

Available online at www.sciencedirect.com**SciVerse ScienceDirect**

Procedia Computer Science 14 (2012) 363 – 370

Procedia
Computer ScienceProceedings of the 4th International Conference on Software Development for
Enhancing Accessibility and Fighting Info-exclusion (DSAI 2012)

Implementation of accessibility standards in the process of course design in virtual learning environments

Hector R. Amado-Salvatierra^{a*}, Rocael Hernández^a, Jose R. Hilera^b^aGES Department, Universidad Galileo, Guatemala^bDepartamento de Ciencias de la Computación, Universidad de Alcalá, España

Abstract

This article presents a case study for the project “E-Inclusion to people with disabilities. Implementation of accessibility standards in the process of course design in virtual learning environments”, the objective of the project is to develop an innovative on-line educational program through pilot course experimentation, introducing key competences in the field of digital literacy through Internet. The project seeks to implement various guidelines and recommendations in an Open Source e-Learning system to develop and document a methodology to produce multimedia/interactive content following the main accessibility standards, improving the process of course design in virtual learning environments and complementing actual Instructional Design methodologies. This article is a work in progress document, presenting the motivation and justification of the project, general information, goals and first results. Finally some conclusions and future work activities are presented, including the main activities within the European project ALFA III – ESVI-AL.

© 2012 The Authors. Published by Elsevier B.V. Selection and/or peer-review under responsibility of the Scientific Programme Committee of the 4th International Conference on Software Development for Enhancing Accessibility and Fighting Info-exclusion (DSAI 2012) Open access under [CC BY-NC-ND license](https://creativecommons.org/licenses/by-nc-nd/4.0/).

Keywords: E-Inclusion; E-learning Pilots; Instructional Design; Accessibility

1. Introduction

The high demand for education and diversification are reflected in the VI EU-LAC summit [1], held in Madrid 2010, in its central theme: "Towards a new phase of the bi-regional association: innovation and technology for sustainable development and social inclusion" which emphasizes the training demands arising from the use of information and communication technologies (ICTs) in the knowledge society. This claim presents different challenges in the countries of Latin America (LA), on the one hand disadvantaged

* Corresponding author. Tel.: +502-24238000; fax: +502-24238000.

E-mail address: hr_amado@galileo.edu

populations or people with disabilities face a new obstacle to be excluded because of the digital divide, on the other hand marginalized youth populations are on the generation of "digital natives" [2], which for fashion or entertainment are used to different technologies (ICTs) through the facilities available at low cost access (mobile, internet cafe, etc), but with a lack of productive use or appropriate content. In this sense, young people at the margins of society and people with disabilities are clearly affected by the so called "digital divide", the term "digital divide", is often used to refer the gap existing in the access to ICT (Information and communication technologies) and the internet, but as some researchers have pointed [3], the medium(technology) is no longer the most critical element; differences in content preferences, the impact, availability and type of information have changed the term into an "information divide". There is not enough access to free educational information correctly adapted to the reality of the user and audience, there is a lack of information on basic skills needed in the current knowledge society [4][5] (e.g. digital competence, cultural and social awareness, sense of initiative and entrepreneurship) in this sense minority groups and disadvantaged young people have relatively few resources available. Several projects have experiences with accessibility in programs to help and benefit people with disabilities [6][7][8] including experiences to adopt and adjust content to personalized learning environments (PLE), and recommender systems [9][10][11] based on the definition of profiles and user characteristics, in which a disability can be identified to make a choice in the type of content that helps users in the learning process.

The authors of this article are currently involved in the coordination of two projects, whose final objective is the creation and implementation of a methodology to create online accessible courses. These projects are "E-Inclusión" and ESVI-AL (Figure 1). The first of these projects is a project of one year of duration and is being partially financed by the government of the Comunidad de Madrid (Spain), and will be presented with more details in this article. The second project duration is of three years and is being partially financed by the European Union; ESVI-AL will use the results of "E-Inclusión" project as the starting point for the Project.

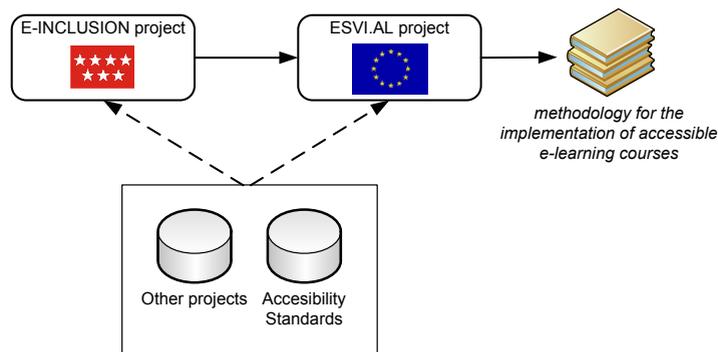


Figure 1. Projects for the creation of a methodology to design online accessible courses

The main activities of the e-Learning cycle are evaluated within the Instructional Design models, defined by Gustafson [12] as a "system or process of organizing learning resources to ensure learner's achieve established learning outcomes". As such, it is a framework for learning, the main models described in literature [12][13][14][15][16] are: ADDIE, Dick and Carey, Kemp, Morrison, Gagné's, Minimalism and Three-Phase Design (3PD). The project "E-Inclusión" takes some of the most used techniques for these models, based on the ADDIE model [17] with its five main stages: Analysis, Design, Development, Implementation, and Evaluation; contributing with best practices and recommendations for the inclusion of accessibility issues in the design of learning activities and units of learning.

The project aim is to identify the main barriers of different virtual learning platforms, complementing similar accessibility studies [18] and generating a series of guidelines to improve the most used content viewers. The project will provide several recommendations to the production cycle of courses in E-Learning modality, particularly on adaptation and evaluation of usability and accessibility. As a support to the design process, the successful solutions implemented in different projects EU4ALL, ALPE and A2UN@ [11][19][20].

The rest of the paper is organized as follows. The following section provides general information about the project "E-Inclusion to people with disabilities. Implementation of accessibility standards in the process of course design in virtual learning environments". Then an identification of problems and needs that the project seeks to address is presented. Then in section 3, a summary of the most important standards related to the accessibility that can be applied in virtual education are presented. Finally some conclusions and future work, introducing the work of the project ESVI-AL are included.

2. General information of the project “E-Inclusión”

The project “E-Inclusión” identifies the great potential provided by ICTs for the different phases of life, among which can be mentioned education, work and entertainment [5]. Several educative entities like schools and universities are adopting informatics systems in the e-learning mode to impart courses or as support means. However, the use of these systems, as well as the use of technology by people with some kind of disability, is hindered by the use of various technological tools, and mainly for the inaccessible learning content.

The purpose to address the requirements of accessibility within e-Learning systems has its grounds on the fact that during certain circumstances or due to functional diversity of people, the information is inaccessible through the channels or formats chosen to be transmitted, with some examples in [20]. The solution to this problem is to specify the level of accessibility of the information so that the student can choose the format and channel to receive information (learning content). Currently, there are already well defined Web accessibility requirements such as Section 508 and the ADA (Americans with Disabilities Act) [21], and organizations devoted to Internet accessibility such as WAI (Web Accessibility Initiative) [22][23], which generate sets of guidelines to implement web content and tools friendly and ease to use for people with disabilities. The project seeks to implement different guidelines and recommendations in an Open Source e-Learning system, applied to the context of the target country and society and adapted to different teaching methodologies and content assembly techniques to design accessible courses. The objectives of the project are:

- To prepare an assessment of the level of accessibility available in the content viewers of the most widely used LMS and virtual education platforms.
- To design a methodological guide for the implementation of courses in e-Learning mode using accessibility standards in Instructional Design process.
- To promote the development of competencies required for the design of educational programs in e-Learning, following accessibility standards.
- To increase the participation of people with disabilities in education, higher education, and Lifelong Learning (e-Learning courses) by teaching basic competences for Life (digital competence, social and civic competences, sense of initiative and entrepreneurship, cultural awareness and expression).
- To create a link between Disabled Persons Organizations (DPOs) to improve their organizational capacity, coordination, human resources and definition of e-Learning courses to promote basic competences.
- To use the results of “E-Inclusión” project, as starting point of the work within the ESVI-AL project for the creation of a methodology to have an accessible virtual campus that will be implemented in universities of the ALCUE common higher education space.

The project methodology seeks for a complete involvement in the analysis, design and evaluation of DPOs for the application and correct validation of the international accessibility standards, performing analysis of needs and prototype tests with the support of DPOs students as well as of instructors. The project seeks to implement a methodology to produce multimedia/interactive content within the e-Learning cycle, improving actual Instructional Design models in terms of accessibility. Three e-Inclusion courses are planned, The courses will be open to all the population to improve selected digital competences [4] (e.g. digital literacy). Also the project aim to improve quality and equity of education and highlight the contribution of different cultures and ethnic groups in economic and social development of the countries.

The project seeks to narrow the “information divide” by bringing education and lifelong learning to all the population. The on-line educational program is benefited by the accessibility that ICT provides: gender, age or race is no longer a strong indicator for access to technology. In this sense, ICT breaks the barriers of time and space (education anytime, anywhere).

2.1. Justification of needs for the project

Web accessibility, in the context of “information divide”, means that people with disabilities (PWDs) are able to use the Web. More specifically, According to Web Accessibility Initiative (WAI)[22], 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 encompasses all disabilities that affect access to the Web, including visual, hearing, physical, speech, cognitive, and neurological disabilities. The Web is an increasingly important resource in many aspects of life: education, employment, government, commerce, health care, recreation, and more. It is essential to have an accessible Web, in order to provide equal access and equal opportunity to people with disabilities. An accessible Web can also help PWDs to have a more actively participation in society. In this sense several initiatives and laws in different countries are forcing official entities and content providers to design and maintain web pages according to accessibility standards (e.g. WCAG 2.0, level AA). [21][23][24]. Activities within the project will use online validators: Achecker[25] and HERA[26], checking the different levels of accessibility within the most used LMS, but especially with the participation of users with disabilities to provide validated solutions to solve accessibility issues.

2.2. Legislation related to Web Accessibility

Although there are different legislation relating to Web Accessibility in some countries [21][24], there are more than 150 signatories governments for the Convention on the Rights of Persons with Disabilities [28]. The Convention emphasizes with the Article 9, (points 2.g and 2.h) the commitment to “promote access for persons with disabilities to new information and communications technologies and systems, including the Internet,” and “promote the design, development, production and distribution of accessible information and communications technologies and systems at an early stage, so that these technologies and systems become accessible at minimum cost”. The convention and different legislation in several countries and particularly in developing countries show the importance to fulfill web accessibility standards at all levels in the e-Learning cycle.

2.3. First pilot course

The project idea has been formulated based on real experiences [27], which support the viability of this project on a larger scale with more ambitious goals, more than 5,000 students were part of the first five editions. The pilot course was called “ENRED” and was held for 5 years (2005-2009). This experience was defined as an on-line education program, composed of 10 online modules (e-courses), taught in 10 weeks with

an e-tutoring methodology. It began with a diffusion process through radio, newspapers and television as well as visits to schools. The pilot course aim is to promote the digital literacy among the young population between 14-18 years old, an open module of ten sessions was defined, showing the main abilities to locate, understand, evaluate and analyze information using digital technology, a basic knowledge of Internet, digital technologies and the basic competences to design/create/manage a website. The new pilot course is called “GNET”, in this new pilot course PWDs are invited to be part of open e-Learning accessible modules, that includes accessibility topics and implementations. Two more pilot projects for digital competencies will be defined, based on the experience, methodology and best practices from previous courses.

3. Accessibility standards

One of the basic principles of the “E-Inclusión” project (and the ESVI-AL project), is the use of accessibility standards for the design of learning contents and e-learning platforms. Currently there exists a group of standards related to the accessibility that can be applied in virtual education. Some of the most important standards are described in Table 1.

Table 1. Standards about “Accessibility in e-learning” [29][30]

	Standard	Org.	Year
	UNE 139801, Computer applications for people with disabilities. Computer accessibility requirements. Hardware.	AENOR	2003
(1)	UNE 139802, Computer applications for people with disabilities. Computer accessibility requirements. Software.	AENOR	2009
(2)	UNE 139803, Computer applications for people with disabilities. Web content accessibility requirements.	AENOR	2012
	UNE 66181, Quality of virtual education.	AENOR	2012
(1)	ANSI/HFES 200, Human Factors Engineering of Software User Interfaces. Part 2: accessibility	ANSI	2008
	Guidelines for the "Access for All" Digital Resource Description Metadata Elements	CANCORE	2009
	IMS AccessForAll Meta-data (IMS ACCMD).	IMS	2004
	IMS Guidelines for Developing Accessible Learning Applications (IMS DALA).	IMS	2005
	IMS Learner Information Package Accessibility for LIP (IMS ACCLIP).	IMS	2003
	ISO 9241-20, Ergonomics of human-system interaction. Part 20: Accessibility guidelines for information/communication technology (ICT) equipment and services.	ISO	2008
(1)	ISO 9241-171, Ergonomics of human-system interaction. Part 171: Guidance on software accessibility.	ISO	2008
	ISO/IEC 24751-1, Individualized adaptability and accessibility in e-learning, education and training.	ISO/IEC	2008
	ISO/IEC 24751-2, Part 2: "Access for all" personal needs and preferences for digital delivery.	ISO/IEC	2008
	ISO/IEC 24751-3, Part 3: "Access for all" digital resource description.	ISO/IEC	2008
	W3C, Accessible Rich Internet Applications (WAI ARIA)	W3C	2009
	W3C, Authoring Tool Accessibility Guidelines (WAI ATAG)	W3C	2000
(2)	W3C, Web Content Accessibility Guidelines (WAI WCAG) (2)	W3C	2008

(1) and (2) are groups of equivalent standards

Besides ISO, there are other guidelines published by different entities, as an example, the Spanish Association for Standardization and Certification (AENOR), American National Standards Institute (ANSI), the IMS Consortium and the World Wide Web Consortium (W3C).

Between the published standards, the UNE 66181 is highlighted, because it offers a method, based in the application of other generic accessibility standards, to measure the accessibility in virtual education. This norm establishes a 5 level scale of accessibility that could be assigned to a virtual education action, based on the accomplishments of hardware, software and/or web contents requirements. In Table 2, a draft of the new version of this norm is presented. This will be published in the 2012 [31].

Table 2. E-learning accessibility levels established by UNE 66181 [31]

LEVEL	HARDWARE ACCESSIBILITY	SOFTWARE ACCESSIBILITY	WEB ACCESSIBILITY
1. Initial	No specific information is offered.	No specific information is offered.	No specific information is offered.
2. Basic	It is indicated in the basic information, if the education action is adapted to people with disabilities. Information about the main problems that a person with disabilities could encounter during the course, is contributed.	It is indicated in the basic information, if the education action is adapted to people with disabilities. Information about the main problems that a person with disabilities could encounter during the course, is contributed.	It is indicated in the basic information, if the education action is adapted to people with disabilities. Information about the main problems that a person with disabilities could encounter during the course, is contributed.
3. Good	The hardware platform of the virtual education has the accessibility aids well identified and explained.	The software platform of the virtual education has the accessibility aids well identified and explained.	The platform of the virtual education has the accessibility aids well identified and explained.
4. Very Good	Accomplishes the priority 1 requirements of the UNE (139801) norm.	Accomplishes some of the basic requirements of the ISO 9241-171 norm of the "must" type.	Accomplishes the level A of accordance of WCAG.
5. Excelent	Accomplishes the priority 1 and 2 requirements of the UNE (139801) norm	Accomplishes some of the requirements of the ISO 9241-171 norm of the "should" type.	Accomplishes the level AA of accordance of WCAG.

4. Conclusions and Future Work

The project "E-Inclusion to people with disabilities. Implementation of accessibility standards in the process of course design in virtual learning environments." aims to strengthen the capacities of institutions of higher education through design, implementation and assessment of accessibility in virtual platforms that support teaching and enhance the participation of people with disabilities in the training process. The search for synergies with different projects and in particular with the European projects within the ALFA programme will allow for greater continuity and replicability of the results at the end of the project. For this type of approach is critical to include the participation from organizations of persons with disabilities to meet their real needs. Experience of Inclusion projects and technological contribution of different learning experiences as EU4ALL ALPE and ADAPTAPlan [11][19][20] bring an important combination as a basis for achieving the project objectives.

4.1. Future work: *ESVI-AL project*

The project ESVI-AL (<http://www.esvial.org>) aim is to improve accessibility in higher education virtual learning systems through the definition of systematic and replicable methodological processes for the design and implementation of accessible virtual curriculum developments and in the training of the staff involved in these processes, these methodological processes will help Higher Education Institutions to meet the requirements from accessibility standards in the context of virtual education, specially Web based. The project will take over a period of three years, 2012-2014, and is partially supported by the European Commission through the ALFA III programme (<http://ec.europa.eu/europeaid/where/latin-america/regional-cooperation/alfa/>), being Universidad de Alcalá the applicant and coordinator, with the participation of 13 organizations: 10 universities from Latin America (LA) and Europe, and 3 international associates, one of them is the Disabled Peoples' International organization (DPI).

The project ESVI-AL, among other objectives, seeks to define a methodology for creating an accessible virtual campus and a procedure for certifying the accessibility within the virtual campus and the curriculum development implemented in such campus. The accessibility of a virtual campus should be validated at all levels:

- LMS: Accessible Learning Management Systems.
- LMCS: Accessible Learning Content Management Systems, including search engines in learning object repositories.
- Open Education Resources (OER): Learning objects with accessibility content.

Some of the main results expected from the project are: the implementation of accessible virtual campuses in the participating higher education institutions from LA, the establishment of a network of cooperation and an observatory on accessibility in Virtual Education and Society, to ensure sustainability of project results. Higher Education Institutions and stakeholders interested in accessible virtual education are invited to be part of both of ESVI-AL networking initiatives:

- Cooperation Network for Accessibility in Virtual Education and Society.
- The Observatory on Accessibility in Virtual Education and Society.

Acknowledgements

This work is supported partially by the European Commission through the project ALFA III – ESVI-AL (DCI-ALA/19.09.01/11/21526/ 279-146 /ALFA 111(2011)-11) and by the Government of the Comunidad de Madrid (Spain) and Universidad de Alcalá, through the project E-Inclusión.

References

- [1] EU Latin America and Caribbean Summit (2010): Madrid Action Plan 2010-2012 (section d and e) http://www.consilium.europa.eu/uedocs/cms_Data/docs/pressdata/en/er/114540.pdf (Comisión Europea) [Last visit 16-02-2012]
- [2] Prensky M. (2001), “Digital Natives, Digital Immigrants”, *On the Horizon*, Vol. 9, No. 5, October 2001.
- [3] Steyaert J. & Gould N. (2009), Social Work and the Changing Face of the Digital Divide, *Br. J Soc Work* (2009) 39(4): 740-753. First published online: February 23, 2009
- [4] Commission of The European Communities, (2009), "Key competences for a changing world". Education & Training 2010 work programme. SEC(2009) 1598. http://ec.europa.eu/education/lifelong-learning-policy/doc1532_en.htm [Last visit 18-02-2012]
- [5] European Framework for Lifelong Learning (2006), Key figures on education. online resource available under <http://www.eubusiness.com/topics/education/education2010.02/> [Last visit 25-01-2012]
- [6] Abou-Zahra S. and Lawton S. (2010). Exploring web accessibility solutions in developing regions as innovations for the benefit of all. In Proceedings of the 2010 International Cross Disciplinary Conference on Web Accessibility (W4A) (W4A '10).

- [7] Hersh M. (2008). Accessibility and Usability of Virtual Learning Environments. In Proceedings of the 2008 Eighth IEEE International Conference on Advanced Learning Technologies (ICALT '08). IEEE Computer Society, Washington, DC, USA, 1038-1039.
- [8] Kelly B, et al. (2010). Developing countries; developing experiences: approaches to accessibility for the real world. In Proceedings of the 2010 International Cross Disciplinary Conference on Web Accessibility (W4A) (W4A '10). ACM, New York, NY, USA, Art. 3.
- [9] Gay, G. et al. (2009). Adapting learning environments with AccessForAll. In Proceedings of the 2009 International Cross-Disciplinary Conference on Web Accessibility (W4A) (W4A '09). ACM, New York, NY, USA, 90-91.
- [10] Santos O and Boticario J. (2011). Requirements for Semantic Educational Recommender Systems in Formal E-Learning Scenarios. *Algorithms* 2011 4(2), 131-154; doi: 10.3390/a4030131, July 2011
- [11] Santos O. and Boticario J. (2009). Building a knowledge-based recommender for inclusive eLearning scenarios. In Proceedings of the 2009 conference on Artificial Intelligence in Education: Vania Dimitrova et al. (Eds.). IOS Press, Amst., the Netherlands, 689-691.
- [12] Gustafson, K. L., & Branch, R. M. (2002). What is instructional design. In R. A. Reiser & J. V. Dempsey (Eds.), *Trends and issues in instructional design and technology*. Upper Saddle River, N.J.: Pearson Education.
- [13] Gagne, Robert M. (1985). *The conditions of Learning and the Theory of Instruction* (4th ed.), NY: Holt, Rinehart, and Winston, 1985.
- [14] Wiley, D., Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy, *Learning Technology* (2000), Volume: 2830, Issue: 435, Publisher: Association for Instructional Technology & Association for Educational Communications and Technology, Pages: 1-35
- [15] Roblyer, M. D. (2006). *Integrating educational technology into teaching* (4th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.
- [16] Sims, R. & Jones, D. (2002). Continuous improvement through shared understanding: Reconceptualising instructional design for online learning. Retrieved May 21, 2006, from <http://www.ascilite.org.au/conferences/auckland02/proceedings/papers/162.pdf>
- [17] Peterson C. (2003). Bringing ADDIE to Life: Instructional Design at Its Best. *Jl. of Educational Multimedia and Hypermedia* (2003), 227-241
- [18] Power C, et al. (2010). Virtual learning environments: another barrier to blended and e-learning. In Proceedings of the 12th international conference on Computers helping people with special needs: Part I (ICCHP'10), Klaus Miesenberger, Joachim Klaus, Wolfgang Zagler, and Arthur Karshmer (Eds.). Springer-Verlag, Berlin, Heidelberg, 519-526.
- [19] Martin L. et al. (2007). Usability and accessibility evaluations along the eLearning cycle. In Proceedings of the 2007 international conference on Web information systems engineering (WISE'07), Mathias Weske, Mohand-Sad Hacid, and Claude Godart (Eds.). Springer-Verlag, Berlin, Heidelberg, 453-458.
- [20] O. Santos, Boticario J, Rodríguez Acaso A, Gutiérrez y Restrepo E, Barrera C (2007), "Cursos accesibles y reusables sobre la plataforma ALPE", Proceedings of the FLOSS FreeLibreOpen Source Systems International Conference 2007, Universidad de Cadiz, Pages 170-185, ISBN: 9788498291248
- [21] Hricko M. (2003). Understanding section 508 and its implications for distance education. In *Design and implementation of web-enabled teaching tools*, Mary Hricko (Ed.). IGI Publishing, Hershey, PA, USA 25-46.
- [22] Web Accessibility Initiative (WAI). World Wide Web Consortium (2012). <http://www.w3.org/WAI/> [Last visit 15-02-2012]
- [23] W3C. "Web Content Accessibility Guidelines (WCAG) 2.0" 2008 World Wide Web Consortium. <http://www.w3.org/TR/WCAG/> [Last visit: 16-02-2012].
- [24] BOE (2007). Real Decreto 1494/2007, de 12 de noviembre (Ministerio de la Presidencia)(BOE de 21/11/2007, páginas 47567 a 47572). www.boe.es/boe/dias/2007/11/21/pdfs/A47567-47572.pdf [Last visit 10-02-2012]
- [25] Gay G. and Qi Li C.. 2010. AChecker: open, interactive, customizable, web accessibility checking. In Proceedings of the 2010 International Cross Disciplinary Conference on Web Accessibility (W4A) (W4A '10). ACM, New York, NY, USA
- [26] Carlos Benavidez, et al. (2006) "Semi-automatic Evaluation of Web Accessibility with HERA 2.0" *Computers Helping People with Special Needs, Lecture Notes in Computer Science*, 2006, Volume 4061/2006, 199-206
- [27] Hernandez R, Pardo A, Delgado C. (2007) Creating and Deploying Effective eLearning Experiences Using .LRN. *IEEE Transactions on Education*, vol.50, no.4, pp.345-351, Nov. 2007
- [28] Convention on the Rights of Persons with Disabilities (2008), <http://www.un.org/disabilities/default.asp?navid=15&pid=162> [last access 10-02-2012]
- [29] Hilera, JR, Hoya, R., Vilar, ET. (2011), "Organizing E-learning Standards and Specifications", Proceedings of the Int. Conf. on E-learning, E-business, Enterprise information systems, & E-government. 2011, CSREA Press, 99-104, ISBN: 1601321767.
- [30] Pons D, Hilera HR, Pagés C (2011), "Standards and specifications to manage accessibility issues in e-learning", *IEEE Learning Technology*, TCLT, Volume 13, Issue 3, ISSN 1438-0625, July 2011
- [31] Hilera, JR, Rodrigo, C., González, A. (2012), "Cuantificación de la accesibilidad de la formación virtual aplicando estándares", III Congreso Ib. sobre Calidad y accesibilidad de la Formación Virtual 2012, Universidad de Alcalá, ISBN 978-84-8138-367-6