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Ontology of e-learning applications

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Abstract – E-learning became very popular on various levels of education (from primary to academic) and as a way of business training. Each organization which is considering implementation of this type of distance learning must choose a software platform. This decision requires complex knowledge from the area of e-learning methodology, available platforms in dimension of costs, technological requirements and (what is the most important) their functionalities. Of course, there is a lot of supporting literature and websites. However, from the decision maker's point of view it would be helpful to have a kind of expert system, which presents e-learning knowledge in a suitable and reasonable way. The goal of that article is presentation of a prototype of e-learning application ontology (this approach enables to reflect multidimensionality of the domain) which in further research will be used as knowledge base for the expert system.

1 Introduction

Rapid Internet usage development which started in the XX. century and is still in use has very strongly influenced all aspects of human life. One of the most relevant phenomenon is called e-business (or electronic economy, new economy). International or national dimension of online transaction and cooperation has changed the world economy. A very similar phenomenon has appeared in learning processes. The attitude called Web-based learning (synonymously called online learning or distance learning) has revolutionized education in the area of traditional schools or universities and in business. Many companies, especially large international corporations (like IBM, Microsoft) have adopted the e-learning idea in the form of software platforms and procedures to educate and train their employees in many aspects of company's functions

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[**1**]. The normal situation in e.g. Microsoft is a set of online courses available for employees in Intranet. The procedures implemented in this company force employees to choose 2-3 courses per month, learn and pass final certificate about a specific branch or a product. Those self-education patterns are very strongly monitored to keep the professional skills on a very high level. Web-based learning became very popular (now we can call it standard service) among traditional universities and even on lower levels of education. The idea of blended learning assumes making lectures or other additional electronic materials accessible as a normal aspect of lecturer's job. There were established even online universities offering all aspects of higher education on special e-learning platforms where there is no need of personal contact with lecturers.

The advantages of Web-based learning are obvious and commonly known - "learn from anywhere and in your suitable time" opportunity makes the e-learning application attractive for business needs and education. The lower costs of training or courses connected with a "scale effect" (materials available for hundreds or thousands of users at the same time) cause enormous growth of the e-learning solutions and content market. Of course there appeared some problems like high license prices of e-learning systems and relatively high maintenance costs – they are used mainly in huge, national or international enterprises and big universities. There are some open source applications available but the initial cost-free solutions are later cost loaded due to a lack of technical support (professional IT support is required in the case of problems) and poor security level.

Another sifnificant issue concerning Web-based learning is the content. The preparation cost of the professional online course which could be used as autonomic learning material (supported accidentally with synchronous contact), is high. This creation process requires 3 main specialists: course domain specialist, e-learning educationalist (experienced with Web-based materials expression) and computer graphic designer. The research focused on preparation of e-learning content presenting general truth that 1 hour of professional online course requires app. 100h of preparation. In this case the "scale effect" is highly desired to gain proportional revenue. Additionally, the novelty of e-learning causes the lack of experience in proper content creation – we can say that the generation of specialists is now still at student's age [**2**].

In spite of those pointed problems e-learning market is one of the most rapidly developing branches of e-business. Low educational costs per employee/student in connection with a constantly increasing number of Internet users makes the phenomenon very attractive for enterprises and educational institutions. Nevertheless, to start Web-based learning they must first of all decide which e-learning model they want to use and which e-learning platform is the most suitable for chosen model. The enormous number of potential software makes the decision rather tough and complicated. Different applications can support more than one e-learning model and of course one model can by supported by several solutions. There must be several criteria considered which makes the problem complex and multidimensional.

In the article a prototype of e-learning application is proposed as a support in choosing proper software. This attitude allows to reflect very precisely complexity of different software features and gives the user possibility of limiting at least the amount of proper software. Further research will be used as knowledge base for expert system.

2 E-learning market and applications review

Last month Ambient Insight released a report on how the global market for self-paced eLearning products and services will grow till 2014. According to it's estimations the market had reached 27.1 billion US dollars in 2009. The demand is growing with annual growth rate of 12.8% and will take the world market to 49.6 billion by 2014. According to the report North America will continue to be the biggest market of Web-based learning solutions, which can be proved by the highest number of software providers of this type. It is estimated that by 2014 Asia (including Australia and New Zealand in this report) will have overtaken Western Europe to become the second largest market next to North America. The compound annual growth rate in Asia is on the level of 33.5%. The countries of East Europe are the second fastest in growth terms with 23.0%. Vibrant outsourcing hubs have come up in the countries such as Belarus and Ukraine. According to the problem of content presented in Introduction the report claims that there is resistance in regional markets to the content that has been translated but not localized. This is creating demand for local content in each region [**3**].

The other interesting information concerns academic e-learning showing the total trend in education - North America where corporates are still the top buyers, will see academic buyers emerge as top buyers in the next five years [**3**].

All those information and huge demand for Web-based learning solution makes the market extremely attractive for software providers. New products (applications, systems, platforms) are introduced on all types of market: mature (like US) or rapidly developing (like Asia-especially China). There are introduced solutions representing all main types of e-learning software:

- Authoring tools – supporting content creators in electronic materials production (software enabling integration of digital content of many types and from many sources).
- Learning Management Systems (LMS) – the applications which can be standalone solutions or ERP modules supporting higher management or educational institutions in learning process managing (courses and employee's or student's assignments, notes, control tests etc.).
- Content Management Systems (CMS) – the systems supporting online parallel content creation and managing access rights.
- Learning Content Management Systems (LCMS) – the combination of LMS and CMS systems in a form of standalone application or module of usual HR ERP solutions.

- Life Communication Systems (LCS) – the application supporting the distance synchronous learning process, based mainly on hardware equipment (can be part of LMS or LCMS solution) [**4**].

Except the basic types presented above there are introduced some new areas and programmed applications due to Internet development and WEB 2.0 and WEB 3.0 achievements. Hardware miniaturization, increased technological efficiency and rapidly developing mobile Internet access gave the beginning to Mobile Learning Solutions (MLS). The content of courses and it's multimedia sources are optimized for low resolution screens of mobile computers (netbooks, tablets) or even PDA/smartphone. The idea is to support the e-learning credo "learn from anywhere and in your suitable time".

The trend of Internet information placement and exchange called WEB 2.0 has also reflected Web-based learning. Such online places where the registered users codify their experience and ideas is perfect beginning of Social Learning Solutions (SLS). The idea of electronic Knowledge Management (KM) was adopted to support distance learning (the difference between the KM and SLS systems became very insignificant).

Combining e-learning market demand (Fig. 1) and ICT development the number of potential software solutions is very high. All big software vendors offer such a systems - usually at extremely high prices as an integrated module of a bigger system, which makes the applications of smaller companies relatively attractive. Presentation of even a small list of Web-based learning systems is rather pointless – one of the biggest catalogues of those solutions can be found on http://www.e-learninglist.co.uk/ (summarized review of almost 430 suppliers of e-learning applications).

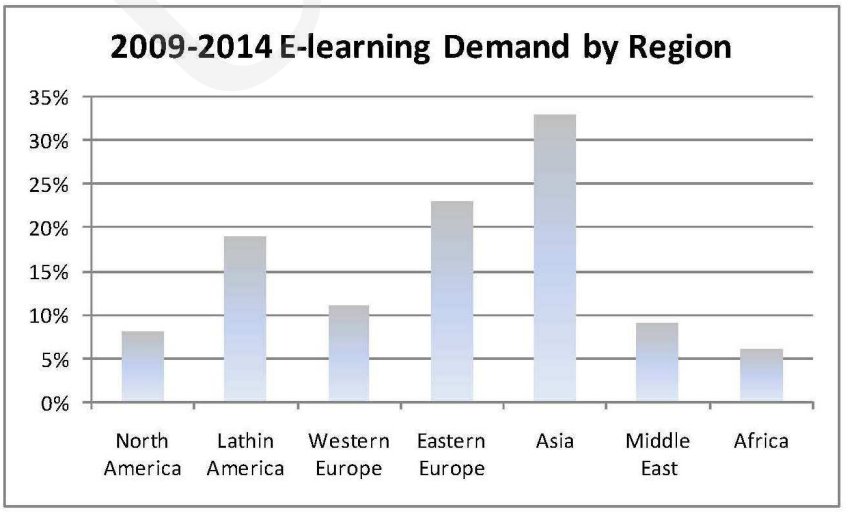

Fig. 1. E-learning Market Demand by Region 2009-2014 (Source: self study based on Ambient Insight Report 2010).

3 Choosing a proper e-learning solution

At the moment the company or educational institution realizes that e-learning is an initiative which should start the complex process, finalized hopefully with a success. The general procedure of choosing a proper distance learning platform seems to be similar to choosing any IT application. Main steps are done as follows:

1. identification of company/institution's goals,
2. checking the marketplace,
3. shortening the list of potential solutions,
4. documentation and a kind of formal or informal tender,
5. final decision and contract signing,
6. system delivery, calibration, tests and usage [**5**] .

The first step should contain very precise and measureable goals description complemented with learning processes mapping – this will identify the class of final system. Sometimes in this step a kind of company reorganization, due to this new form of education, is proposed in a form e.g. of procedures or structure changes. The marketplace review should give some general information about systems used in a specific country, branch or even competitive companies. Steps three and four are the most interesting as they are connected with the goal of this article. As discussed in previous points the number of potential applications is very large. Each of them should be evaluated using many criteria: technological, functional, organizational, economic or usability. There are offered some decision supporting tools or services like:

- online systems based on forms (several questions asked to give a list of applications, which fulfill the marked criteria e.g. http://www.technologyevaluation.com/,
- internet forums with several posts or advice of specific system's users,
- science research and models whose goal is to present objective evaluation of market solutions,
- professional consultants specialized in e-learning platforms/systems.

The main weaknesses of those solutions are: necessity of understanding all detailed options in criteria, lack of open-access actualization, high prices of consultant services, lack of query defining, strict classification of systems (lack of sub-, upper- or abstract class definition). As the solution of those gap between the needs of decision maker and a possible support a prototype of open ontology of e-learning application is proposed.

4 Ontology of e-learning application

The first step in building a domain ontology of e-learning was very careful analysis of literature and implementation reports. The result was identification of initial range of ontology and the list of LMS types and features (Table 1).

Table 1. LMS types and features (Source: self study).

Feature	**Options**
Fee type	Free
	Commercial
Source code availability	Open source
	Proprietary software
Licensing models	Per number of registered/enrolled users
	Per number of concurrently connected users
	Per license validity period
	Per number of courses
Installation type	Hosted (Software as a Service)
	Own
Business orientation	eCommerce
	Educational institutions
	Corporate training
	Government structures
eLearning standards compliance	International Standard (SCORM, AICC, IMS etc) compliant
	Local standards compliant
	No standards compliance
Content creation possibilities	Integrated tools for native courses creation
	Separate tools for native courses creation
	Possibility to use reusable content only
Platform	Stand-alone solution
	Integrated solution
Integration possibilities/Compatibility	Open source
	Documented API
	Integration via bridges
Accessibility	Internet based
	Intranet based
	Off-line access
Software maintainability	Automatic updates
	Semi-automated updates
	Self-maintainance
Modularity	Course as closed object
	Module of a course as closed object
Usability	Self-impresion of the software

As the ontology editor the Protégé platform was chosen due to the open source advantage (no license costs). The Protégé versions were checked and verified for the task and finally the 4.1 Alpha with compatible HermiT reasoner was chosen. The domain data was implemented using the ontology modelling language.

The examplary codification of LMS system types is presented below:

```
<!--
http://www.semanticweb.org/ontologies/2011/1/OntologyOfELearningSoftware.owl#LCMS -
->
   <owl:Class rdf:about="&OntologyOfELearningSoftware;LCMS">
      <rdfs:subClassOf                    rdf:resource="&OntologyOfELearningSoftware;E-
learningSoftwareTypes"/>
   </owl:Class>
<!--
http://www.semanticweb.org/ontologies/2011/1/OntologyOfELearningSoftware.owl#LMS   --
>
<owl:Class rdf:about="&OntologyOfELearningSoftware;LMS">
      <rdfs:subClassOf                    rdf:resource="&OntologyOfELearningSoftware;E-
learningSoftwareTypes"/>
   </owl:Class>
```

The examplary code generated for software business orientation:

```
<!--
http://www.semanticweb.org/ontologies/2011/1/OntologyOfELearningSoftware.owl#Free -->
 <owl:Class rdf:about="&OntologyOfELearningSoftware;Free">
      <rdfs:subClassOf                    rdf:resource="&OntologyOfELearningSoftware;E-
learningSoftwareFeeType"/>
   </owl:Class>
<!--
http://www.semanticweb.org/ontologies/2011/1/OntologyOfELearningSoftware.owl#Govern
mentStructuresOrientation -->
<owl:Class rdf:about="&OntologyOfELearningSoftware;GovernmentStructuresOrientation">
      <rdfs:subClassOf                    rdf:resource="&OntologyOfELearningSoftware;E-
learningSoftwareBusinessOrientation"/>
</owl:Class>
```

All the listed features were implemented in hierarchy and connected with object properties. The example of such connection is presented below.

```
<!--
http://www.semanticweb.org/ontologies/2011/1/OntologyOfELearningSoftware.owl#hasBusi
nessOrientation -->
<owl:ObjectProperty rdf:about="&OntologyOfELearningSoftware;hasBusinessOrientation">
      <rdfs:domain rdf:resource="&OntologyOfELearningSoftware;E-learningSoftware"/>
      <rdfs:rangerdf:resource="&OntologyOfELearningSoftware;E-
learningSoftwareBusinessOrientation"/>
      <rdfs:subPropertyOf rdf:resource="&owl;topObjectProperty"/>
 </owl:ObjectProperty>
```

Then two e-learning platforms were chosen (open source Moodle and commercial Joomla LMS) for ontology testing. A part of Moodle description is presented below.

```
<!--
http://www.semanticweb.org/ontologies/2011/1/OntologyOfELearningSoftware.owl#Moodle
-->
<owl:Class rdf:about="&OntologyOfELearningSoftware;Moodle">
    <rdfs:subClassOf rdf:resource="&OntologyOfELearningSoftware;NamedE-
learningSoftware"/>
    <rdfs:subClassOf>
      <owl:Restriction>
        <owl:onProperty
rdf:resource="&OntologyOfELearningSoftware;hasIntegrationPossibilities"/>
        <owl:someValuesFrom
rdf:resource="&OntologyOfELearningSoftware;OpenSourceBased"/>
      </owl:Restriction>
    </rdfs:subClassOf>
    <rdfs:subClassOf>
      <owl:Restriction>
        <owl:onProperty
rdf:resource="&OntologyOfELearningSoftware;hasContentCreationPossibilities"/>
        <owl:someValuesFrom
rdf:resource="&OntologyOfELearningSoftware;IntegratedToolsForNativeCourcesCreation"/
>
      </owl:Restriction>
    </rdfs:subClassOf>
…
```

The final shape of the ontology prototype is presented below.

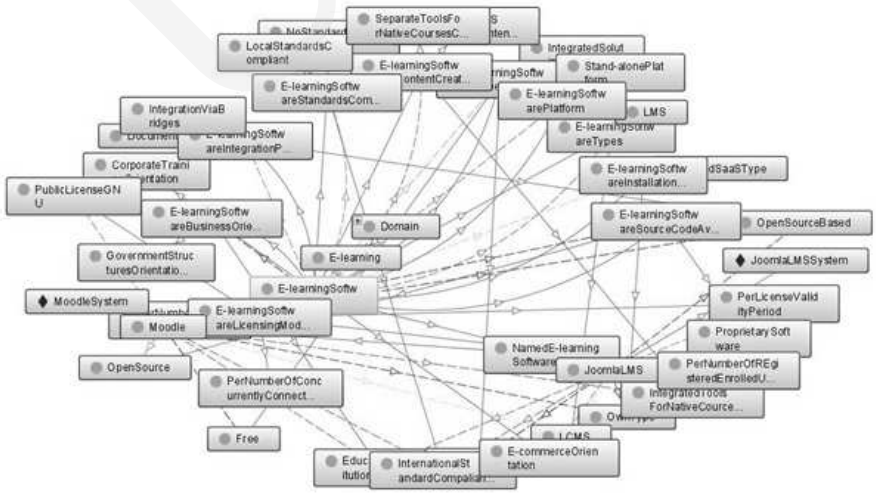

Fig. 2. Prototype of LMS ontology (Source: self study).

5 Conclusions

The results of research focused on building a prototype of e-learning ontology are encouraging further activities. The flexibility of ontological description of the domain of Web-based learning systems enabled the Author to reflect whole complexity of real world connections (without necessity of any simplification, which characterizes relational attitude towards data representation) and additionally was free in class (specially abstract) definitions. The ontology building process was not free from problems. The main obstacles were caused by the used software – several options, which were supposed to be active and available were blocked. More than half of research time was spent on searching Protégé online community forums looking for solutions to those problems. Some of them were promised to be solved in the following versions of the Protégé package like e.g. input form for individuals, which would really speed up the ontology development and was available in 3.x version. Nevertheless, the positive impression and independence of implemented information motivated the Author to continue the research towards extraction (SPARQL as an ontology query language) and transfer of the codified information into knowledge base for expert system. The phenomenon of e-learning as the idea supported by the sophisticated LMS solutions is unquestionably the future of business and academic learning process. Open Decision Support System (DSS) supporting the choice of distance learning platform would simplify a complex decision problem.

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