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The Integrated Environment for Learning Objects Design and Storing in Semantic Web

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Abstract: There is a variety of tools and environments for Learning Objects (LOs) design and delivery as well as learning object repositories (LOR) but the researchers could not find a repository that includes both functions: creation and storing of LOs. A number of different integrated learning systems are suggested for users that demonstrate the variety of e-learning methods and semantic capabilities. LO repository oer.ndma.lt/lor, that we are going to present, is very friendly and interoperable to use and assure LO design, search in semantic web, adaptation of the re-used objects and storing. There are no more existing LO repositories with the functionality presented by researchers. Transformation of closed education into open one without existence of well-structured, multifunctional and integrated environment becomes problematic. Authors will present an integrated environment for the LO design, search in semantic web, adaptation and storing of newly designed or re-designed LO. Measures will support the transformation of closed education into open and will assure effective design, re-usability and adaptation of LO in the integrated environment.
Keywords: learning objects (LO), models, semantic web, semantic technologies.

1 Introduction

The authors of the paper explore the existing learning objects repositories throw the open education and transformation of education into openness where it is a need to have an integrated environment for LO design, search and storing in the Semantic Web [4, 5]. Bellow presented different scientific papers and authors have analyzed technological challenges for LOR and IS implementation into learning design process. In this paper, Learning Objects (LOs) are referred as "small, modular, discrete units of learning design for electronic delivery and use" [27]. All Learning Objects can be identified by these features: interoperability, reusability, manageability, flexibility, accessibility, durability and scalability [22]. Analyzing Learning Objects from the technological perspective, they are based on the "paradigm of object orientation" [14] which means that the parts of a learning object can be used, changed or created repeatedly. This feature allows the user to create new and unique Learning Objects that can be used multiple times. In this process, the semantic web plays an important role.

The Semantic Web is "the extension of the World Wide Web that enables people to share content beyond the boundaries of applications and websites" [12]. In other words, the Semantic Web can be understood as a web of related meanings. The authors of the paper analyze the opportunities of the Semantic Web in the perspective of the search of a Learning object. In this

case, semantic web broadens the search and provides more and better fit with the search requests on the various aspects.

The context of semantic web, most of the practical implementations and use of standards are related to the marking of learning objects, which creates a lot of additional requirements for the successful use of standards [16]. When searching for ways to improve the courses using semantic web technologies, it is very important to develop simple methods and tools for LO labeling, separation of the objective and subjective metadata to create metadata sets and schemes from a variety of sources, to integrate production and labeling, to include formal semantics into existing standards and dynamically associate metadata with different LO. These are the challenges that are expected to be solved.

For sharing reusable learning objects, repositories are required so that these learning objects could be stored and delivered . The role and functions of learning objects' repository are described in the IMS digital storage compatibility specification [11].

A variety of learning object repositories are existing, however metadata studies show that the majority of metadata of currently existing Learning Objects Repositories (LORs) is only a general description of the content and settings [21]. Such data is difficult to use for program agents. Therefore, it is important to create semantic relations in the repositories so that learning objects would be fully integrated and linked [10]. A Semantic learning object repository is a system containing the educational resources and metadata (or metadata only) which provides search interface to people or other systems [2].

The analysis shows that the existing LORs and IS analysed and presented by the authors do not assure effective e-learning objects (ELO) design, search in semantic web and adaptation, as well as there is no suggested model, which will assure ELO adaptation in semantic web and automatically will integrate ELO to be re-used.

2 A research methodology

The research methodology was prepared in the frames of constructive method. The constructive research method takes 5 phases (see fig.1): (1) literature review; (2) problem identification; (3) theoretical framework; (4) practical implementation and (5) experiment. (Figure 1).

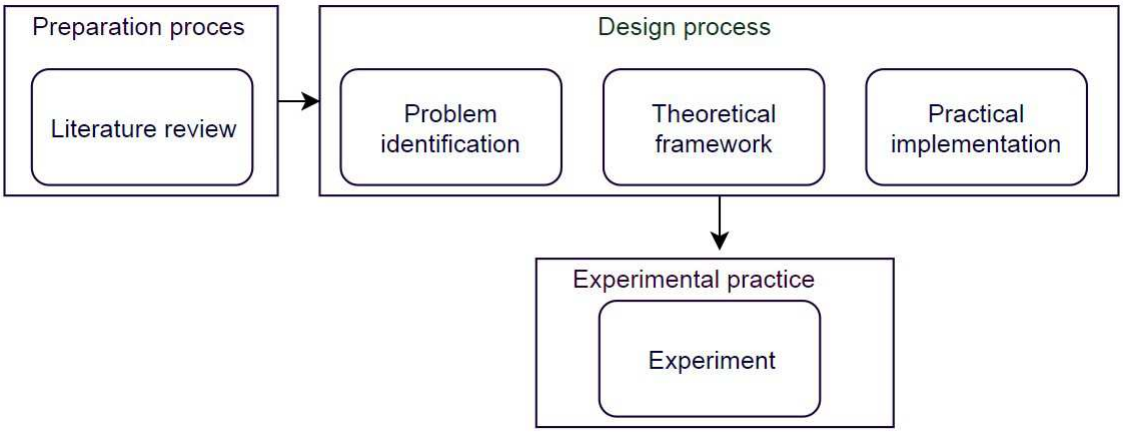

Figure 1: Constructive research method

A systematic review of related research works and analytical research methods were used for revealing the advantages of the use of Semantic Web technologies for integrated environment and for raising issues related to the semantic learning objects' use in semantic education as well

as for exploring existing LOs design approaches and models and for extracting initial data from our model linked to a theoretical framework.

The theoretical framework is designed to explain the integrations in the environment and the need of the new technological solutions after problem identification. Practical implementation phase evaluated during the experiment phase.

3 Related works on learning object repositories implementation

The comparative analysis of smart e-learning systems and architectures [26] [25] highlights the challenges of e-learning: (1) development of mobile agent's architecture in semantic web-based e-learning systems, while the agent knowledge is improved; (2) increased number of visualized educational resources; (3) new cooperation and communication with the learner to apply artificial intelligence achievements and the updating of internal and online databases, wikis etc.

3.1 Learning object repositories

Learning object repositories are operating online by providing the users a lot of different LOs by covering different educational levels and topics and also developed by variety of technologies and having different metadata described with the aim to classify LOs [19].

There are a lot of different well known learning object repositories like: CLOE; MIT Open Courseware (OCW); VCILT; CAREO; OLI; Commonwealth of Learning Object Repository; Edclicks; Encore; GEM; LOLA; MERLOT (specialized in microworlds); NDMA (www.oer.ndma.lt/lor/) repository for LO and different educational activities design and store.

Most of these LORs follow IEEE-LOM metadata standard and metadata annotation is done manually. However, the learning object repositories are used not only for storing but also for sharing, reusing and LO design [18].

Mohan and Brooks [23] discussed a situation where learning objects are embedded within learning systems. Today we have an analogous situation with mainframe systems. Learning systems today are essentially centralized, with learning objects (data) managed at a single place by a single system. However, with the growth of learning object repositories on the Semantic Web, it is necessary to find a model for the LO search, exchange and design where a learning object may also contain links to other courses or content packages, where it has been used before to support searches by software and human agents on the Semantic Web [17].

Goncales and Pimenta [13] analyzed the LO's integration into virtual learning environment and made a conclusion that in a dynamic environment of content sharing and educational practices the LOR has to integrate, thus creating dynamic learning environments to allow the interoperable user to retrieve them by searching through federated repositories, with the ability to modify those objects and compose lessons out of them.

The integration aspects were discussed by Shen, Ullrich and Borau [28] who outlined the importance of metadata in the LOR implementation process. LOR uses metadata to describe LOs and helps to improve the search for users. Learning Object Metadata lower barriers for repository growths as the server or learning environment does not contain the whole object but the metadata. This feature allows to have big Learning Object Repositories with less expenses. The model based on metadata of Learning Objects were implemented in proposed LOR as well.

3.2 Learning object design models

The researchers worked on the integrated environment for LO design and search in the semantic web.

Table 1: Comparative analysis of the LO models

Models	Features of the model
Verbert and Duval model	The model components are: content parts, learning objects, content objects. The model explains how the authors distinguish the fragments of content, content and learning objects (text, audio and video), presents individual resources [29].
Meyer model	LO components are designed on the basis of a clearly defined concept. LO components are well defined and focused on reusing. LO has one or more evaluation criteria and their usage areas includes several lessons [3].
Boyle model	Structural generative learning model (GLO) of an object contains inner and outer structures. GLO behavioral model consists of development tool, an XML file, and player program. As the main characteristic of the model, Boyle distinguishes the ability to change the flexibility of the XML file, using authoring tools to create instances of GLO layouts [8].
Santiago and Raabe generative model	Generative learning objects of higher levels (AGLO) come from the advanced options of heterogeneous meta-programming technology that allows to convey many aspects of learning (such as content, didactic, social and technological aspects) clearly through parameterization [7].
"Learnativity" content model	The model defines five levels of content hierarchy [29]: 1. The raw data and media items belong to the lowest level. 2. Information object includes raw data as well as media items and focuses on one piece of information. 3. On one task basis, information objects are connected to the third level - software objects. Learning objects are sets of information objects. 4. The fourth level - complex sets for larger (end) tasks. 5. Lessons or sections can be combined into larger sets.
NETg LO model	This model defines the rate as a matrix, divided into three main components: subjects (vertical), lessons (horizontal) and topics (fields) [1].
BNTOPM model	Widely used set of specifications for creating learning content independently from specific content delivery platform. BNTOPM includes content model compounds, consisting of shared content objects and containing compound [14].
"Navy" content model	"Navy" content model is an improved BNTOPM content model that offers more specific content definitions for detail levels that are necessary for the "Navy Interactive Learning Environment". The content of "Navy" is compatible with BNTOPM. "Navy" distinguishes LO compounds, final LOs, enabling LOs [29].
"Cisco" DNMO/DNIO model	Cisco classifies each DNIO. Possible content element classifications are: definition, example, overview, further steps, analogy, topology illustration, block scheme, additional resources, pie charts, teacher's notes, introduction, a key wording, illustration, importance, plan, facts, list, objectives, contrast, table, working scenario, conditions, guidelines, procedures' table, decisions' table, demonstration, table of prepared or combined [9].

Dynamic learning content management system model	The aim is to increase learning content reusability providing a modular design strategy together with a structured description [20]. The system includes a component model that defines three circuit levels: 1. The asset is media elements: pictures, video clips, animations, and simulation. 2. The content elements are defined as small, modular learning content units, which: (1) form the basis of learning content, (2) can be combined into larger, didactically based learning units (3) are independent, (4) are based on a single didactic content type (5) can be reused in different teaching contexts and (6) can be made of assets. Learning unit is defined as a set of elements.
ALOCOM model	It defines different levels of detail of contemporary content models as well as their mutual relations. It is based on OWL language, which uses ontologies for relating the content models [24].
Integrated modeling method - conceptual, educational and didactical model	It is a sustainable model developed to model the educational content. It consists of several models: conceptual, educational and didactic. Each of them defines specific learning object development aspects. The conceptual model is the basis for the field of knowledge, because it provides teaching concepts and determine their mutual relations [6].

The analysis shows that currently there is no model where LO functionality would be directly semantically tied to LO repository and LO development environment, where different learning objects are created.

4 The integrated environment for learning object's design and storing

Traditional teaching must be re-evaluated and adapted in a way to of open education. We cannot forget the educational aspects of the LO, which have a direct impact on a successful organization of learning process, and for efficient LO development. For the creation of such learning object, the educational model of LO planning, development and delivery is applicable. The essential functionality is related with LO design, delivery and search for additional material by using semantic web [15] i.e. search in other repositories of open educational resources for improving the designed LO.

Semantic network software agents can use contractual language service that allows agents to work together and actively introduce the learning material in the context of current problems. The aim to create links between learning objects and semantic network is very important in LO adaptation or improvement (Figure 2). The framework for the user profile is close related with the learning program and a different types of LO distributed in the integrated environment having also functions of learning object repository (LOR) (Figure 3).

The context is complex and dynamic, composed of a variety of problematic situations. According to the LOM specifications, context is the environment in which the LO may be created.

All contextual components are directly related to the tasks, content structure, available resources and contextual model, bringing together all these resources into the whole with the help of LO repository. The aim is to provide the necessary information to the consumer, and to carry out a search of electronic sources using keywords.

The new framework links semantic web technologies and learning objects: the technologies that facilitate search and re-use of learning objects in LO repositories are developed. The idea of search in the semantic web, is to find similar content LO not only in national but also internation-

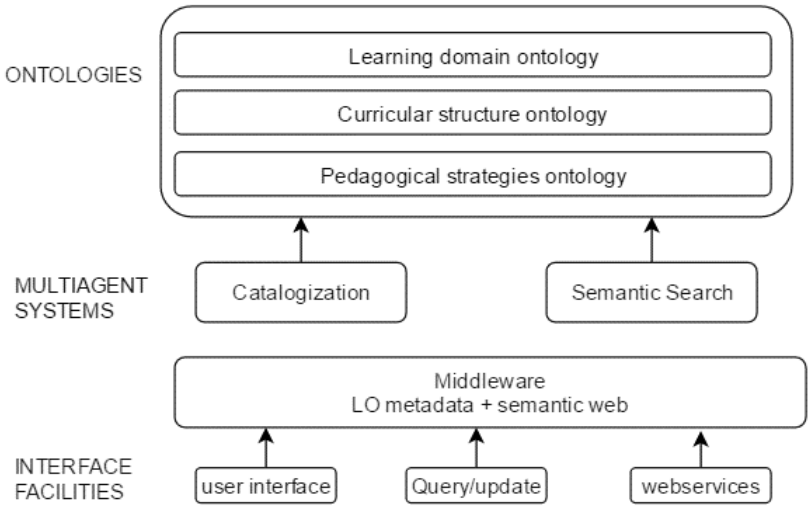

Figure 2: Integrated environment for learning objects design and storing in semantic web

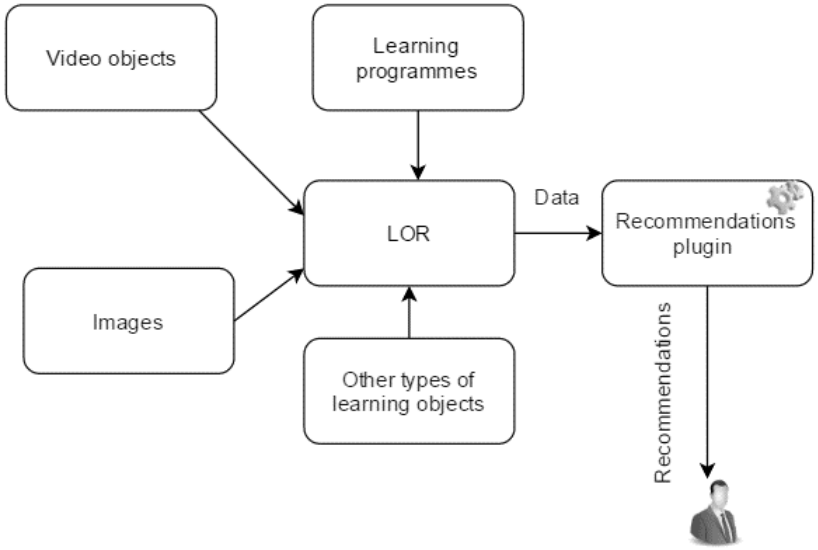

Figure 3: Framework for the user profile in the LOR

al/external learning object repositories, directing into storage that support certain educational topics (Figure 4).

LO search is performed from the user development environment and directly channeled into educational learning object repositories. Figure 4 shows the LO search algorithm in semantic web. Such a search cannot be carried out without using, i.e. each LO must be described and assigned to a specific storage area containing the various technologies and content objects (see Table 2).

For example, when modeling the LO repository, we distinguish the following entities: book - abstract publication in a repository; catalogue - systematic LO catalogue, in which the knowledge area includes a part of books or LO of the repository; teacher - LO developer, etc. The designed environment's functionality allows to users to develop different types of LO (see Figure 5) and

to upload it directly to the repository www.oer.ndma.lt.

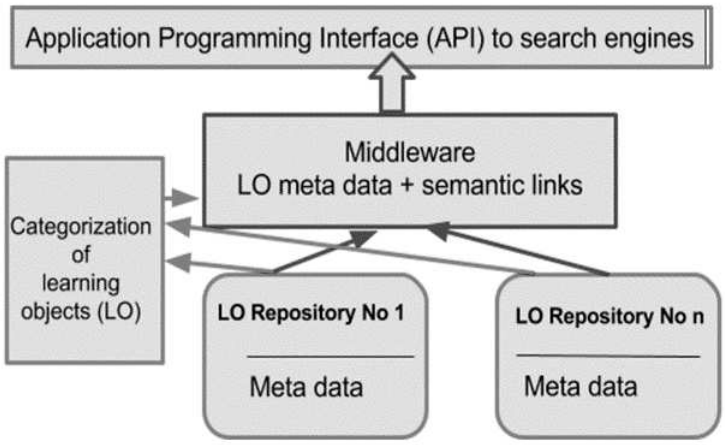

Figure 4: The framework of integrated environment for LO design and delivery

Table 2: Meta data for LO description

Type of file	Format
Text	(plain, richtext, html, xml)
Images	(bmp, gif, jpeg, png, tiff)
Video records	(avi, mpeg, quicktime)
Other formats	(pdf, doc, xls, ppt, java, x-shockwave-flash, zip, scorm)

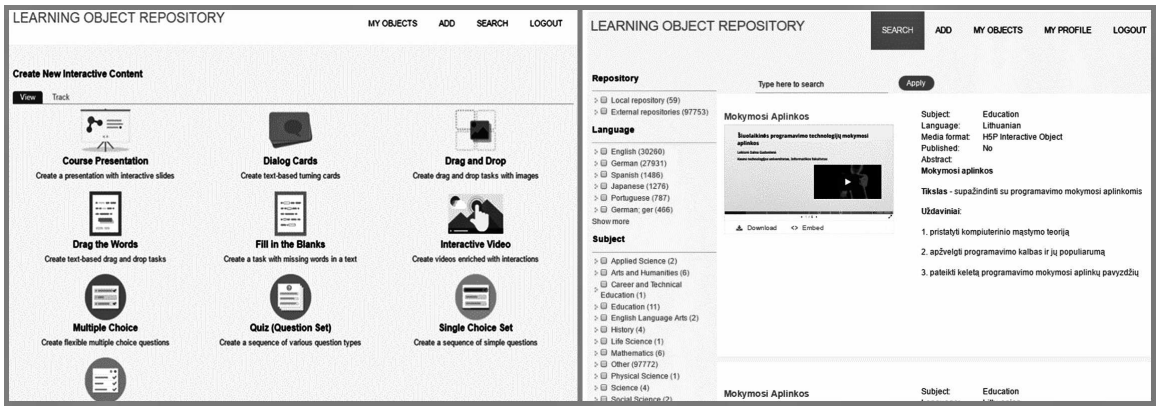

Figure 5: Learning object design tools in the environment (oer.ndma.lt/lor)

Search LO in the semantic web is assured by relations with external repositories of open educational resources, giving open access to it.

In a search in the semantic web the meaning of the words used in the query is considered in the search process what involves, for instance, the understanding of the intention of the user and the context of the search term, either on the newly designed LOR (Figure 5).

5 Experiment on effectiveness of the integrated environment for LO design and delivery

The distributed nature of the semantic web enables continuous improvement of learning materials. It enables the use of distributed knowledge provided in various forms, enabled by semantic annotation of content. For example, if user is in a video presentation system, he gets similar videos based on analysis of all data on systems together.

The created environment enables personalized LO development and delivery as well as its integration into different learning environments, regardless of their origin and type. This means that it assures minimal time consumption and gives an opportunity for teachers to create learning objects, complement them semantically with other educational content, and integrate them into personalized learning environments, integrated learning environments, repositories and teaching management environments. It allows improve educational module's fitness for the learner, and to increase learning efficiency and quality as well as the effectiveness of different learning environments.

The proposed framework and its practical application is useful for course developers, when designing and developing distance learning courses, massive open online courses, and other ICT-based content.

Table 3: Comparison of existing IS for LO design and the newly designed

Features of the systems/environments	Integrated environment	Virtual learning Environment	Information System
LOs form the basis of learning content	X	X	X
LOs can be combined into larger	X	X	
LOs are independent	X		X
LOs are based on a single didactic content type	X	X	X
LOs can be reused in different teaching contexts	X		X
LOs can be searched in the semantic web	X		X
LOs described in metadata	X	X	X
Learning domain ontology	X	X	
Curricular structure ontology	X	X	
Pedagogical strategies ontology	X	X	
Environment have categorization functions	X		X
Environment have a semantic search for other external LO	X		
Existing user interface	X	X	X
Existing Query / update	X	X	
Existing Web Services Facilities	X		X

The newly designed framework identifies user's need to develop and organize the learning

content. Content modeling activities can be carried out at different levels of abstraction - from coordination to instructional and educational level. LO models defined a formal framework, where learning objects can be modelled defining their formats, functions, participants and activity sequences.

High-resolution digital objects are stored in the repository (oer.ndma.lt/lor). However, using them for further development of the learning process and creating educational programs and courses, requires these objects to be transformed into different formats and to ensure their reusability in other content or courses.

Information systems and their components designed to work in an environment that is adapted to communicate with standard IT platforms, operating systems and computer networks.

6 Conclusions and future studies

The authors have proposed a friendly and interoperable integrated environment framework, which is able to use and assure LO design, search in semantic web, adaptation of the re-used objects and storing.

There are no more existing LO repositories with the functionality presented by researchers.

The integrated environment will contribute to the transformation of education into openness.

The integrated environment for the LO design, search in semantic web, adaptation and storing of newly designed or re-designed LO is identified as an effective to use.

The created environment enables personalized LO development and delivery as well as its integration into different learning environments, regardless of their origin and type.

The authors of the paper are planning to continue the research related with smart learning objects for smart education. Following the new strategies of the HE to be more active in MOOCs design and transformation of closed education into open one, the smart learning objects and integration with the wide functionality will serve for the new learning methods implementation and new smart learning objects design.

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