ACCESSIBILITY CONSIDERATIONS IN LEARNING OBJECTS AND OPEN EDUCATIONAL RESOURCES

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Abstract

The motivation for this paper resides in two societal phenomena. First, the rapid expansion in the use of technologies to support learning in formal education on universities and educational institutions, as well as in online environments that promote open and free learning. Second, the dynamic growth of educational resources that faculty and learners have globally released for use in open and free learning contexts, which allow interaction and collaboration between students and academic peers, giving rise to a new space that promotes equity opportunities in access to non-formal learning.

Moreover, there is an important recognition in a global scale about the rights of people with disabilities in all social spheres, and certainly the access to non-formal education is one of them.

In this paper we will conduct a preliminary evaluation over some of the most important websites of Open Educational Resources, in terms of the web accessibility to the web page and the educational resources themselves. The obtained results provide a starting point about the dissimilar levels of concern around the accessibility issues and try to identify the needed actions to ensure accessibility for and inclusion of persons with disabilities.

1 INTRODUCTION

One of the biggest challenges for the society today, is to ensure that people, regardless of their geographic location, their socio – economic status, their physical or cognitive limitations, have the opportunity to access to education, particularly in the context of lifelong learning.

In such context, the importance of web-based learning environments is growing increasingly, since they significantly influence the scope of the educational proposals that they support. Therefore, Open Educational Resources (OER) Initiative, provide a strategic opportunity to improve the access and the quality of education. It also has the statement, UNESCO 2012 PARIS OER DECLARATION, about the relevance of OER in the widen access to education [1].

The OER initiative seeks to use information technology to promote equitable access to knowledge and educational opportunities across the world. The digital resources provided in such environments are called Learning Objects (LOs), i.e., pieces of knowledge designed by instructors that make sense for themselves and are independent of the context of use.

The development of LOs must include didactical issues, applicability and interoperability of the technology, and its adaptability and reusability in different contexts. Moreover, its development should also address the concept of web accessibility, which refers to the inclusive practice of making websites and web content usable by people with disabilities.

Currently, there are some standards that deal with accessibility issues of LO. In particular the IMS AccessForAll [2] project proposes an adaptive model for digital resources that attempts to match resources and services to users' needs and preferences. There are two AccessForAll specifications: the Accessibility for Learner Information Package specification (AccLIP) that expresses the learner's accessibility needs and preferences, and the AccessForAll Meta-data specification (AccMD), which fully describes accessible learning content and its ability to match a learner's preferences.

There are quite a few websites that offer OER (e.g., OpenCourseWare websites), but the level of accessibility of these websites varies greatly. Therefore, in this paper we present a preliminary analysis of the accessibility of some of the most important websites of OER, in consideration of the above specifications. The analysis is conducted from two points of view: on the one hand, the accessibility of the website itself is analyzed; on the other hand, the accessibility of the OER available on those websites is also analyzed.

ISBN: 978-84-616-3847-5

2 OPEN EDUCATIONAL RESOURCES

OER are teaching, learning, and research resources prepared by educators, that reside in the public domain or have been released under an intellectual property license that permits their free use and re-purposing by others. Open educational resources include full courses, course materials that can take the form of text, images, audio, textbooks, slides, streaming videos, tests, software, and any other tools or techniques used to support access to knowledge [3].

In essence, those resources are LOs that incorporates an open source license to let reuse, modified, adaptation and distribute in other distinct learning environment or into self-learning.

The number of universities and other educative institutions around the world that has joined this initiative has grown substantially, as well as the number of resources that have been shared. The first idea behind this concept is to motivate more accessible and equitable education on a global scale, indeed this large audience must to include person with disabilities.

3 LEARNING OBJECTS

In the broadest sense, a LO is any digital resource that has a learning purpose [4]. So for this paper, any web-accessible learning material, for use free and open, will be thoughtful as LO.

Some quality aspects of LOs are [5] [6]: content quality, learning goal alignment, interaction usability, interoperability, reusability and accessibility.

There are some standards and specifications that allow to achieve these quality features, e.g.:

LO Metadata standard *(LOM)*

Developed by Institute of Electrical and Electronics Engineers / Learning Technology Standards Committee (IEEE – LTSC) [7]. This standard will specify the syntax and semantics of LOs Metadata, defined as the attributes required to describe a LO. Relevant attributes of LOs to be described include type of object, author, owner, terms of distribution, and format. The standards let extend the basic fields and entity types, and the fields can have a status of obligatory (must be present) or optional (maybe absent). This standard allows users to search, acquire, evaluate and use LOs, exploring its metadata.

AccessForAll Meta-data specification (AccMD)

Developed by IMS (Instructional Management System) Global Learning Consortium (IMS) [2]. Fully describes accessible learning content and its ability to match a learner's preferences. The IMS AccessForAll project proposes an "adaptability model for digital resources that attempts to match resources and services to users' needs and preferences. Complementing to the AccMD, the Accessibility for Learner Information Package specification (AccLIP) expresses the learner's accessibility needs and preferences".

Shareable Content Object Reference Model (SCORM)

Developed by Advanced Distributed Learning (ADL) Initiative [8], based on some specifications previously defined by IEEE-LTSC and IMS. SCORM [9] was created to help the re-usability, interoperability, portability, access, maintenance and adaptation of LOs. Is a collection of standards and specifications that enable learning platforms to find, import and deliver learning content in a standardized format.

To make that LOs be affordable to the users, these must be stored in Repositories. A repository is a kind of digital library or database used for storing and/or enable the interoperability of LOs [10]. The access to these repositories is through a web interface available in a website.

Over recent years, there have emerged many online repositories that store digital resources in many formats, presentations and sizes [11]. These repositories can be for a specific discipline or can be multidisciplinary, the content on repositories covers all education levels, and are open freely.

4 WEB ACCESSIBILITY

The World Wide Web Consortium, Web Accessibility Initiative (W3C – WAI) [12], provides the following definition of web accessibility, "Web accessibility means that people with disabilities can

perceive, understand, navigate, and interact with the Web, and that they can contribute to the Web. Web accessibility also benefits others, including older people with changing abilities due to aging".

Nowadays, too many websites have accessibility barriers that make it difficult or impossible for people with disabilities to use them. Across the world, laws are in place or under definition [12] [13] to ensure that interactive/on-line services and, sometimes, specifically learning supported through web platforms, are made accessible to people with disabilities.

Accessibility is of overriding importance to learners with disabilities, especially when dealing with web media resources. Under the proper conditions, they can benefit from learning with OER and LOs, not simply because it allows distant and flexible learning activities, but mainly because it could support impaired students in overcoming barriers to resources which would otherwise be hard to access [14].

5 EVALUATION CRITERIA

The analysis conducted in the context of this paper is preliminary and is based on a review of some important aspects:

- *Accessibility on the home page of the website*. If the website is not accessible from the presentation interface will complicate the navigation to find the LOs into the repository. The desirable condition is that fully website be accessible, but the welcome page is the most decisive one to allow or denied the access. This is comparable with a physical barrier that prevents a blind student or with visual impairments, can access to a library building.
- *Easiness to search / find LOs*. A proper searcher should include a reasonable amount of search criteria to locate LOs that meet the user's needs and preferences. In particular it would be desirable to incorporate considerations arising from limitations or disabilities of the users. This is comparable with a person with some disability, as a visual impairments that try to select books in a library. He needs to search and find the books that he want, and then he can decide if use it into the librarian or take it to other environment.
- *LOs description through meta-data.* The role of metadata is essential to retrieval of LO. Metadata is basically a detailed description about the LO. There is a quite few LO metadata standards that are being used in the distinct repositories. The standard is comparable with a book catalog into the library; it is not required to examine the book precisely, in order to choose the book, it is possible to make the selection through its description into the catalog.
- *Accessibility of the LOs itself*. The selected LO should match the needs and requirements of user and must to be useful without any impediment. In other cases, the LO must be provided some assistive technology. Using the preview analogy, for a blind person to read a book, it must be written in Braille, and if you have a visual impairment, the size of the font in the book should be large.
- *Awareness of special accessibility issues expressed on the website.* Additionally, as part of the analysis, we see if the website includes some mention regarding accessibility considerations.

In a simple approach, the elements mentioned, complement each other. A barrier-free access to the website, allows user introduce his preferences into the searcher. The search examines the metadata of LOs stored in the repository to find the matches. And finally the LO can be used, if it contains the accessibility features required by the user with disabilities. It is important to also check if the website considers important aspects concerning accessibility for people with disabilities.

5.1 Repository selection for analysis

To select the repositories for analysis, the basis is the research repositories listed in "A Typology of Learning Object Repositories" [10]. It also includes well-known repositories that are not in that list.

The discussion about typology of the LOs repositories is regarded as beyond the scope of the paper, therefore, will consider three types of repositories, based on the locality of the LOs. *Type A*: content primarily on site; *Type B*, mainly provide metadata with links to LOs housed at other sites, *Type C*: other hybrid sites provide both content and links to external content [10] [15].

Some surveys conducted about the repositories have found a dynamic creation and disappearing of the websites [16] [17]. In the same way, some have moved so that the stated links do not work and no redirection is provided.

For this evaluation have been selected repositories that meet these conditions: be active, include higher education contents, should not be focused on a single area, the number of stored resources should overcome the thousand, reviewed at the date of this paper considering primarily for higher-education oriented content, and ought to have content in English language. The repositories that meet this conditions are listed in Table 1, considering the types of repositories described above.

Table 1. List of Repositories

Type	Name of Repository	URL Home Page of Website	Resources
A	MIT OpenCourseWare (Massachusetts Institute of Technology)	http://ocw.mit.edu/	2150
A	OLI (Open Learning Initiative) Carnegie Mellon University	http://www.cmu.edu/oli/	1000
B	ConneXions	http://cnx.org/	22486
B	MERLOT (Multimedia Educational Resource for Learning and Online Teaching)	http://www.merlot.org/merlot/index.htm	41527
B	OpenCourseWare Consortium	http://www.ocwconsortium.org/	20000
B	Tufts OpenCourseWare	http://ocw.tufts.edu/	+1000
B	OCW Universia	http://ocw.universia.net/	20000
C	ARIADNE Foundation	http://www.ariadne-eu.org/	+1000
C	NSDL (National Science Digital Library)	http://nsdl.org/	150000
C	OER Commons	http://www.oercommons.org/	48621

5.2 LOs selection for analysis

The analysis focuses on learning objects to support higher education, therefore, after that selection, will seek LOs that include multimedia (video, animations, audio) and verify accessibility features. Preferably will elect the LOs in areas of science and technology.

5.3 Specification selection for analysis

LOM and SCORM standards are widely used in the repositories, but they solve only part of the interaction between the user and the object of learning. LOM allows an exhaustive and flexible LO, based on different types of attributes that can be mandatory or optional, but does not consider the definition of user requirements. Moreover, the SCORM standard facilitates interoperability of LOs, to set options for packaging the elements of a LO, so they can be restored in other e-learning platforms.

Meanwhile, the IMSAccForAll specifications include the Accessibility for Learner Information Package specification (AccLIP) that expresses the learner's accessibility needs and preferences, and the AccessForAll Meta-data specification (AccMD), which fully describes accessible learning content and its ability to match a learner's preferences.

It shall be given in this specification as the basis for evaluation. Although discussed repositories do not use this specification, we evaluate the existence of a search interface on the website for requirements specification and user preferences on the other hand, if LOs include a full description of features or metadata.

6 EVALUATION

6.1 Automatic tools for evaluation

The most often used method to analyse the web accessibility is the standards review or conformance testing considering the WCAG 1.0 [18] y WCAG 2.0 [19] guidelines.

For the purpose of this paper, the evaluation can be conducted through automated tools to obtain a preliminary report; these results will be complement with other observations into the websites. It should be emphasized that only complete and thorough manual analysis of the websites, by an expert can provide a reliable result of a page web accessibility [20].

Automatic analysis will be based on two automated tools: TAW and eXaminator.

- *TAW* [21], is an automated tool for evaluating web accessibility developed by Fundación CTIC (Technology Center of Information and Communication), W3C headquarters in Spain. TAW automatically evaluates compliance level guidelines WCAG 1.0 and WCAG 2.0. It also allows to evaluate the degree of compatibility of a website with mobile devices such as mobile phones. TAW outputs a report containing the results of the analysis are classified by priority level set by the W3C.
- *eXaminator* [22], is a free service to evaluate web accessibility, using as reference some techniques recommended by WCAG 2.0. eXaminator awarded a score between 1 and 10 as a quick indicator of the accessibility of the pages. The tests are different assessments for their impact on each of these user profiles: Blind user, serious visual impairments, limited upper limb mobility, comprehension problem and limitations associated with the age. The individual values are used to obtain a score for each of the profiles and the final grade of the page is obtained by averaging the five partial qualifications.

6.2 Accessibility on the home page of the website

The automatic evaluation gave the following values: score obtained through eXaminator tool, the number of errors detected through TAW tool on accessibility guides WCAG 1.0 and WCAG 2.0, priority level AA which is mandatory.

The media score obtained through eXaminator is 4.96 over 10. The best score is for NSDL with 6.6. In all pages evaluated, troubles were detected, especially for users with visual impairments and blind.

According to the results of TAW, ARIADNE and OLI Carnegie Mellon University, meet compliance level WCAG 1.0 AA, all Priority 1 checkpoints satisfied. About the checkpoints Priority 2, only ARIADNE meets compliance; but NSDL and OER Commons, there are 2 or 3 errors detected.

The repositories NSDL and ConneXions, have the lower number of errors detected in the compliance verification of WCAG 2.0. The evaluation over the perceivable principle delivers the highest number of errors in relation to the other principles.

6.3 Easiness to search / find LOs.

It assesses whether the website allows a refinement of the search criteria of the LO. In particular be reviewed if the search include considerations about needs or requirements arising from user's disabilities, as the IMS AccLIP specifications sets. The evaluation results shows in Table 2.

Table 2. Automatic accessibility evaluation

Type	Name of Repository	Search refinement	Accessiblity considerations
A	MIT OpenCourseWare	Search by topic, subtopic, specialty, improvement the search by resource type	None
A	OLI Carnegie Mellon University	Search by entered term	None
B	ConneXions	Search by content, title, author, collection, improve search by category, area, specific theme	None
B	MERLOT	Search by Keywords, Title, URL, Description, Community, Category Language, Material type, Technical format, Audience, improve search by Mobile apps, Author, Cost, Copyright, Creative Commons License, Accessibility, Date added to MERLOT, Peer reviews, Member comments, Learning exercises, and more	Accessibility information available
B	OpenCourseWare Consortium	Search by entered term and language	None
B	Tufts OpenCourseWare	Search by entered term	None
B	OCW Universia	Search through Google by entered term	None
C	ARIADNE	Problems detected in search link	None
C	NSDL	Search by entered term, improve search by educational level, resource type, subject	None
C	OER Commons	Search by Subject area, Grade level, Conditions of use, improve search through application form which include: Common core standard, Resource evaluation criteria, Subject area, Educational use, Material type, Member actitvity, Content source, Primary user, Grade level, Media format, Accessibility, Condition of use	Detailed accessibility considerations: visual, auditory, textual, audio description, caption, verbatim captions, long description, transcript

6.4 LOs description through meta-data

In the context of this paper, no cater exclusively to the standards and specifications, the central issue is, if the LOs has been produced by providing appropriate and equivalent alternatives, considered the learners preferences and needs, and according to W3C Web Content Accessibility Guidelines.

Only the ARIADNE repository declares in its website, the use of IEE/LTSC -LOM metadata standard. The other repositories don´t declare in explicit way the metadata that they are using.

6.5 Accessibility of the LO itself

Given the huge amount of LOs stored in each repository and considering the preliminary nature of the analysis conducted in this paper, this analysis is qualitative.

According the issues established previously, we select some LOs that include multimedia: video, animations, audio, to verify accessibility features. For each of the repositories, a minimal of ten LOs are evaluated. In the case of Type B repositories, are chosen at least two sources (universities or institutions that are aggregated in this repository). The evaluation is based on direct inspection; and we analyze the level accessibility on the resource in relation to the accessibility barriers for visual impaired, hearing impaired or deaf, and limitations on upper limbs.

6.5.1 MIT OpenCourseWare

LOs features

The information is available through course web pages that correspond to formal courses in the university.

Generally the material offered correspond to videos recorded in classes as video lectures and recitations lectures. There are no subtitles on videos, except for these hosted in YouTube that have automatic Closed Caption. There is no transcript for videos. There is no alternative description to diagrams and images. The information is mostly in pdf format.

LOs accessibility considerations

There are strong limitations in LOs accessibility for visually impaired or blind hearing impaired or deaf.

6.5.2 OLI Carnegie Mellon University

LOs features

The information is available through course web pages. The web pages pass the standards review and conformance testing about guidelines of web accessibility. The videos embedded into web pages offer a text / printable alternative version.

LOs accessibility considerations

Good level of LOs accessibility.

6.5.3 ConneXions

LOs features

The information is available through course web pages. Not all the web pages pass the standards review and conformance testing about guidelines of web accessibility.

Only a few videos embedded into web pages offer Closed Caption. There is no transcript for videos. The videos hosted in YouTube offered the automatic Closed Caption. There is no alternative description to diagrams and images. The information is mostly in pdf format.

LOs accessibility considerations

There are limitations in LOs accessibility for visually impaired or blind.

6.5.4 MERLOT

LOs features

The offered LOs have distinct granularity level, from entire courses to individual pieces.

Some videos and animations have been reviewed, especially those that have accessibility information. The videos hosted in YouTube have automatic Closed Caption. The animations have no subtitles or alternative description.

LOs accessibility considerations

Good level of LOs accessibility. However some LOs have accessibility limitations for visually impaired or blind, hearing impaired or deaf.

6.5.5 OpenCourseware Consortium

LOs features

There is a very wide variety of LOs of different granularity. The formats and presentations vary from one university to another.

Analyzed LOs are in English language. Belong to universities that offer content in such language.

Some LOs are course web pages. Not all the web pages pass the standards review and conformance testing about guidelines of web accessibility. Only a few videos embedded into web pages offer subtitles. There is no transcript for videos. The videos hosted in YouTube offer the automatic Closed Caption. There is no alternative description to diagrams and images. Some animations has no alternative description and no offer subtitles. Mostly the information are in pdf format.

LOs accessibility considerations

There are limitations in LOs accessibility for visually impaired or blind hearing impaired or deaf and even for users with limited upper extremity movement.

6.5.6 Tufts OpenCourseware

LOs features

Courses belonging to each school or faculty of the University. Some LOs are course web pages. No videos found. The images in the web page has no alternative description. The information is mostly in pdf format.

LOs accessibility considerations

There are limitations in LOs accessibility for visually impaired or blind.

6.5.7 OCW Universia

LOs features

The ibero-american universities are part of this repository, therefore Spanish is the first language. Only a few universities offer content in English language. The information is available through course web pages. No videos found. The images in the web page has no alternative description. The information is mostly in pdf format.

LOs accessibility considerations

There are limitations in LOs accessibility for visually impaired or blind.

6.5.8 ARIADNE

LOs features

LOs available through Projects participants. LOs are videos and documents in pdf format. The videos hosted in YouTube offer the automatic Closed Caption. There is no transcript for videos. The videos hosted in YouTube have automatic Closed Caption. The animations have no subtitles or alternative description.

LOs accessibility considerations

There are limitations in LOs accessibility for visually impaired or blind.

6.5.9 NSDL

LOs features

Many websites are part of this repository. Not all the web pages pass the standards review and conformance testing about guidelines of web accessibility.

LOs are videos and documents in pdf format. The videos hosted in YouTube offer the automatic Closed Caption. There is no transcript for videos. The animations have no subtitles or alternative description.

LOs accessibility considerations

There are limitations in LOs accessibility for visually impaired or blind.

6.5.10 OER Commons

LOs features

The website offer an interface to adjust display features of the site to meet the user's preferences. This is an advantage for people with visual impairments.

The web pages pass the standards review and conformance testing about guidelines of web accessibility. The videos hosted in YouTube offer the automatic Closed Caption. Some videos have subtitles or transcript.

This repository implement accessibility criteria for searching. However, no results found with criteria Accessibility: Audio description, Caption, Verbatim captions, Long description, Transcript.

6.6 Awareness about accessibility issues on the website

Looking in each website, statements about web accessibility and the actions being carried out to improve the treatment of that topic, we find:

MERLOT is working to support accessibility on its website. A summary about accessibility changes completed can be founded in the Accessibility Policy in the website [23]. Also declares that, it is not responsible for the ADA Standard for Accessible Design [24], compliance of sites whose links are listed.

There are no similar statements in the other websites.

7 CONCLUSIONS

The evaluation reported can be used as a preliminary data. Is necessary to insist that a major effort will be required to make a full assessment. This includes a detailed and complete manual review of the website by an expert group and user testing for distinct incapacities.

The accessibility of the home page of the websites in a few repositories, can be improved with a minimal effort in the syntax's adjustment.

The academic community require better team support to guide the appropriate design of LOs. Some analysed LOs do not complies minimal quality criteria and there is no assessment of its validity. Some of the repositories show LOs reviewed or qualified, but the most simply whatever LOs.

Some LORs investigated have insufficient ability to search and find LOs, this feature makes difficult for users disposes the LOs that they need. Besides this, the searching is conducted through metadata, but this metadata not include accessibility features, so this is an exclusion situation for people with disabilities.

Some important efforts are evident but it is necessary that the educational community to produce more accessible learning objects in repositories enter them.

We believe that this report will help to awareness about the accessibility issues in the context of non-formal education, facilitated by OER. Reduce access barriers to open learning must be one of the key matter to meet the goal of an inclusive society.

ACKNOWLEDGEMENT

This research has been partly supported by the projects MESOLAP (TIN2010-14860) and GEODAS-BI (TIN2012-37493-C03-03) from the Spanish Ministry of Economy and Competitiveness (Ministerio de Economía y Competitividad).

REFERENCES

[1] UNESCO, "2012 WORLD OPEN EDUCATIONAL RESOURCES (OER) CONGRESS UNESCO," UNESCO, Junio 2012. [Online]. Available: http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/CI/CI/pdf/Events/Paris%20OER%20Declaration_01.pdf. [Accessed 3 9 2013].

[2] IMS Global Learning Consortium, "Accessibility," [Online]. Available: http://www.imsglobal.org/accessibility/. [Accessed 18 8 2013].

[3] HEWLETT FOUNDATION, "Open Educational Resources," [Online]. Available: http://www.hewlett.org/programs/education-program/open-educational-resources. [Accessed 07 09 2013].

[4] P. Polsani, «Use and Abuse of Reusable Learning Objects,» *J. Digital Information,* vol. 3, nº 4.

[5] J. Sinclair, M. Joy, J. Yin-Kim Yau and S. Hagan, "A Practice-Oriented Review of Learning Objects," *IEEE Transactions on Learning Technologies,* vol. 6, no. 2, p. 177, 2012.

[6] E. Kurilovas, V. Bireniene and S. Serikoviene, "Methodology for Evaluating Quality and Reusability of Learning Objects," *The Electronic Journal of e-Learning,* vol. 9, no. 1, pp. 39-51, 2011.

[7] IEEE, "WG12: Learning Object Metadata," [Online]. Available: http://ltsc.ieee.org/wg12/.

[Accessed 20 8 2013].

[8] ADL, "Advanced Distributed Learning," [Online]. Available: http://www.adlnet.org/. [Accessed 27 8 2013].

[9] "SCORM," ADVANCED DISTRIBUTED LEARNING, [Online]. Available: http://www.adlnet.org/scorm/scorm-2004-4th. [Accessed 5 9 2013].

[10] R. McGreal, "A Typology of Learning Object Repositories," [Online]. Available: http://hdl.handle.net/2149/1078, 2007. [Accessed 8 9 2013].

[11] X. Ochoa and E. Duval, "Quantitative Analisis of Learning Object Repositories," *IEEE TRANSACTIONS ON LEARNING TECHNOLOGIES,* vol. 2, no. 3, pp. 226-238, 2009.

[12] W3C, "Web Accessibility Initiative," Word Wide Web Consortium, [Online]. Available: http://www.w3.org/WAI/intro/accessibility.php. [Accessed 2 9 2012].

[13] S. Luján-Mora, "Accesibilidad Web: Legislación," Universidad de Alicante, [Online]. Available: http://accesibilidadweb.dlsi.ua.es/?menu=legislacion. [Accessed 3 9 2013].

[14] A. Di Iorio, A. A. Feliziani, S. Mirri, P. Salomoni and F. Vitali, "Automatically Producing Accessible Learning Objects," *Educational Technology & Society,* vol. 9, no. 4, p. 2006, 3-16.

[15] M.-A. Sicilia, X. Ochoa, G. Stoitsis and J. Klerx, "Learning Objects Analytics for Collections, Repositories & Federations," in *Proceedings of the Third International Conference on Learning and Analytics and Knowledge (LAK'13)*, Leuven, Belgium, 2013.

[16] F. Neven and E. Duval, "Reusable Learning Objects: A survey of LOM-Based Repositories," in *Proceedings ACM Conference Multimedia*, 2002.

[17] A. Tzikopoulos, N. Manouselis and R. Vourikari, "An Overview of Learning Objects Repositories," in *Learning Objects for Instruction*, Idea Group Publishing, 2007, pp. 29-55.

[18] W3C, "W3C, Web Content Accessibility Guidelines 1.0 , Recommendation 5-May-1999," [Online]. Available: http://www.w3.org/TR/WCAG10/. [Accessed 19 8 2013].

[19] W3C, "WCAG (2008). Undersanting WCAG 2.0 - A guide to understanding and implementing Web Content Accessibility Guidelines 2.0," [Online]. Available: http://www.w3.org/TR/UNDERSTANDINGWCAG20/. [Accessed 17 8 2013].

[20] S. Luján-Mora, "Accesibilidad Web: Evaluación de la accesibilidad web, disponible en http://accesibilidadweb.dlsi.ua.es/?menu=evaluacion,," Universidad de Alicante, [Online]. Available: http://accesibilidadweb.dlsi.ua.es/?menu=evaluacion. [Accessed 19 8 2013].

[21] TAW, "TAW, CTIC Centro Tecnológico," [Online]. Available: http://www.tawdis.net/index.html?lang=es. [Accessed 19 8 2013].

[22] "eXaminator, Evaluación automática de la accesibilidad," [Online]. Available: http://examinator.ws/. [Accessed 10 9 2013].

[23] MERLOT, «Accessibility Policy,» [En línea]. Available: http://taste.merlot.org/accessibilitypolicy.html. [Último acceso: 17 9 2013].

[24] U. S. D. o. Justice, "Information on Technical Assistant of the Americas with Dissabilities Act," [Online]. [Accessed 17 9 2013].