Strategies for improving the level of accessibility in the design of MOOC-based learning services

Francisco Iniesto
Institute of Educational Technology
The Open University
Milton Keynes, United Kingdom
francisco.iniesto@open.ac.uk

Covadonga Rodrigo
School of Computer Science
Universidad Nacional de Educación a Distancia (UNED)
Madrid, Spain
covadonga@lsi.uned.es

***Abstract*—Access to MOOC platforms has barriers: there is a lack of accessibility to educational resources, communications tools and even the personalisation of user interfaces. Added to this are difficulties such as the need to develop specific digital or even social skills for those students with functional diversity. Therefore, a vision of the different strategies in relation to the achievement of accessibility (from the content to user preferences) is presented in this work; strategies which must be tackled with the aim of achieving a better level of accessibility during the design of new learning services based on MOOCs.**

***Keywords*—Accessibility, Learning services, MOOC, Design strategie.**

I. INTRODUCTION

Massive online open courses (MOOC) have provided a major boost to the educational sector, putting open education at the disposal of the public domain with an unimaginable supply, by offering society the possibility of accessing university courses and higher education at a minimum cost: the price of an Internet connection from home. This innovation has become so deeply rooted in higher education institutions that they are planning to migrate the educational platforms that they currently have to new open education environments, demonstrating that the evolution of open education on the Internet is now allowing thousands of people all over the world to follow diverse educational initiatives [1].

The flexibility of the learning services provided by MOOCs allows students to learn at their own pace and location, to improve communication and maintaining a high degree of social interaction between all the participants in the building of learning communities. However, access to the MOOC platform may also create additional difficulties such as the need to develop specific digital skills. An example of this being the amount of audio-visual content and interactive elements, tests and self-evaluations which form part of this type of course or the need for connections to social networks may present new difficulties in the accessibility requirements [2]. The pedagogical and visual design of the MOOC, information architecture, of the usability of the visual design and the interaction itself may be having a negative impact on the levels of participation, retention and termination by the students on these courses, as has previously been analysed in education for adults [3]. However it seems that this typology of courses may be of special benefit to people with functional diversity as it offers academic services at low cost and without having to travel [4].

The objective of this article is to look at the transversal analysis of all of the critical factors that appear in the definition of a correct specification of the requirements for an accessible MOOC system in greater depth. It presents a summary of all of the accessibility problems that must be tackled: the needs of the users, the user profile, the associated domain and technological infrastructure service, the delivery requirements of eLearning and the revision of the main standards applicable.

The structure of the article is, in the first place, to detail the access the needs for accessibility in MOOC services and goes on to look at the strategies for improving this accessibility, followed by the main conclusions.

II. THE NEED FOR MOOC SERVICES

MOOC platforms are based on collections of shared visual and audio-visual resources. These courses are made up of video-classes, animations, automatic evaluation tests, all of which are integrated into the courses. The existence of audio-visual content in the MOOC platforms gives rise to additional needs in the accessibility requirements for the actual management of the resources to make them available to the users.

Different components arise when thinking about the design of a service based on MOOC to be used by people with functional diversity in which it is important to bear in mind the individual degree of accessibility, such as access to the system, the platform itself, the educational content and the role of meta-information related to functional diversity (see fig. 1) [5]. A good example is the design of the system of MOOCs for people with functional diversity [6].

Independently of the possible improvements in the in the user experience, the universities, the teachers and the instructional designers will always have the last word on the structure of the user experience in the courses. The way of organising the content and labelling the sections of the menu or how the different pages are structured is absolutely crucial. Human-machine interaction guidelines must be considered in taking these decisions as well as best practices of recommendations for the writing of text in usable lines.

Therefore the design of the learning and specifically the overall design for learning play an important role [7, 8].

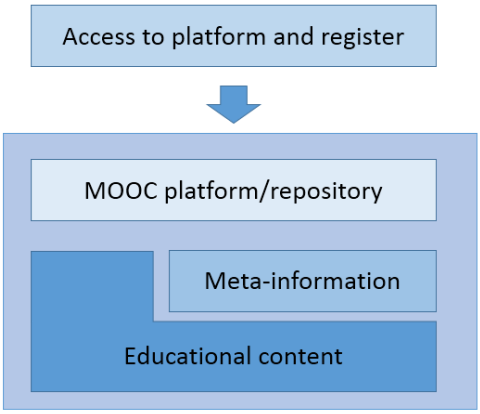

Fig. 1. Components in which the degree of accessability must be taken ito account.

As regards the design centred on the user, the planning of the learning is not only carries out by means of goals and actions, but also by specifying different contexts of use and requirements of the different "actors", including teachers and students [9, 10]. In the context of MOOCs, design centred on the user and evaluation centred on the user have been driven by the concept of "task".

The student has to be able to carry out tasks such as studying the materials of the course, taking notes, watching video classes, carrying out their work, accessing the forum or chat pages, communicating with the course curator, etc. However the learning process is not always easy and dividing the sequential activities into something like "study materials of the course" could be a very complex task depending on the way in which the materials could be studied. Some authors have tried to go beyond technical criteria: consistency or feasibility using pedagogical components such as control of the learning process by the student, the learning activity itself, its motivation and feedback [11]. One platform which has structured the courses by means of pedagogical tasks is FutureLearn[1], in which they are called steps.

TABLE 1. COMPONENTS AND THEIR RELATIONSHIP WITH ACCESSABILITY

Components	
Access to the platform and register	Accessible access to the MOOC platform. A register module of accessible users
MOOC Platform	Modules to begin the session, P2P tasks (peer to peer or pair revision), forums and test evaluation. Repositories and accessible content management
Meta-information	The definition of a specific user profile which includes data on the support tools used, visualisation preferences or the management of educational resources.
Educational content	Accessible educational content available within the platform as educational resources in document or video-class format. Accessible access to external links and social networks.

[1] FutureLearn, https://www.futurelearn.com

III. STRATEGIES TO IMPROVE ACCESSIBILITY IN MOOC SERVICES

With all of these considerations, some strategies may be applied to improve the level of accessibility to the MOOC systems including the platforms and services combined.

A. Access to the platform and register

In practice, MOOC services are presented by means of Web technologies, which is why MOOC platforms represent a domain in which the paradigm for Web accessibility is a large application. In this sense, The Web Accessibility Initiative (WAI)[2] promotes accessibility through directives related to the Web content (WCAG)[3], the authoring tools (ATAG)[4], and user agents (UAAG)[5]. The multimedia formats which are very popular in MOOC platforms are based on audio-visual content with high quality sound and image technology, as have the interactive services which make participation and communication between the students possible. Facilitating access for people with functional diversity and making them active users in the learning process.

Those students who use technical aids may have problems navigating the MOOC environment, and it is a key point in access to the platform as it is vital in the registry process.

The different components must have the different key accessibility factors as set out in table 1.

B. The MOOC platform

The design of the MOOC interface is often determined by the platform as some of its characteristics, the learning and evaluation tools, cannot be personalised by the actors in the learning process. In the case of the materials and the way of handing them in, they must follow a series of accessibility standards.

As regards the elements of the interface, such as the opening and closing of the session, navigation through the courses and resources and communication with all of the interested parties, MOOC environments have, as do other learning management systems (LMS), structures on various levels through which the users with functional diversity are able to navigate. On the other hand, this accessibility, where it exists, is directed mainly at the students rather than teachers or administrative staff. There seems to be a void in scientific research as to how the teachers who require technical aid are able to use these systems as creators of learning. The modules and sequencing of the content is usually managed by means of "drag and drop" movements although keyboard alternatives are also often possible. However these alternatives without a mouse in which the management of large quantities of information are required or in which complex content appear seem difficult to use.

MOOC environments also usually have a variety of components that do not always share a consistency of a logical interface or the interactive elements that go from: messages in

[2] Web Accessibility Initiative, http://www.w3.org/WAI/
[3] Web Content Accessibility Guidelines, http://www.w3.org/WAI/intro/wcag
[4] Authoring Tool Accessibility Guidelines, http://www.w3.org/TR/ATAG20/
[5] User Agent Accessibility Guidelines, http://www.w3.org/WAI/intro/uaag

a forum, tests, timed trials, the reproduction of embedded video classes or the downloading of documents in a different variety of formats. More problems arrive in the participation process with other students by means of collaborative work tasks.

A solution to the challenge of more and more complex computer systems and more interaction consists of making the computer systems easier to use. One way of doing this is through the research and the development of more intelligent interfaces which adapt to the user in a more natural and progressive way, by trying to detect their characteristics in such a way that the system is able to adapt to their level and preferences. The premise must be that the interface adapts to the person and not the contrary. The need for adaptive systems derives in the first instance from the heterogeneity of the user population. With the objective of achieving sufficient dynamics and facilitating the simple integration of people with functional diversity, it is necessary to create a suitable technological infrastructure that monitors and sustains the different tasks that the user has to deal with in the context of the use of computer environments.

One relevant specification is the Accessible Portable Item Protocol (APIP)[6], which is related to accessibility in evaluation and eLearning tests. It provides a data model to standardise the way of saving the exchange for the digital test elements to the evaluation programs and the developers. In the MOOCs there are usually sections of the test at the end of each module to carry out an evaluation of the knowledge of the students, since they allow an immediate feedback to be received and carried out automatically.

C. Meta-information: the user profile

An efficient MOOC environment must take into account the capacities of each student together with the learning objectives, in which the learning is carried out and those specific devices that are used by the student. In this context it is strategic to describe the preferences and needs of the student by means of a profile. The way in which this profile interacts with the MOOC platform and the objectives which it contains can impact on the learning experience of the users with functional diversity [12, 13, 14, 15].

With the aim of improving accessibility to the eLearning content, the specification of the AccessForAll metadata (ACCMD)[7] describes the metadata which can be used to describe the types and the relationships between an original resource and its available adapted formats. The textual alternatives which are available for the corresponding images, descriptions of audio for video classes, transcripts or subtitles for the audio tracks, alternative visuals for text and a variety of other alternative formats which coincide with the preferences of the user can be described. These suitable alternative resources can be recovered and presented to the user; a student with a visual disability, for example, can see a video class which has been previously defined in the ACCLIP[8] profile, and will automatically receive this video class with audio descriptions while a student with a listening disability will receive the same video class but with subtitles included in the presentation.

This profile provides a means of describing how the students interact with a MOOC environment, centred on the accessibility requirements. Therefore, a series of the user preferences can be used in accordance with the different contexts of use of the aforementioned environment, making it able to personalise the visualisation of the content of learning or select the preferred opening or closing device.

According to the standards, the students can specifically state only one way of alternative access to each of the learning resources but it will not allow changes: for example, a blind user may prefer an audio description but if these alternatives are not present in his or her profile he or she will not be able to choose a description of text in its place. For this reason the new version of AccessForAll (AfA)[9] in its personal needs and preferences section (PNP) tries to resolve this type of problem and enable the student to be able to specify multiple requests for adaptation for each existing way of access. However, PNP has some restrictions when choosing the size or the quality of the video and audio resources. For example, it is not possible to request an inferior version of a video clip or audio archive to adapt it to the user device. Therefore the specific quality for the learning resources would be desirable, as would clarification norms to describe the list of alternative options better. In order to mitigate it, AfA in its section on the digital resource description (DRD), changes the point of view: now it is possible to state one or more ways to access to each resource, define existing accessible adaptations and determine whether it comes from the specific original resource.

Some platforms such as edX[10], already save information related to the subtitles of preference of the user by default. In the use of metadata several projects related to eLearning have been carried out, which due to its potential and importance may be of great interest for its application in MOOC platforms such as EU4ALL[11] and METALL[12].

D. Educational content: video classes and documents

The video classes (see Fig. 2) are key elements in the MOOC model and the interaction obstacles with the platform and the resources must be minimised. Unfortunately having the format accessible by means of subtitles, sign language, alternative content for audio-visual materials, recordings with audio description, are not easy to achieve, even when there are large orientation guides [16]. Some platforms already work by facilitating subtitles in several languages such as edX or access to transcripts like Futurelearn or the ECO eLearning[13] project [17].

[6] Accessible Portable Item Protocol, http://www.imsglobal.org/apip/
[7] IMS Access-For-All. Meta-Data, http://www.imsglobal.org/accessibility/accmdv1p0/imsaccmd_infov1p0.html
[8] IMS Learner Information Package Accessibility for LIP, http://www.imsglobal.org/accessibility/acclipv1p0/imsacclip_infov1p0.html
[9] IMS Access-For-All http://www.imsglobal.org/accessibility/afav3p0pd/AfAv3p0_SpecPrimer_v1p0pd.html
[10] edX, https://www.edx.org/
[11] Project EU4ALL, https://adenu.ia.uned.es/web/es/projects/eu4all
[12] Project METALL, https://access.ecs.soton.ac.uk/projects/metall
[13] Project ECO eLearning, http://ecolearning.eu

The Flash format has often been used to create multimedia elements. Its content is independent of the navigator and to be able to see it the corresponding plug-in must be installed. Flash Player[14] currently provides a compatible multi-media player which serves as a link between the multimedia material created and the technical aid that the users use. Therefore applications such as screen readers can have access to the aforementioned material. However, Flash is not independent of the device as is demanded in the WCAG directives. The alternative to this access to information problem is to provide a standard version of the content of the course, for example, in HTML[15] format. There also exists the SVG[16] technology standard as an alternative in the field of vectorised graphics, also recommended for its use by the W3C in spite of the need to use a plug-in and which the multimedia elements cannot be included directly (unlike the Flash format).

Fig. 2. Options for the subtitles in a video class of the "sMOOC Paso a Paso(Step by step)" course of the ECO eLearning project

As regards documents, the versatility of the PDF[17] format has given rise to its rapid extension on the Web and it is the most used format to present documents within MOOCs. Adobe allows accessible PDF documents to be produced which can be navigated by means of a keyboard, and PDF formulas can be filled in and sent online easily. A significant characteristic is the support offered to screen readers which allows the content of the documents to be labelled in a similar way to HTML. It also allows textual content in PDF documents to be reproduced by voice by means of synthesisers found in the operating systems. The advances make it easier for the authors to create complex accessible documents, however, in order to do so the author has to create the documents with care and bear in mind the improvement in accessibility [18].

PDF documents are very common for presenting support to the content of the video classes, summaries of the subject or additional materials by the educational team, but in P2P activities the handing in of document is usually in Word format[18] in which the accessibility guides must also be followed [19].

The use of open educational resources (OER) allows a potential use to be added and the reuse of educational content within the MOOCs due to its availability, including the ubiquity of the technology which is used by the students [20].

At the beginning of the MOOCs open access was emphasised, by means of open content licenses, open structures and learning objectives which promoted reuse. Some MOOCs use licences restrictive to the materials the courses, or not even with the licences defined, while free access is maintained to students. Platforms such as Lagunita[19] or the aforementioned FutureLearn allow access to the content although the courses are finished.

IV. Conclusions

For those students with functional diversity the possibility of freely enrolling in MOOCs could be a first viable step in higher education or training. The challenge for the MOOC concept then is that of accessibility in terms of the community with which he or she wishes to participate, ensuring that processes such as enrolling in the course, navigating the system, access to the educational resources and interaction with their colleagues is achievable through the use of technical aids.

However, the problem continues to be that the development of a successful learning based on MOOC is highly dependent on human interaction and of their digital abilities in the use of the platform, the multimedia content and social technologies. The majority of the learning activities carried out continue to take place using software that was not designed for specific use in educational activities and problems of use often come about. On the other hand, technical or incompatibility problems often arise when it is not possible to have the necessary technology or it is not possible to obtain the materials in alternative formats.

Educational resources are used in the MOOCs which had not originally been designed either for MOOC platforms or for a specific learning scenario. Therefore, the educational resources that are handed in give rise to some problems for certain groups that receive them such as those people with complex communications needs. As a result, the degree of accessibility to these resources is often less than that desired based on previous analyses [21, 22, 23, 24, 25], even in the degree of usability and user experience [26, 27].

This is a clear step backwards if they are going to be used to a greater scale for inclusive learning.

The order of the adaptations is important bearing in mind that access and accessible register to the platforms must be provided to avoid bottlenecks in the platform itself and its courses and to finally add the user profile in the form of metadata and the educational content (see Fig. 3).

[14] Flash player, http://www.adobe.com/es/products/flashplayer.html
[15] HTML, https://www.w3.org/html/
[16] Scalable Vector Graphics, http://www.w3.org/TR/SVG11/
[17] PDF, https://acrobat.adobe.com/us/en/why-adobe/about-adobe-pdf.html
[18] Microsoft Word, https://products.office.com/en/word
[19] Lagunita, https://lagunita.stanford.edu

Some of the accessibility characteristics proposed to improve access in the MOOC platforms are:

- The designs of the available interface must be provided with the aim of inviting the users to choose the one which best suit their needs.
- The MOOC platform must be compatible with the accessibility standards, not only in relation to the Web interface, but to support the students in the configuration of the environment and the learning content in accordance with their preferences.
- The MOOC platform must also deal with accessibility from the point of view of the teachers, not only the students. It must be made easy for those people with functional diversity to have academic profiles within the MOOCs as digital facilitators and content curators.

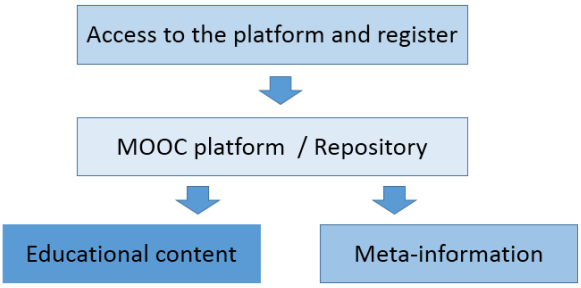

Fig. 3. Steps to carry out the strategy of improving accessibility

The proposals in this article as regards the standards are summarised in table 2.

TABLE 2. COMPONENTES Y ESTRATEGIA PROPUESTA

Component	
Access to the platform and register	Directives related to Web content (WCAG) Authoring tools (ATAG) User agents (UAAG).
MOOC platform	Accessible Portable Item Protocol (APIP)
Meta-information	AccessForAll (AfA): Personal needs and preferences (PNP) Digital resource description (DRD)
Educational content	Accessibility to video classes Accessibility to text documents

Although there may be the usual barriers to accessibility to MOOC platforms, the large-scale participation and social accessibility model [28] may be used to help those users with functional diversity by providing help between pairs in terms of studying techniques, adaptation to the content and remote assistance. If there is sufficient interaction between the users, the students within the system can learn from their study colleagues and make a contribution to helping them. Finally, the resources can be enriched with the consequent achievement of a greater degree of quality: transcriptions for mental maps, audio recording for podcasts, etc. All of the resources therefore can be grouped together in collections of educational resources which benefit all of the students in the MOOCs.

ACKNOWLEDGEMENT

Authors thank the support given by the Research Chair on "Technology and Accessibility" UNED - Fundación VODAFONE and the Global OER Graduate Network (GO-GN) which is supported by the William and Flora Hewlett Foundation. The work of Francisco is supported by a Leverhulme Trust Doctoral Scholarship in Open World Learning based in the Centre for Research in Education and Educational Technology at The Open University.

REFERENCIAS

[1] S. Haggard, "Massive open online courses and online distance learning: review". GOV.UK Research and analysis, 2013

[2] C. Rodrigo, "Accessibility in Language MOOCs". Martín-Monje, E., & Bárcena, E. (Eds.). (2015). *Language MOOCs: Providing Learning, Transcending Boundaries*. Walter de Gruyter GmbH & Co KG. 2015

[3] K. Tyler-Smith, "Early attrition among first time eLearners: A review of factors that contribute to drop-out, withdrawal and non-completion rates of adult learners undertaking eLearning programs". Journal of Online learning and Teaching, 2(2), 73-85, 2006.

[4] I. De Waard, M.S. Gallagher, R. Zelezny-Green, L. Czerniewicz, S. Downes, A. Kukulska-Hulme and J. Willems, "Challenges for conceptualising EU MOOC for vulnerable learner groups". Proceedings of the eMOOCs Conference. Edited by P.A.U. Education (Laussane, Switzerland), pp. 33-42. 2014

[5] C. Rodrigo and F. Iniesto, "Holistic vision for creating accessible services based on MOOCs". Open Education Global Conference. 22-24 April 2015. Banff, Alberta, Canada, 2015

[6] F. Iniesto and C. Rodrigo, "Accessible user profile modeling for academic services based on MOOCs". In: *Proceedings of the XVI International Conference on Human Computer Interaction (INTERACCIÓN 2015)* (Ponsa, Pere and Guasch, Daniel eds.), ACM New York, New York, USA, article no. 55. 2015

[7] L. Toetenel and A. Bryan, "Designing for inclusion: Supporting disabled students in a distance learning context". Proceedings of the 1th D4|Learning international Conference Innovations in Digital Learning for Inclusion. 2015

[8] D. H. R. Rose and D. Gordon, "Universal design for learning: Theory and practice". CAST Professional Publishing. 2014

[9] A. Kukulska-Hulme and L. Shield, "Usability and Pedagogical Design: Are language learning websites special?" Paper presented at ED-MEDIA 2004 World Conference on Educational Multimedia, Hypermedia and Telecommunications. June 22-26. Lugano, Switzerland, 2005.

[10] M. Kinzie, W. Cohn, M. Julian and W. Knaus, "A User-centered Model for Web Site Design". Needs Assessment, User Interface Design, and Rapid Prototyping. J Am Med Inform Assoc; 9:320-330, 2002.

[11] O. C. Santos and J .G. Boticario, "User-centred design and educational data mining support during the recommendations elicitation process in social online learning environments", Expert Systemsx, Wiley Online Library, 2013

[12] L. Neville, M. Cooper, A. Heath, M. Rothbergeine and J.Treviranus, "Learner-centred Accessibility for Interoperable Web-based Educational" Systems. In: International World Wide Web Conference (WWW2005), 10-14 May 2005, Chiba, Japan. 2005

[13] S. Green, R. Jones, E. Pearson and S. Gkatzidou, "Accessibility and adaptability of learning objects: responding to metadata, learning patterns and profiles of needs and preferences". ALT-J, 14(1), 117-129. 2013

[14] P. Salomoni, S. Mirri, S. Ferretti and M. Roccetti, "Profiling learners with special needs for custom e-learning experiences, a closed case?". In Proceedings of the 2007 international cross-disciplinary conference on Web accessibility (W4A) (pp. 84-92). ACM. 2007

[15] S. Mirri, P. Salomoni and C. Prandi, "Augment browsing and standard profiling for enhancing web accessibility". In Proceedings of the International Cross-Disciplinary Conference on Web Accessibility (p. 5). ACM. 2011

[16] E. Sánchez. "Usability guidelines for labeling MOOC videolectures", 2013. http://uxthoughtsabout.wordpress.com/2013/06/11/small-details-matter-videolectures-page/

[17] S.M. Tejera, and S. Osuna, "ECO project MOOCs. MOOCs for everybody". Proceedings of the 1th D4|Learning international Conference Innovations in Digital Learning for Inclusion (D4Learning, 2015). 2015

[18] V. Sama and E. Sevillano, "Guía de accesibilidad de documentos electrónicos". Centro de atención a la discapacidad. Universidad Nacional de Educación a Distancia. ISBN: 978-84-362-5669-7. 2012.

[19] L. Moreno, P. Martínez and Y. González, "Guía para elaborar Documentación Digital Accesible. Recomendaciones para Word, PowerPoint y Excel de Microsoft Office 2010", Tecnología y Sociedad Vol. 5, CENTAC 2014. ISBN: 978-84-616-8575-2. 2014.

[20] Open Educational Resources kit. 2010. https://jisc.ac.uk/guides/open-educational-resources

[21] S. Sanchez-Gordon and S. Luján-Mora, "Web accessibility of MOOCs for elderly students". In Information Technology Based Higher Education and Training (ITHET), 2013 International Conference on (pp. 1-6). IEEE, 2013.

[22] N. A. Al-Mouh, A. S. Al-Khalifa and H. S. Al-Khalifa, "A First Look into MOOCs Accessibility. The Case of Coursera". K. Miesenbergeret al. (Eds.): ICCHP 2014, Part I, LNCS 8547, pp. 145–152. Springer International Publishing Switzerland, 2014

[23] M. Bohnsack and S. Puhl, "Accessibility of MOOCs". In Computers Helping People with Special Needs (pp. 141-144). Springer International Publishing, 2014.

[24] F. Iniesto, C. Rodrigo and A. Moreira Teixeira, "Accessibility analysis in MOOC platforms. A case study: UNED COMA and UAb iMOOC". Proceedings V Congreso Internacional sobre Calidad y Accesibilidad de la Formación Virtual CAFVIR 2014. ISBN: 978-9929-40-497-7, p. 545 - 550, Antigua, Guatemala. 2014.

[25] F. Iniesto and C. Rodrigo, "Accessibility assessment of MOOC platforms in Spanish: UNED COMA, COLMENIA and Miriada X". Computers in Education (SIIE), 2014 International Symposium on, vol., no., pp.169, 172,12-14 doi: 10.1109/SIIE.2014.7017724, 2014.

[26] P. Espada, J. García-Díaz, V. Castillo Rodriguez, and R. González Crespo, "Method for analysing the user experience in MOOC platforms". Computers in Education (SIIE), 2014 International Symposium on, vol., no., pp.157,162, 12-14. doi: 10.1109/SIIE.2014.7017722, 2014

[27] J. Xiao, B. Jiang, Z. Xu and M. Wang, "The usability research of learning resource design for MOOCs". Proceedings of IEEE International Conference on Teaching, Assessment and Learning for Engineering: Learning for the Future Now, TALE 2014, pp.277–282.

[28] H. Takagi, S. Kawanaka, M. Kobayashi, T. Itoh and C. Asakawa, "Social accessibility: achieving accessibility through collaborative metadata authoring". In Proceedings of the 10th international ACM SIGACCESS conference on Computers and accessibility (pp. 193-200). ACM, 2008.