# INTEROPERABILITY GUIDELINES FOR DIGITAL LIBRARY OF EDUCATIONAL RESOURCES AND SERVICES

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Abstract: The main scientific and technologic problems investigated in this article deal with creation of flexible e-Learning content and services system (Digital library of educational resources and services - DLE) providing learning customisation possibilities for its users. The aim of the work is to examine existing and emerging international interoperability standards and specifications, and to provide recommendations how to improve e-Learning standards' application profiles and their adoption and application in e-Learning practices as well as to help to combine existing standards and specifications into complete solutions that address the needs of the school sector in terms of Learning Objects (LOs) discovery, exchange and reuse. The main recommendations (for curricula mapping and for LOM Application Profiles (APs)) are presented in the article. Lithuanian DLE for general education based on flexible approach is presented in more detail.

## 1 INTRODUCTION

The main scientific and technologic problems investigated in this work deal with creation of flexible e-Learning content and services system (Digital library of educational resources and services - DLE) providing learning customisation possibilities for its users. The authors consider DLEs to be the aggregates of LO repositories, and services, organized as complex information systems, and LO to be 'any digital resource that can be reused to support learning' (Wiley, 2000).

The aim of the work is to examine international interoperability standards and specifications, and provide recommendations how to improve e-Learning standards' APs and their adoption and application in e-Learning practices as well as to combine existing standards and specifications into complete solutions that address the needs of the school sector in terms of LOs discovery, exchange and reuse.

The tasks according to this aim are:

**(1)** to formulate and analyse the key principles of creation and development of flexible DLE: ultimate reusability and interoperability of LOs (Learning Assets (LAs) and Units of Learning (UoLs)) and Virtual Learning Environments (VLEs) adaptation capabilities;

**(2)** after investigation the main interoperability standards and specifications for DLE, to provide recommendations how to improve e-Learning standards and specifications, namely;

**(2.1)** to analyse, validate and provide recommendations for European Learning Resource Exchange (LRE) service for schools;

**(2.2)** to analyse and provide recommendations for curriculum mapping and integration with LOs metadata on European and Lithuanian level;

**(2.3)** to provide recommendations for improvement of existing IEEE Learning Object Metadata (LOM) standard's application profiles (APs);

**(2.4)** to provide recommendations for flexible DLE components' and their interoperability;

**(3)** to partly create the practical example of implementation of flexible DLE – DLE for Lithuanian general and vocational education, and to prepare recommendations for its development.

## 2 DLE CONCEPT

The presented approach for DLE is based on the proposition that it should consist mainly on 'ultimately reusable' LOs and their metadata repositories as well as appropriate services to create, modify and manage LOs, e.g. adaptable VLEs.

The need for reusability of LOs has at least three elements: (1) interoperability: LO is interoperable and can be used in different platforms; (2) flexibility in terms of pedagogic situations: LO can fit into a variety of pedagogic situations; (3) modifiability to suit a particular teacher's or student's needs: LO can be made more appropriate to a pedagogic situation by modifying it to suit a particular teacher's or student's needs (McCormick et. al., 2004).

The authors' approach is that ultimate reusability of LOs should be ensured by their partition to two main separate parts (LAs and UoLs) which should work independently and should have clear different functions: (1) LAs are considered not to be directly interconnected with particular pedagogical activities / designs, and therefore it should be possible to reuse the same LAs to implement different learning designs; (2) UoLs are conversely considered to be LOs containing learning activities / designs reusable for different subjects and different LOs / LAs.

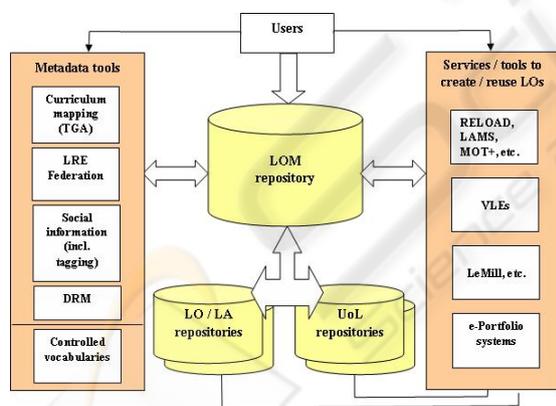DLE components' scheme based on this approach is presented in Fig. 1.



Figure 1: The scheme of flexible DLE.

## 3 RECOMMENDATIONS FOR DLE INTEROPERABILITY

Conclusions of the analysis of existing standards and specifications performed by the authors are:

(1) the majority of standards and specifications are not adopted and do not conform with educational practice; (2) there exists a problem of complex solutions for application of standards and specifications in education; (3) standards and specifications often do not cooperate.

### 3.1 European Learning Resource Exchange for Schools

European LOs implementation in education policy is based on LRE. This is a federated network of 20 learning content repositories that has been developed by European Schoolnet (EUN) and its supporting Ministries of Education (incl. Lithuania) together with other partners that include the ARIADNE Foundation.

The main principles of LRE are: (1) LOs are described using LOM standard for expressing metadata about LOs; (2) federated search engine to search for LOs is implemented. 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. LRE system is implemented by connecting national LO repositories of various countries to the federation system - an infrastructure for discovering and exchanging LOs, where each partner remains in control of LOs and their metadata.

Core services provided by the LRE system are: (1) LOs discovery; (2) LOs exchange (including Digital Rights Management (DRM)); (3) LOs semantic interoperability. The quality of the former two services depends on implementation of the latter service - semantic interoperability of the LOs (Jevsikova, Kurilovas, 2006).

The newest EUN initiative in the field is ASPECT project proposal to European Commission. ASPECT is Best Practice Network for educational content that involves 23 partners from 16 countries, including 10 Ministries of Education (incl. Lithuania), four commercial content developers and leading technology providers. For the first time, experts from all international standardisation bodies and consortia active in e-learning (CEN / ISSS, IEEE, ISO, IMS, ADL) will work together in order to improve the adoption of learning technology standards and specifications.

Most stakeholders will benefit from agreed profiles and established practices as projects like ASPECT help combine existing specifications into complete solutions that address the needs of the school sector in terms of LOs discovery, exchange and reuse (ASPECT, 2007).

LRE validation in Lithuania has shown that the teachers prefer LOs from national repositories which

have the potential to 'travel well' and can be used in different national contexts. These reusable LOs preferred by the teachers are mainly 'small' decontextualised LAs.

There are two main conditions for LOs reusability elsewhere: (1) LOs have to fit different countries' national curricula; (2) different countries' LOM application profiles have to be oriented towards quick and convenient search of reusable LOs. Approaches concerning application profiles and curricula mapping (incl. controlled vocabularies) are the main while creating any metadata guidelines or strategies. Therefore the recommendations to curricula mapping and LOM AP are the main in the author's DLE interoperability guidelines.

## 3.2 Curriculum Mapping

(CALIBRATE) project's approach makes interoperability possible by making use of two smaller controlled vocabularies instead of a very large one on competencies which would be more volatile. The approach builds on proven technologies, i.e. thesauri, and well-known vocabularies for the action verb expressions and allows for relaxing the search criteria building upon the hierarchical structure of the two vocabularies (Van Assche, 2007).
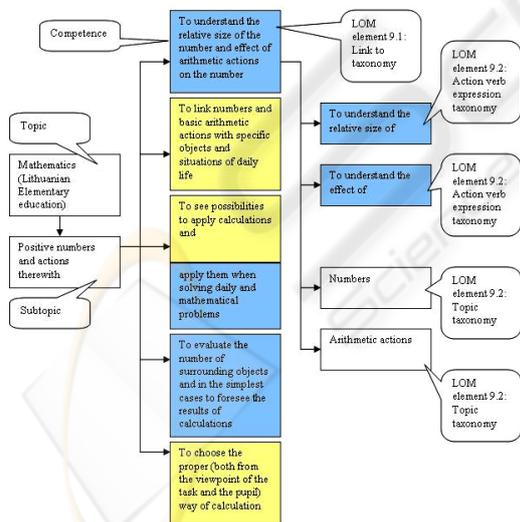


Figure 2: Lithuanian example of mathematics curriculum mapping and connection with LOM AP.

## 3.3 Proposals to LOM AP

The authors' research and Lithuanian teachers-experts survey performed during CALIBRATE

project's summer school in Slovenia in August 2007 have shown that it would be purposeful to improve the existing LRE AP v3.0 to provide more quick and convenient search possibilities for those searching ultimately reusable e-content components by the means of changing (advancing) the status of several LRE AP elements (see Fig. 3).

This principle could be the basic one for preparation of Lithuanian LOM AP.
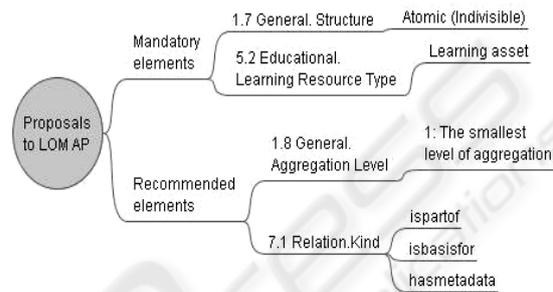


Figure 3: Proposals to Lithuanian LOM AP.

## 4 DLE FOR LITHUANIAN EDUCATION

## 4.1 Contemporary Practice

Several important developments in the field were carried out in the Centre of IT of Education under Lithuanian Ministry of Education in 2006:

(1) EUN LOM AP 2.0 was localised;

(2) separate LOM repository based on MySQL database management system, PHP software package and Java technology was created together with user-friendly interface to aggregate all LOs metadata into LOM repository;

(3) metadata for more than 1200 Lithuanian LOs were created in conformity with LOM AP, and aggregated into LOM repository by specially trained indexers;

(4) all approved distance learning courses were disaggregated to smaller courses (and even LAs level) and introduced as SCORM 2004 packages to reuse in different VLEs;

(5) LOM repository was connected to European LRE system via Simple Query Interface technology and Brokerage system.

## 4.2 Recommendations to Development of Lithuanian DLE

Recommended developments for flexible DLE for Lithuanian education are yellow coloured in Fig. 4.
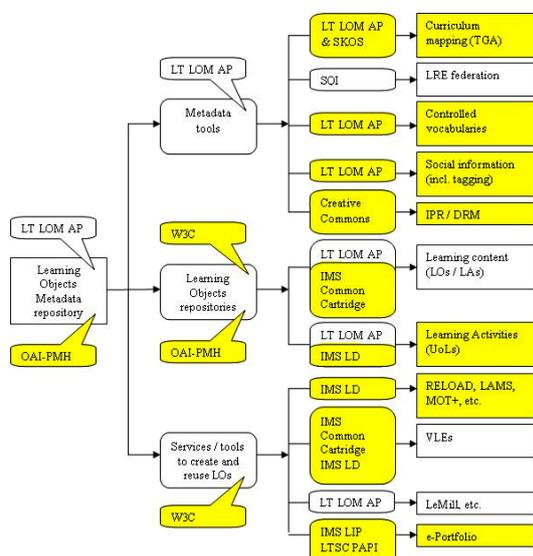


Figure 4: Recommendations for development of DLE for Lithuanian education.

The recommendations are:

(1) horizontal implementation of W3C accessibility standards for all components of DLE;

(2) for repositories: (2.1) implementation of repositories interoperability based on ability to integrate with other repositories (OAI-PMH compliance), and ease of integration with systems such as VLEs; (2.2) creation of fully LD-compliant environment to reuse UoLs and implementation of Learning Activity (UoLs) repository; (2.3) implementation of IMS Common Cartridge and Learning Design specifications;

(3) recommendations for metadata tools: (3.1) implementation of Topic-Goal-(Learning) Activities (TGA) ontology-based curriculum mapping in main subjects to search for LOs in the repositories and VLEs; (3.2) implementation of main controlled vocabularies (e.g., Topic and Competency taxonomies); (3.3) implementation of social tagging and bookmarking tools to enrich LO metadata with the learning practice experience; (3.4) implementation of LOs digital right management (DRM) system based on localised and approved Creative Commons licences;

(4) recommendations for services and tools to create and reuse LOs: (4.1) implementation of IMS LD-compliant tools (e.g. RELOAD, LAMS v.2.0.3 together with Moodle v.1.8, MOT+ etc.) to create and reuse UoLs; (4.2) to localise and implement IMS CC and IMS LD compliant VLEs; (4.3) to implement teachers' and students' e-Portfolio systems based on IMS LIP or IEEE LTSC PAPI.

## 5 CONCLUSIONS

The key principles of creation flexible DLE are ultimate reusability of LOs and VLEs adaptation capabilities.

The majority of standards and specifications are not adopted and do not conform with educational practice, there exists a problem of complex solutions for application of standards and specifications in education, and standards and specifications often do not cooperate.

Approaches concerning application profiles and curricula mapping are the main while creating any metadata guidelines or strategies.

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