point, because it strongly affects the usefulness, interoperability and reusability of a LO and its assets. In short, IMS LD can be described as an XML-based description of requirements for e-Learning based on the conceptual model of "people doing activities with resources". The emphasis on activities is important both from a pedagogical perspective as well as from an educational technology perspective as the XML describes how the different activities should be organised. This includes which roles the different users in the learning scenario have, how the activities will flow during the learning scenario and when and how the users will use the different LRs available to them [Empirical study…, 2006].

IMS LD is not a tool or environment, but a specification that provides a model for developing LRs and VLEs. IMS LD describes tasks and activities, their assignment to roles, and the flow of activities that constitute a course module or lesson known as UoL.

The meta-model contains four packages:

1. The learning model: describes how learners learn based on commonalities in learning theories, kinds of activities learners carry out when learning, and aspects of motivation and results.
2. The unit of study model: represents aspects that a learning designer has to take into account when designing a unit of study. Roles, learning objectives, prerequisites, learner characteristics, learning domain, learning context and assessment are all considered important aspects.
3. The domain model: represents the characteristics of the subject domain (e.g. mathematics, history etc.). Different domains embody different cultures for learning and have their own way of dealing with knowledge and skills.
4. Theories of learning and instruction [Empirical study…, 2006].

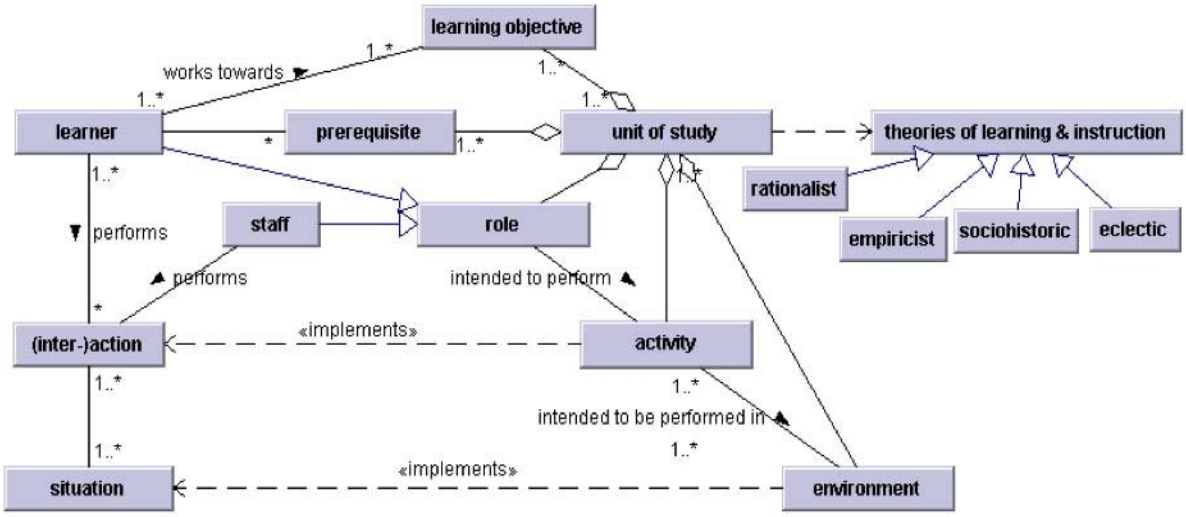

Figure 4. EML pedagogical meta-model

Together, these four packages form a meta-model (Figure 4). Important aspects identified are learning objectives, roles (both learners and staff), activities and environments (containing services and content material).

IMS LD benefits from a well-documented conceptual model and architecture, and IMS LD "learning objects" are based on XML. IMS LD's concept of a learning module, lesson or course is called 'Unit of Learning' (UoL) [Empirical study…, 2006].

UoL itself and all its components are embedded LOs, including learning objectives, prerequisites, learners' or trainers' roles, activity assignment, information objects, communication objects, tools and questionnaire objects [Paquette, 2004].

Identifying the LOs associated to a UoL and the interrelations between them is not sufficient from a technical perspective. The IMS LD information model needs to be expressed in a standard XML binding enabling computer processing by any compliant e-Learning system. It should then be possible for any VLE to interpret and use the unit of study, reuse the LOs composing the unit in new contexts, as well as adapt, distribute and archive UoLs and all the LOs they contain.

A UoL refers to any delimited piece of education or training, such as a course, a module, a lesson. When activating a UoL, the method element is central. It is located within the UoL set of XML files. This central element and its sub-elements control the behaviour of the UoL at runtime, coordinating the activities of the actors in the various roles they play and in their use of LOs. A method is composed of plays that provide alternative scenarios for the same unit of study, to adapt to different target populations or to different delivery models such as distance or classroom learning. Each play unfolds in a series of one or more acts which are always run in sequence. An act brings together one or more role-parts, each role-part associating exactly one role (learner, trainer, tutor, manager, etc.) with exactly one activity, associated or not to a set of LOs. At every level within a method, it is possible to specify rules when a role-part, act, play or UoL is completed [Paquette, 2004].

UoL is basically IMS Content Package where the Organizations element (that defines the structure of the overall learning experience) is IMS LD specific (Figure 5).

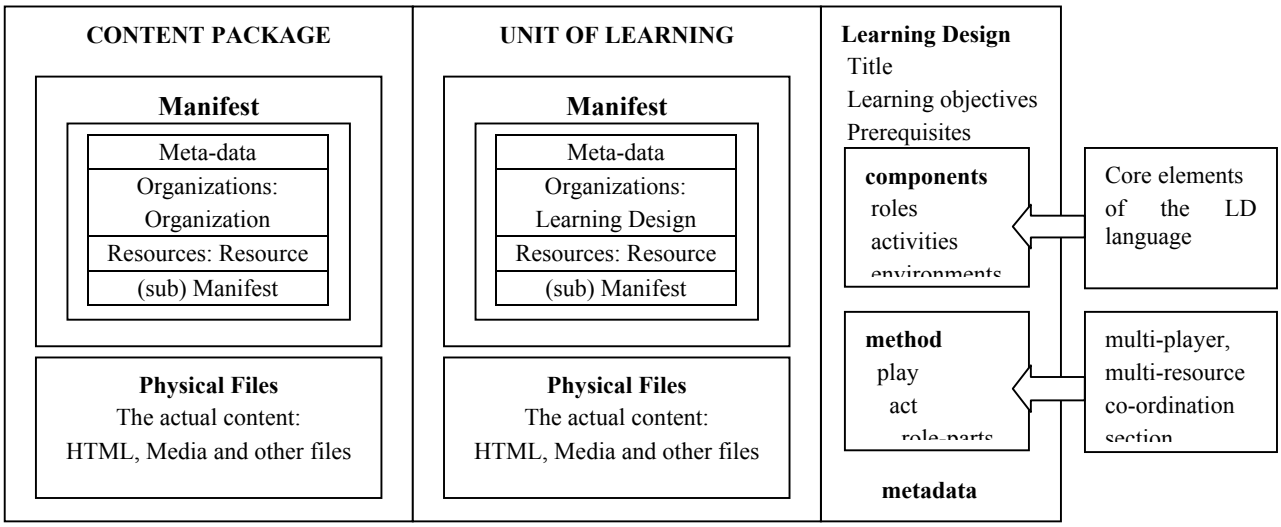

Figure 5. IMS LD's location in an IMS Content Package and structure of IMS LD elements [Olivier & Tattersall, 2004]

IMS LD consists of a set of components that play together during a method. Key components in LD are roles, activities, activity structures, environments, properties and conditions.

Roles: In LD, there are two predefined roles, a learner role and a staff role. Each one of these roles can be further specialised into sub-roles. For example, in a learning scenario, students can have different roles. Each role can then be assigned to different activities.

Activities: In LD, activities are associated with a role and they contain the actual instruction for a person in that role. There are two types of activities; learning activities that are directed at a student and aims to achieve a specific competence and support activities that where students support peer-students or a teacher supports the students.

Activity Structures are basically aggregated activities that can reference other activity structures, environments and UoLs.

Environments are URLs to LOs and services that can be inside or outside the UoL. Students typically use LOs when performing an activity, but these objects are not a part of the activity description itself. Services are used to provide facilities that are helpful for completing activities like discussion forums and e-mail systems.

Properties are containers that can store informa-

tion such as the progression of a student in a course module, completed activities and results of tests.

Conditions enable designers to define rules that govern the behaviour of a UoL as a whole and what gets presented to individual roles [Empirical study…, 2006].

Unfortunately, there are currently almost no environments that can take an existing learning design and run it, also there is a paucity of tools available to assist in creating a learning design. However, there are several recent developments (tools) that are worthy of mention here:

- LAMS (Learning Activity Management System), URL: *http://www.lamsfoundation.org/*. LAMS is learning design inspired system for the creation and running of learning designs in the form of sequences of learning activities [Kurilovas, 2005].
- RELOAD project, URL: *www.reload.ac.uk*. This project funded under the JISC X4L Program is engaged in producing tools for the creation, editing and running of both LOs and learning activities that implement the appropriate IMS / SCORM specifications. The project is implementing IMS content packaging, simple sequencing and LD specifications in a suite of open-source tools including a package editor based on the existing PackageIt, a SCORM player for running SCORM 1.3 content and the Colloquia VLE [Kurilovas, 2005].
- EduSource project, URL: www.edusource.ca. The IMS LD specification has been retained as a major eduSource component. The central goal of the project is to enable existing Canadian LO repositories, or future repositories in Canada or elsewhere, to communicate seamlessly so that their LOs can be found and aggregated in UoL [Empirical study…, 2006].
- The future Moodle version 2 is expected to become a big break, with major core changes, and it is planned to include LD input [Kurilovas, 2005].

6.2. UoLs Reusability Aspects

How can one extract pedagogical methods from a LD? Creating ready-made templates for teachers is a new area of focus within the field of educational technology and was also demonstrated in FP5 Celebrate project where teachers used templates [McCormick et al., 2004]. This question is closely connected to work on the reuse of LOs [Wiley, 2002] and the more recent work on pedagogical patterns [Bergin et al., 2005].

In IMS LD the idea has been to reuse the elements representing learning processes in different ways. Using IMS-LD, it is possible both to take an existing learning design and use it with new content resources (for example applying a learning design for Problem-Based Learning to the different subject areas or have existing content resources be used with different learning designs) [Downes, 2003].

This statement reflects much of the current work done on reuse of IMS LD's UoL:

- Ready made templates where the teacher fills in desired elements of an "empty" UoL.
- Reusable UoL's where the whole unit can be exchanged between repositories and modified on a detailed level.
- Reusable elements of a UoL where specific components (like an act or activity structure) are exchanged between repositories and modified [Empirical study…, 2006].

When reusing whole UoL's like LO's there would be problems regarding metadata for exchange and how a system could give a teacher access to modify the UoL.

A UoL consists of an IMS-manifest XML-file and corresponding resource files. If we want to reuse only parts of a learning design, we would have to look into the manifest file to identify structures that could be extracted.

Looking only at the activity element would not make any sense because to this element the designers only give it a title and assign resource files that describe that activity, the learning objectives of that activity and the prerequisites. The designers can also describe what will happen when the user ends the activity. This could be reused as a possible LO (content), but is unlikely to represent a teacher's pedagogical method [Empirical study…, 2006].

The activity-structure element does not give any meaning as a pedagogical method either because in this element the designers only group together activity elements, which still have not been connected to role-parts. We should therefore look at the elements in the method section where the design actually works as learning activities coupled with support activities and role-parts. We could reuse the whole method element, but that would basically be the same as reusing the whole LD. However, if we go down to a reasonable granularity level where there is a sequence of activities connected to role-parts, we can focus us on plays and acts. Both these elements have a granularity level that makes them reusable. We could also go down to the level of acts where many activities play together with role-parts and reuse these containers of meaningful learning processes. To reuse the individual act, we would have to extract the act-element where the different role-parts are embedded and also have to be extracted. These role-parts are connected to activity structures that consist of activities and their referenced resources. Elements for activity-structures, activities and resources would then have to be extracted as well.

There has been a growing community of researchers working on the reuse aspects of IMS LD. They primarily look for new and innovative ways to reuse pedagogical methods that are embedded in a learning design. Usually, this way of doing instructional design is based on the idea of translating theoretical ideas into a design. Others approach the problem differently

looking at many different learning designs that through empirical evaluation identify patterns for "best practices". There are still not many working examples of reusable learning designs except where the designers have imported a UoL and modified it to suit their needs [Empirical study…, 2006].

We consider that UoLs and LD implementation together with several LD compliant tools such as RELOAD and LAMS have to be essential parts of Lithuanian DLE. Therefore ITC has planned this topic of the major interest for Lithuania while implementing EU-funded P2V project coordinated by EUN (Peer to Peer networking for Valorisation, URL: *http://eacea.ec.europa.eu/static/en/elearning/compendia2006/documents/p2v.pdf*), and the first P2V UoL-related thematic workshop will take place in Vilnius in June 2007.

6. Conclusions

The main components of Lithuanian DLE under implementation are LR repositories together with their metadata repository as well as appropriate services (such as VLEs and other IMS LD compliant tools).

The main idea of Lithuanian DLE is the idea of partition of LRs to two separate parts (LOs and UoLs) which have clear different functions.

Provision of reusability and interoperability of LOs, UoLs and different services inside the system and on European level by connecting it to European learning resource exchange is one of the main functions of DLE.

The main scientific and technical decisions proposed to provide semantic interoperability of DLE's components are:

- LOs' and UoLs' description in conformity with EUN LOM AP and thesaurus, and full implementation of LOM repository.
- Implementation of TGA ontology and curriculum mapping to find appropriate LOs.
- Implementation of tools to create and reuse UoLs.

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