AC 2009-929: AN EXPERIENCE ON LEARNING OBJECTS REUTILIZATION BASED ON EDUCATIONAL RESOURCES DEVELOPED

Miguel Latorre, Universidad Nacional de Educacion a Distancia

Manuel Blazquez, Universidad Nacional de Educacion a Distancia

Elio Sancristobal, Universidad Nacional de Educacion a Distancia

Sergio Martin, Universidad Nacional de Educacion a Distancia

Francisco Garcia-Sevilla, Castilla-La Mancha University

Catalina Martinez-Mediano, Universidad Nacional de Educacion a Distancia

Gabriel Diaz, Universidad Nacional de Educacion a Distancia

Manuel Castro, Universidad Nacional de Educacion a Distancia

An Experience on Learning Objects Reutilization based on Educational Resources Developed

Miguel Latorre, Manuel Blazquez, Elio Sancristobal, Sergio Martín, Francisco Garcia-Sevilla, Gabriel Díaz, Catalina Martinez-Mediano and Manuel Castro

Abstract

High quality content is not easy to find. Search engines are not suited for this task because they only follow hyperlinks. This technique is often ineffective at finding e-learning resources.

Learning objects are the answer to sharing, reusing and locating educational materials. Additional descriptions represented in form of metadata are required to achieve this goal, among other requirements. The information stored there is very important not only for institutions but for individual instructors or students as well. However, it takes time and experience for authors to create valuable metadata. Users -teachers and students- do not need to know learning specifications when they use standard compliant software (knowledge of the collection of TCP/IP protocols is not essential for a simple user), but it is essential for developers. Instructors cannot become expert metadata editors. Thus, a solution with the lesser intervention of the former is necessary.

Here is explained a short automatic metadata generation process for different courses about Electronics engineering. The results are collections of circuit simulations and tutorials directly available from a learning repository.

Development

Electronic circuits almost have all the desired characteristics that learning objects need[1]. They are complete unto themselves to allow a student to easily apply them. Diagrams can be rather complex, or assessments of minimum size appropriate for their use. Objects may be as short as a single tutorial or a complete lesson. Language is not a barrier because schematics use a symbolic representation. Furthermore, cost is nearly zero with the help of free simulators or demos. Nevertheless, teachers and students need detailed descriptions of their contents to quickly locate them in a network.

The Learning Object Metadata (LOM) Standard represents an important step towards fostering the construction of a new generation of artificial intelligence-based Web Learning systems[2]. Learning object metadata cannot be distributed without using a common format. IEEE LOM[3] is the basis of most metadata standards. This metadata element set is encoded in a binding, such as XML or RDF for computer processing[4]. Institutions select some elements or extend the default set to adapt the standard for their local education systems. Some of these profiles are CanCORE or LOM-es. Once all previous conditions are taken in mind, we can start to create our own metadata.

Till recent years, digital media production was not relevant on education. Most authoring software did not provide any information about user-created content. Technical requirements, rights or origin were unknown when a resource was published in the World Wide Web, unless we viewed its contents opening the files -and even then it was not possible at all. Developers of learning object repositories have also found many limitations in current operating systems and tools to analyze data.

Circuit simulations are not exempt from these difficulties. There is a lack of open standards that could allow access to file contents in Electronic software. The theoretical comparison of the life cycle of a LO with the life cycle of an OpenLO demonstrates that the latter never reaches obsolescence, since an OpenLO in its mature stage could undergo several phases of elaboration[5]. Therefore, large collections of files can only be described with external sources such as original book references or hand-written listings.

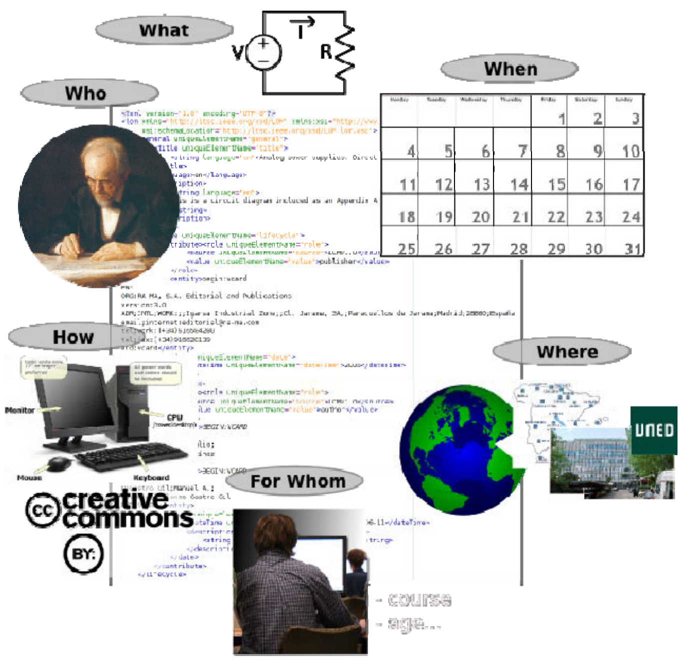

Figure 1. Learning Metadata: characteristics of a resource

Descriptions can become very large if a certain range of attributes is not selected. For this purpose, LOM contains nine main categories. We will give more importance to its educational features, but remaining aspects must be fulfilled too. DIEEC (Electrical, Electronic and Control Engineering Department) has compiled a large number of exercises from various subjects: analog systems, circuit theory, etc. They are a really helpful complement to laboratory sessions, as students can understand physical models of components without any risk. These digital materials were disseminated through text books or instructional CD-ROMs, and are our starting point for creating metadata instances.

Content must be structured[6] to allow it to be used in multiple environments, by multiple tools and systems. After reorganizing exercises in a known structure by book, topic and circuit simulator we ended up with almost two thousand resources. Next, titles of exercises were retrieved from each book through an optical character recognition (OCR) analysis. Once the two previous steps were accomplished, the metadata generation process started. At that time LOM-es application profile was not available to the public, so we followed the CanCORE guidelines to design electronic records. A simplified LOM XML schema allowed us to validate them with a single file.

A blank template was used to generate all valid documents or instances. Field data were filled with simple runonce scripts. The main advantage of using this method is that we need to validate only one instance against the schema definition, because there are only small variations in the remaining XML documents. Metadata values were created like this:

- *General* category was relatively easy to get. File names can be directly associated with their respective titles and descriptions previously stored in an archives list.
- *Life cycle* category was directly extracted from book titles in a vector list
- *Meta-metadata* is straight-forward, as its values do not change (only one schema is used)
- *Technical* requirements were retrieved with internal functions provided by the operating system (i.e. file type, size, date).
- Due to the cultural differences between countries, in the *Educational* category was included only the recommended age range and learning resource type (simulation in most cases). The typical age range can be converted to the course year without any hassle.
- Simulations were licensed under a Creative Commons Attribution License in the *Rights* section. It permits users easy and user-friendly means to use content lawfully without the necessity of requesting permission[7].
- *Relation* category is somewhat useful. We could link statements, data sheets and their corresponding solutions. A student can look for an exercise and later verify its results following a link included in the former.
- *Classification* category is really interesting and offers almost limitless capabilities. It contains a series of taxonomies, from global to specific. If we share descriptions from different countries, we will be able to locate in a map the location of each learning object in the world, or create complete ontologies from diverse topics, statistics about scientific production by topic, etc. In this particular case we defined three of them: electronic disciplines, topic dealt, and department that imparts that subject.
- *Annotation* has been left empty in this work.

Once descriptions are created and validated, we must provide administrative functions to instructors and institutions. Through them users will add, modify or view descriptions. Learning object repositories are collections of digital assets and/or meta-data accessible without prior knowledge of the repository's structure through interoperable functions via a network[8]. A database contains useful teaching information. Generally metadata points to the location of the computer on which resources are stored. The main benefit of learning object repositories is that users know exactly what they see and how to open it, whereas a hierarchical file system does not give enough information. Registries are locations with which we facilitate the discovery and sharing of learning objects through metadata (Figure 2).

Our final goal was a program that could be accessible from the laboratory, students' homes and the department. Also, we looked for a method to keep synchronized our remote server with the distributed content in optical storage. An unique database[9] is used to keep learning objects across systems up to date. Jetty, an open source Java web server was chosen to deploy our digital repository. Xquery/XPath scripts analyze and extract metadata from the database.

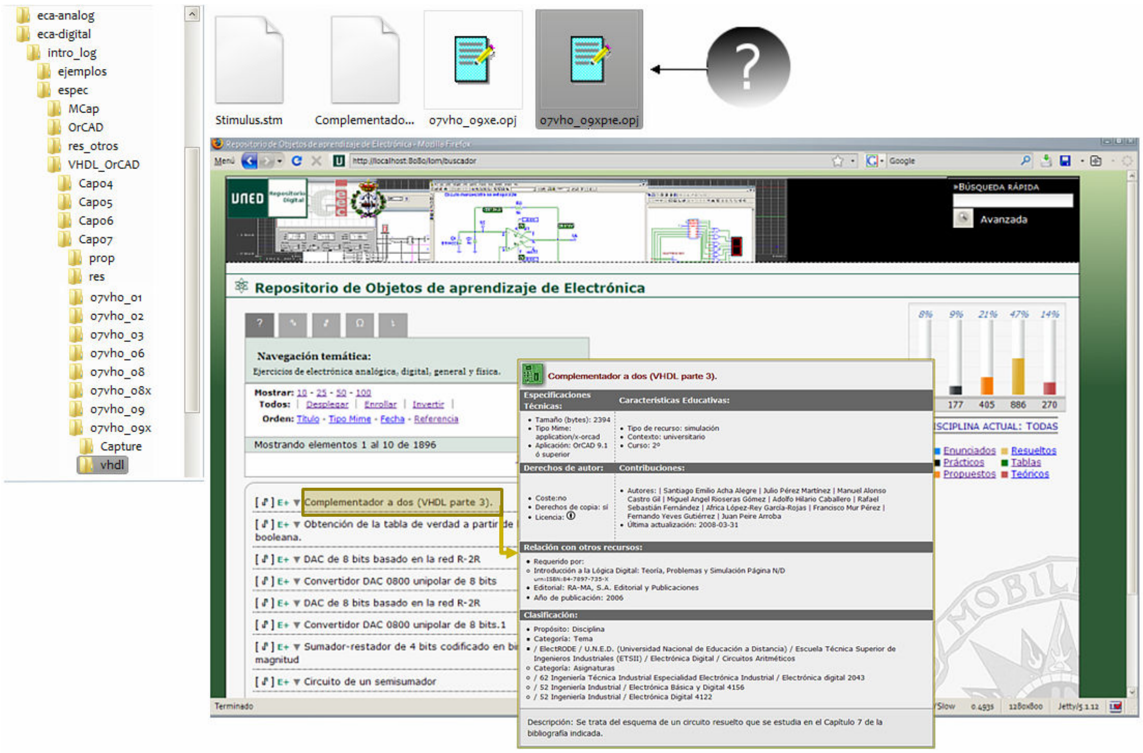

Figure 2. A semantic interface provides rich features for organizing and interrelating assets

Repositories must be designed from two different points of view: students and instructors. Both of them should not need to install anything in their systems, thus avoiding typical issues with maintenance. The ability to update and maintain web applications without distributing and installing software on potentially thousands of client computers was a key reason for their choice. Students need a lot of interactivity, because they shall filter results with some criteria (topic, discipline, year...) and be able to open the circuits. In consequence a graphical interface is mandatory. In order to attain this challenge, a standalone desktop application was built that can be stored in read-only media.

On the other side, teachers have to manipulate objects. It means publishing their resources and editing their corresponding metadata. However, we should not complicate the life of end users by asking them to fill in extensive forms manually[10]. What was the best solution? A WebDAV shared folder connects to the remote web server in the local university network. Assets and metadata can be opened directly from the user's desktop like they were common files. To automate metadata generation of single resources we are working on a drag and drop applet, quite similar desktop metadata generators[11] but without installation.

How do we reuse learning objects? Since metadata is used to organize data, this makes individual objects easier to find. Reuse depends on discovering the reusable components quickly and easily. With a large database of components, it would not be possible to know every component in detail in order to make a judgment on how best to reuse it in other software (i.e. LMS, authoring tools). For example, we have a digital course about circuit theory. Surely there will be a simulation of a voltage divider – i.e one object. We want to improve that activity with a better example. If we have a collection of resources, teachers would be able to locate a similar exercise about that matter, adapt it later and include it in the previous course pointing to that reference and its author. That is the key of learning objects, we can adapt our accumulated works to make them accessible. Modifying them requires a lot less effort.

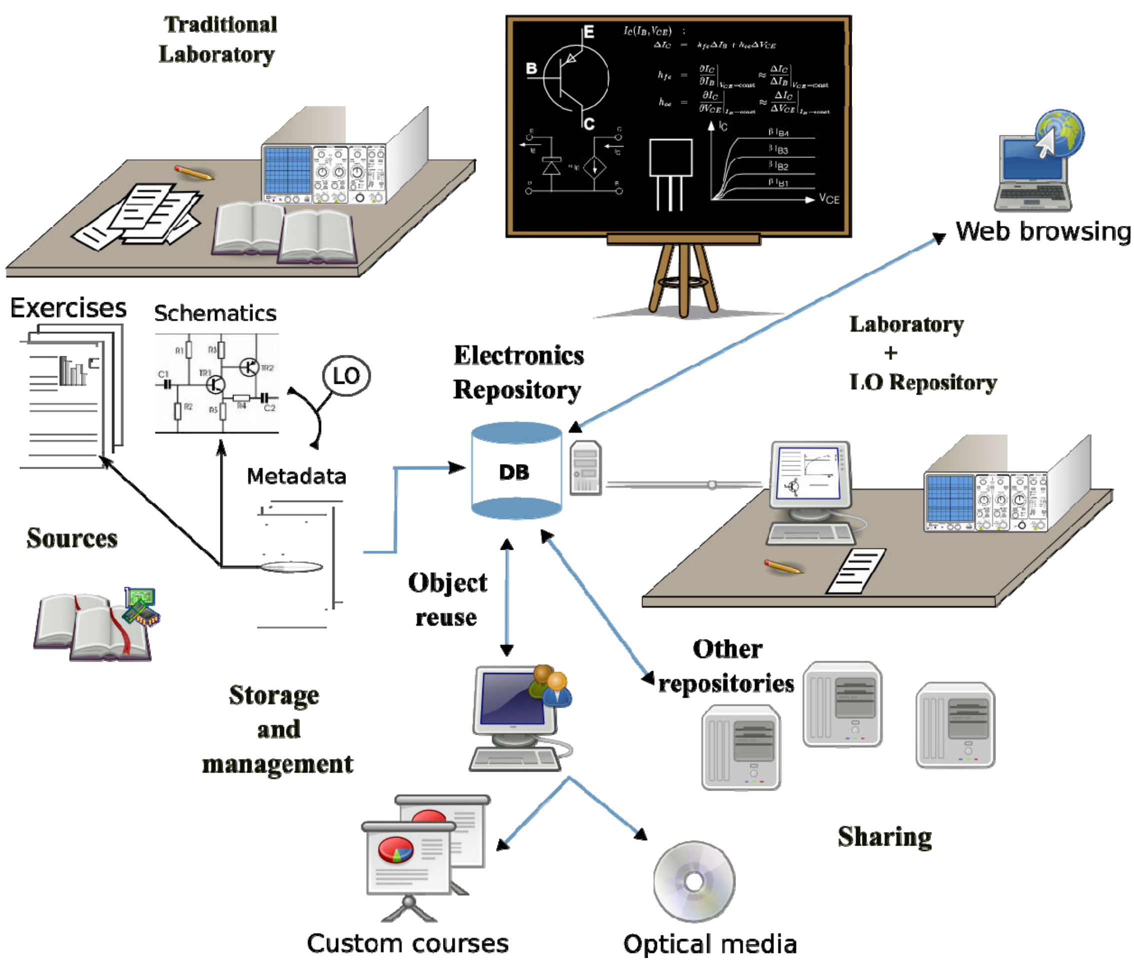

Figure 3. Life cycle of a learning object for users in different usage contexts

Of course, there must be a standard technology to distribute elearning courses across multiple platforms. Interoperability is the ability to take course materials developed in one location with one set of tools or platform and to use them in another location with a different set of tools or platform[12]. It can be done by using a SCORM-compliant LMS. Nowadays, SCORM is broadly used in many learning management systems and authoring tools[13]. It is simply a zip file containing a group of web pages that are linked together. They are combined like this to distribute them faster in a network. Another reason to combine learning objects in a single package is because that way we can transfer them seamlessly to the LMS of our choice.Those web pages can be built with many different contents such as animations, applets, interactive questionnaires, and so on.

Metadata in SCORM is used as a specification while an individual is looking for a particular type of learning object. SCOs -a special kind of LOs- are associated with rich and standardized descriptions of the content (LOM). Courses about Electronics will be distributed this way. To that purpose, we took the aforementioned learning objects classified by topic, and then they were packaged in structured courses[14]. Results can be browsed later in a LMS or imported/exported to various file formats.

Another interesting feature of learning paths is communicating automatic scoring/assesment data to of multiple choice, true/false, and short-answer questions. We can keep track of students' progress (each page or a whole course) through this standard. However, it is somewhat problematic. To test this feature, a digital electronics course including some questionnaries was developed from some objects with the eXe authoring tool. Some LMS implement the Javascript functions to use it but others follow strictly the SCORM specifications. All this can be confusing to creators of learning courses. I works some times, others does not. Aside from these issues, being able to get the statistics of what a large group of users has done becomes really useful.

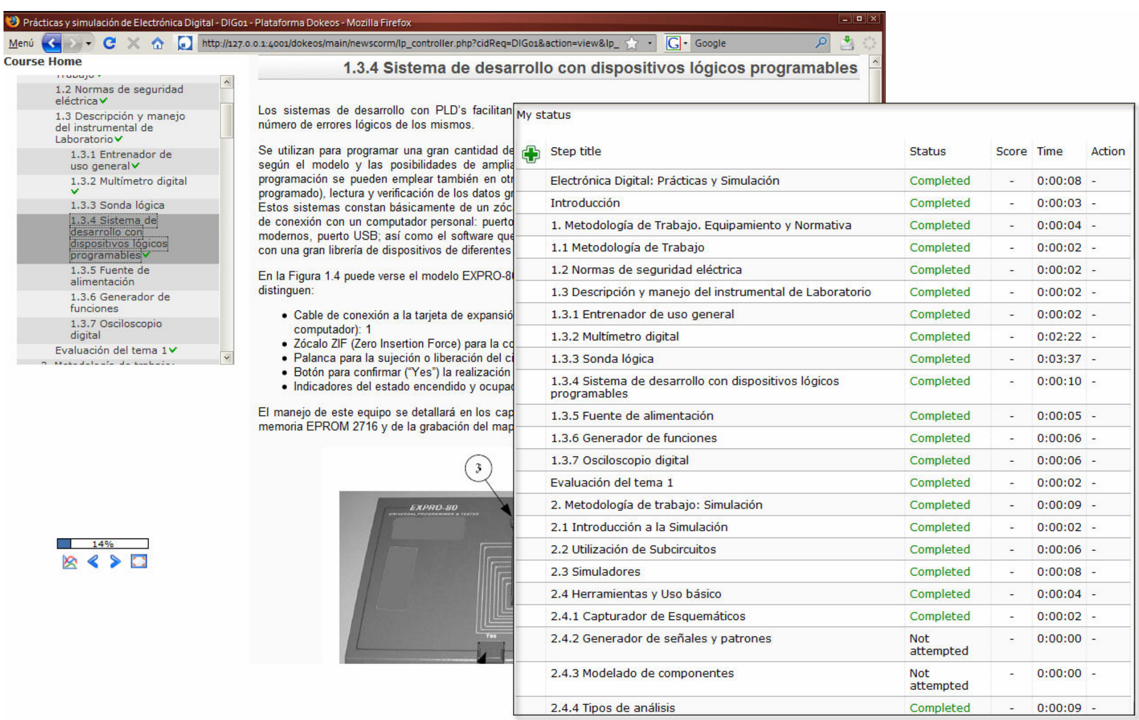

Figure 4. Keeping track of students through SCORM packages

Immediate feedback and frequent evaluation are strong preferences for most of students[15]. Instructors have here a better way to check easily if their learners focus their attention during and immediately after lectures. It provides an instant application opportunity and allows common misconceptions to be revealed and explored. Identify concepts that are proving difficult for students to grasp in a traditional way usually turns out a hard task if the number of people is really large or they are reluctant to speak up in the classroom. We could seriously think that too much computer exposure may hinder creativity, but it seems quite reasonable to integrate quizzes or surveys in this learning object approach. The next challenge will be to develop more and more courses that follow this methodology. Some guidelines shall be discussed in great detail from now on. Better authoring tools that can be used by teachers with little technical know-how are necessary.

Conclusions

elearning contents are not tied to any location or physical device. Emerging semantic technologies open a wide world of possibilities in education. Metadata is the foundation on which everything is going to be built from now on. The confluence of semantic desktop and web will be a step towards a more natural language in human computer interaction. The advent of software based on these principles is the first consequence. We have exposed here a example of how to use metadata to describe large collections of digital resources. However, there are some questions that need to be addressed if we want this new approach to have success. Academic institutions should give value to digital content publications.

Current standards are too complicated for teachers and developers. SCORM 2.0 and LOMNext will be the next generation. We hope most issues will be addressed, an so educational concepts shall turn into main principles of their specifications. Meanwhile we have to improve educational metadata and elearning frameworks. The evolving process of the resources reveals the need for new tools which can treat metadata not only as static data but as information in constant evolution, thus supporting the effective development of educational resources. Secure and comfortable authentication systems (SSO), trust facilities or how to connect on line communities are issues we are going to take into account in future developments.

Acknowledgements

The authors would like to acknowledge the Spanish Science and Innovation Ministry and the Spanish National Plan I+D+I 2004-2007 the support in the project TSI2005-08225-C07-03 "MOSAIC Learning: Mobile and electronic learning, of open code, based on standards, secure, contextual, personalized and collaborative" and to the CYTED-508AC0341 “SOLITE-SOFTWARE LIBRE EN TELEFORMACIÓN” Project support. Also would like to acknowledge the support of the Complimentary Action TSI2007-31091-E “Objetos educativos reutilizables (para el EEES en las especialidades en las especialidades de las tecnologías de la información y las comunicaciones)”, as well as research projects DPI2005-09132-C04-04 and DPI2008-04872. And the support offered by the UNED Rectorate of the network projects (2007, 2008 and 2009) to develop educational innovation adapting the curriculum according to the Bologna Process.

Bibliography

1. Wiley, D. A. “Connecting Learning Objects to Instructional Design Theory: A Definition, Metaphor, and a Taxonomy”, Utah State University, Digital Learning Environments Research Group. The Edumetrics Institute, 2002.
2. Sicilia Urbán, M. A. et al. “On the integration of IEEE-LOM Metadata Instances and Ontologies”, Learning technology newsletter Vol 5 Issue 1, January 2003.
3. IEEE 1484.12, “Final 1484.12.1 LOM draft standard”, http://ltsc.ieee.org/doc/wg12/LOM_1484_12_1_v1_Final_Draft.pdf. Accessed on January, 15th, 2009.
4. Duval, E. et al. “Principles of Metadata Registries: A White Paper of the DELOS Workshop Group on Registries”, DELOS Network of Excellence on Digital Libraries, 2002.
5. Fulantelli, G. et al. “The Open Learning Object model to promote Open Educational Resources”, Journal of Interactive Media in Education, 05 May 2008.
6. Avgeriou, P. et al. “Towards a Pattern Language for Learning Management Systems”, Educational Technology & Society, 6(2), 11-24, (ISSN 1436-4522), 2003.
7. Creative Commons, Retrieved January 21, 2009 from: http://creativecommons.org/. Accessed on January, 15th, 2009.
8. Neven, F. et al. “Reusable Learning Objects: a Survey of LOM-Based Repositories”, In Proceedings of the tenth ACM international conference on Multimedia (pp 291–294). ACM Press, 2002.
9. Meier, W. “eXist: An Open Source Native XML Database”. Web, WebServices, and Database Systems: Node 2002 Web- And Database-Related Workshops, Erfurt, Germany, October 7-10, 2003.
10. Duval, E. et al. “Making Metadata go away - Hiding everything but the benefits”, Dublin Core conference, Shanghai, China, 2004.
11. Eduworks Desktop Metadata generator. http://www.eduworks.com/download/PDS-DMG.pdf. Accessed on January, 15th, 2009.
12. Friesen, N. “Interoperability and learning objects: an overview of e-learning standardization”. Interdisciplinary Journal of Knowledge and Learning Objects. i1. 23-31.
13. Broisin, J. et al. “Bridging the gap between learning management systems and learning object repositories: exploiting learning context information”, In Proceedings of the AICT-SAPIR-ELETE(pp 478 – 483), 2005.
14. Grossmann, T. et al. “Sustainability of E-learning projects - the GITTA approach”. In: XXIth ISPRS Congress, Beijing, 55-58, 03 July 2008 - 11 July 2008.
15. Kassop, M. “Ten Ways Online Education Matches, or Surpasses, Face-to-Face Learning”, The Technology Source, May/June. http://pegmarc.com/csusb/pdf/10WaysOnlineEducation.pdf. Accessed on February, 25th, 2009.