

Web Accessibility Requirements for Massive Open Online Courses

Can MOOCs be really *universal* and *open* to anyone?

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Abstract—The Convention on the Rights of Persons with Disabilities stresses that persons with disabilities should be able to participate fully in all aspects of life, including education. Nevertheless, statistics shows than a low percentage of persons with disabilities complete higher education.

MOOCs, being online courses available to a very large number of people, have a great potential to satisfy the learning needs of millions of people. When designing a MOOC, it is important to consider the diversity of abilities of all potential learners. Genuine universality and openness can only be achieved if all kind of users can access and use MOOCs to engage in learning regardless their abilities.

This paper proposes two categories of web accessibility requirements: for personal and for non-personal disabilities. Each category is characterized and a preliminary list of web accessibility requirements for each one is presented. Both MOOC's platforms and contents must meet web accessibility requirements. If contents are accessible but not the platform, or vice versa, the MOOC is not accessible.

Keywords—Massive open online courses; web accessibility requirements; universal design; personal disabilities, non-personal disabilities

I. INTRODUCTION

*I have no legs,
But I still have feelings,
I cannot see,
But I think all the time,
Although I'm deaf,
I still want to communicate,
Why do people see me as useless, thoughtless, talkless,
When I am as capable as any,
For thoughts about our world.*

Coralie Severs, 14, United Kingdom [1]

In 2008, the Convention on the Rights of Persons with Disabilities (CRPD) entered into force. This happened after decades of work by the United Nations to change attitudes

towards viewing persons with disabilities as capable of claiming their rights as well as being active members of society. Basically, the CRPD guarantees that the same rights recognized in the Universal Declaration of Human Rights of 1948 are respected for persons with disabilities. It is anecdotal, to say the least, that 60 years have elapsed for this to happen.

As of March 2014, the CRPD have 158 signatories and 143 states parties [2]. When a country signs and ratifies a convention, it becomes a legal promise and it often leads the government to adapt and change its own laws to support the goals of the ratified convention.

The CRPD stresses that persons with disabilities should be able to live independently and participate fully in all aspects of life. To this end, states parties should take appropriate measures to ensure that persons with disabilities have access to the physical environment, to transportation, to information and communications technology, and to other facilities and services open or provided to the public.

Of particular importance in the context of this research is Article 24 of the CRPD. This article recognizes the right to education. States parties must make sure that persons with disabilities are able to get access not only to general education but also to tertiary education, vocational training, adult education and lifelong learning without discrimination and on an equal basis with others [3].

Nevertheless, statistics show that there still is a long way to go. For instance, in Colombia, only 2.3% of the population with disabilities have some level of higher education (technical, technological or professional), 1% completed their higher education and only 0.1% have completed graduate degrees [4]. In Spain, 3.6% of the population with disabilities complete higher education and 84% of students with disabilities state that they face several barriers through their college studies [5].

In this context, Massive Open Online Courses (MOOCs) are a great opportunity for persons with disabilities than would not be able to engage in learning otherwise because educational institutions might not have accessible facilities, accessible equipment nor accessible educational resources. The physical adaptations needed can be costly, while the design of accessible MOOCs is technically and financially possible.

There are also attitudinal and communication barriers with instructors and fellow students in educational institutions. People often does not known how to interact and communicate with persons with disabilities, thus prefer to avoid contact. In accessible online learning environments, such as MOOCs, the situation of a person with disabilities may go unnoticed, hence the person can be treated truly equally by their instructors and peers.

II. MASSIVE OPEN ONLINE COURSES

A course is a space in which a teacher leads a group of students in learning about a specific topic. A traditional course takes place in spaces such as classrooms or laboratories, in a specific period, and uses educational resources. A course is not necessarily part of an official curriculum towards a professional degree or certification. A course can be taken by personal interest and growth in the context of lifelong learning.

An online course is a course in which teacher and students interact and communicate, as well as access to content and learning activities, over the Internet. In other words, online courses are a type of distance education mediated by information and communication technology.

A MOOC is “an online course with no formal entry requirement, no participation limit, and free of charge” [6]. Oxford dictionary defines MOOC as “a course of study made available over the Internet without charge to a very large number of people” [7].

MOOCs are also showing a potential for providing continuing professional development. Organizations can support the training needs of their employees through MOOCs. One example of this is the industry alliance of MOOCs platform FutureLearn and company British Telecom started on October 2013. The courses created through this collaboration will be open not only to the almost 88,000 British Telecom’s employees but to all learners that choose to use FutureLearn [8].

MOOCs, being massive and global reaching, provide learning opportunities to millions of people around the world. MOOCs can also potentially reach thousands of persons with disabilities.

III. DISABILITY AND ACCESSIBILITY

According to the World Report on Disability, made by the World Health Organization in 2011, more than 1,000 million of people live with some form of disability. This is about 15% of the world's population. Lower income countries have a higher prevalence of disability than higher income countries; and the greater the poverty, the greater the exclusion produced by the disability [9].

The number of persons with disabilities increases appreciably when taking into account that this number should include not only permanent disabilities but also people with the following conditions [10]:

- **Temporary disabilities.** For example, people recovering after surgery (i.e. eye, ear, throat), with trauma

injuries (i.e. broken bones), parents with their baby in arms, pregnant women.

- **Progressive disabilities due to natural aging.** These conditions are particularly complicated due to rejection of the gradual decline in certain abilities or just because the person does not realize it. Life expectancy is growing. Projections by United Nations show that by 2030, population of 65+ years old and 80+ years old will be 11.7% and 2.3% respectively, of a total of 8,321 million. That is, 1,165 million of people will be 65 or older [11]. There is also a tendency of more elderly people engaging in online learning not only for personal growth but also to mitigate loneliness [12].

All of the above makes us ponder that ourselves or someone close to us could potentially be in a disability situation at some stage in life, but we do not foresee this due to our limited understanding of disability and accessibility.

At the end of the last century, the inventor of the web, Tim Berners-Lee, stated: “Accessibility is the art of ensuring that, to as large an extent as possible, facilities (such as, for example, web access) are available to people whether or not they have impairments of one sort or another” [13].

The International Organization for Standardization (ISO) defines accessibility as “the usability of a product, service, environment or facility by people with the widest range of capabilities” [14].

Universal design aims to simplify performing tasks by designing environments, products, and services easier to use by everyone. Therefore, universal design benefits all people of all ages and abilities. Especially important is the prospect of universal design applied to teaching and learning [5].

Humankind is diverse. Hence, when designing a MOOC, it is important to consider the diversity of abilities of all potential learners. Genuine universality and openness can only be achieved if all kind of users can access and use MOOCs to engage in learning regardless their abilities.

IV. WEB ACCESSIBILITY GUIDELINES AND REQUIREMENTS

To apply universal design to MOOCs, it is important to consider the Web Content Accessibility Guidelines 2.0 (WCAG 2.0) published by the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C) in 2008. WCAG 2.0 provide guidance on how to make web content more accessible to a wider range of persons with disabilities. WCAG 2.0 covers a range of recommendations for universal access of web applications and services organized by 4 layers: principles, guidelines, success criteria and techniques to accomplish them. At the top are four principles that provide the foundation for web accessibility: perceivable, operable, understandable, and robust. Under the principles are twelve guidelines that provide basic goals. Each guideline has a testable success criteria. There are three levels of conformance: A (lowest), AA, and AAA (highest). For each of the guidelines, there are several techniques that fall into two categories: those that are sufficient for meeting the success criteria and those that are advisory. There are also documentation on common failures [15].

WCAG provides input for general accessibility requirements but MOOCs should also comply with specific accessibility requirements for learners and instructors.

In this research, we propose a division of web accessibility requirements for MOOCs into two categories: for personal disabilities and for non-personal disabilities. Fig. 1 illustrates the relative closeness of each category to the learner.

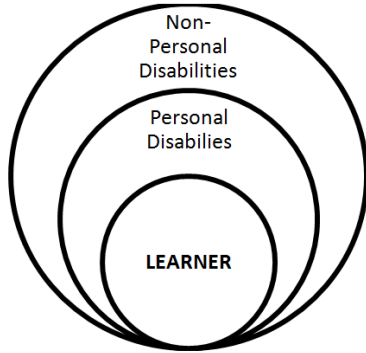


Fig 1. Categories of disabilities and their relative closeness to the learner

In the following sections, we characterize these categories and present preliminary lists of web accessibility requirements for each one.

V. WEB ACCESSIBILITY REQUIREMENTS FOR PERSONAL DISABILITIES

We define personal disabilities as those associated to body or mental impairments of the human being. A personal disability may be congenital or occur at any point in a person's life. These include: vision, hearing, speech, motor, cognitive, psychosocial, language issues, and cultural considerations as illustrated in Fig.2.

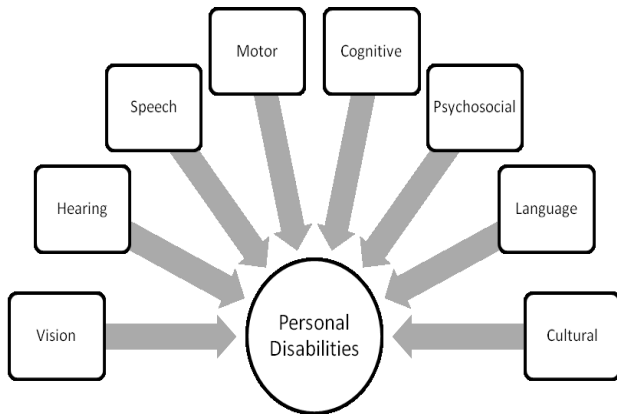


Fig 2. Personal Disabilities

A. Vision disabilities

Vision disabilities include low vision and blindness. According to the World Health Organization, by October 2013, there were 285 million visually impaired people worldwide: 39 million blind and 246 million with low vision. About 90% of the world's visually impaired live in developing countries [16]. Learners and instructors with visual disabilities cannot properly access visual information or use the mouse. Blind persons

usually use text-to-speech software, also known as screen readers, and text-to-Braille hardware. Computer users with low vision uses magnifiers. [17] [18]. Tables I and II summarizes main characteristics and web accessibility requirements proposed for blindness and low vision. The rationale behind each requirement s has been omitted in all tables due to space limitation.

TABLE I. WEB ACCESSIBILITY REQUIREMENTS FOR BLINDNESS



Characteristics	Vision less than 20/200 in the better eye. Visual field less than 20 degrees in the better eye.
Accessibility Requirements 	B01. Images, sensitive areas of image maps and other non-textual elements should have explanatory alternative text. B02. Links should have significant titles. B03. Forms should have labels for fields. B04. Tables should be comprehensible when read sequentially. B05. Do not use nested tables. B06. Do not use animations and other moving content. B07. Functionality should be operable by keyboard. B08. Use consistent structure for web pages. B09. Images and videos should have textual narratives. B10. Ensure accessibility of formats such as pdf-files. B11. Include explanatory hidden text content for screen readers.

TABLE II. WEB ACCESSIBILITY REQUIREMENTS FOR LOW VISION


Characteristics	Vision less than 20/200 in the better eye. Visual field less than 20 degrees in the better eye.
Accessibility Requirements 	V01. Support text and images resizing. V02. Provide high contrast between foreground and background colors. V03. Do not use color as the only mechanism to convey information. From other categories: B08, H04.

B. Hearing disabilities

Hearing disabilities range from mild, moderate, severe to profound. 360 million people worldwide has disabling hearing loss. The majority live in low- and middle-income countries [19]. For persons born profoundly deaf, sign language become their native language. As a result, textual information becomes difficult to understand. Table III summarizes main characteristics and web accessibility requirements for hearing loss.

TABLE III. WEB ACCESSIBILITY REQUIREMENTS FOR HEARING LOSS


Characteristics	Hearing loss greater than 40dB in the better hearing ear.
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	H01. Provide video content with captioning. H02. Provide alternative video content in sign language. H03. Provide textual transcripts of audio content. H04. Simplified textual content.
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C. Speech disabilities

Speech disabilities refers to difficulties with vocal communication and may range from mild to severe. Speech disabilities includes: lack of speech, slurred, slowed, hoarse, stuttered or rapid speech. At present, computer user’s entries are made mostly with mouse and keyboard. However, it is very likely that different forms of voice activated user interfaces become more popular in the future, especially in circumstances in which the use of mouse and keyboard is not the best option. For example, when there is also a motor disability or due to external conditions. Computer users with speech disabilities uses communication devices that produce either synthetic or digital speech output based on their textual input. Learners and instructors with speech disabilities might have difficulties participating in activities involving vocal communication [20]. Table IV summarizes main characteristics and web accessibility requirements for speech disabilities.


TABLE IV. WEB ACCESSIBILITY REQUIREMENTS FOR SPEECH DISABILITIES

	S01. Provide alternative mechanism using written communication to audio chats and/or video conferences that require learner’s synchronic participation using vocal communication. S02. Provide alternative mechanism using written communication to assignments that imply creation of audio content using learner’s voices.
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D. Motor disabilities

Motor disabilities include limited fine motor control, slow response time, inability to control unwanted movement, lack of movement or missing limbs. Learners and instructors with motor disabilities in upper limbs have inability or difficulty using mouse and keyboard. They use voice recognition software, head wand, mouth stick, alternative keyboard or alternative mouse. Table V summarizes main characteristics and web accessibility requirements for motor disabilities.


TABLE V. WEB ACCESSIBILITY REQUIREMENTS FOR MOTOR DISABILITIES

	M01. Provide proper spatial distribution of the elements of the web pages. M02. Design web pages to be error-tolerant. M03. Provide a mechanism for skipping over long lists of links. From other categories: B08.
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E. Cognitive disabilities

The concept of cognitive disabilities is extremely broad and not always well-defined. In general terms, a person with a cognitive disability has difficulties with one or more types of mental tasks than the average person ranging from mild to profound. Cognitive disabilities include difficulties with memory, problem-solving, attention, reading, linguistic and verbal comprehension, math comprehension, and visual comprehension [21] [22]. Unfortunately, cognitive disabilities are one of the most under researched topics of web accessibility. Table VI summarizes main characteristics and web accessibility requirements for cognitive disabilities.

TABLE VI. WEB ACCESSIBILITY REQUIREMENTS FOR COGNITIVE DISABILITIES

	CG01. Content with short, simple, clear paragraphs focused on a single idea at a time. CG02. Content logically and consistently organized. CG03. Provide a glossary for complicated or technical terms. CG04. Avoid content with non-literal text, such as sarcasm, satire, parody, allegory, metaphor, slang, and colloquialisms. CG05. Provide conceptual explanations of mathematical expressions. CG06. Use correct spelling and grammar. CG07. Use consistent navigation mechanisms, including links to home page and previous page, a navigation bar and a website map. CG08. Incorporate option to disable multimedia elements. CG09. Do not use too many text fonts and font sizes. CG10. Use adequate line length and height. CG11. Use white space. CG12. Include a search option. CG13. Provide appropriate error messages. CG14. Provide extra time to develop learning and evaluation activities. From other categories: B02, B06, B09, V01, V02, H04.
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F. Psychosocial disabilities


25% of people have a mental health condition at some stage in their life. This might range from transient anxiety following an accident to conditions like depression or schizophrenia, which can be recurring, and extremely disabling. The disabilities arising from mental health conditions are called psychosocial disabilities. At present, about 450 million people worldwide are affected. Conditions leading to psychosocial disabilities include depression, psychosis, epilepsy, post-traumatic stress disorder and dementia. These conditions are more prevalent in low income than in wealthy countries [23].

Depression is a common mental disorder. Globally, more than 350 million people of all ages suffer from it. It can cause

the affected person to suffer greatly and function poorly at work, at school and in the family [24].

Dementia is a syndrome in which there is deterioration in memory, thinking, behavior and the ability to perform everyday activities. Worldwide, 35.6 million people have dementia and there are 7.7 million new cases every year [25]. Table VII summarizes main characteristics and web accessibility requirements for psychosocial disabilities.


TABLE VII. WEB ACCESSIBILITY REQUIREMENTS FOR PSYCHOSOCIAL DISABILITIES

Characteristics	Disabilities arising from mental health conditions.
Accessibility Requirements 	P01. Use appropriate examples and study cases. P02. Provide positive feedback to evaluation activities. P03. Use appropriate vocabulary in video lectures P04. Provide option to habilitate relaxing music P05. Provide option to switch to relaxing colors. From other categories: CG01, CG02, CG03, CG04, CG07, CG8, CG9,CG11.

G. Language issues

Language issues affects to international learners taking courses in a language different to their native one. They also affect to learners whose native language is sign language. At present, the majority of MOOCs are offered in English. For example, as to March 2014, 88% of MOOCs at platform Coursera were offered only in English. Non-native English speakers might face difficulties due to their level of proficiency in the language. Non-native speakers read at slower speed than native speakers; the speed difference leads to information overload and cognitive issues. Non-native speakers also experience stress related to workload and visibility of their written responses in essays, forums and textual chats [26]. Table VIII summarizes main characteristics and web accessibility requirements for language issues.


TABLE VIII. ACCESSIBILITY REQUIREMENTS FOR LANGUAGE ISSUES

Characteristics	Difficulties arising from learning in a language different from the native one.
Accessibility Requirements 	L01. Provide alternative mechanisms to learning activities, such as texting chats and forums that require learner's participation via written statements. L02. Provide alternative mechanism to assignments, such as essays and academic papers that involves learners' creation of text content. From other categories: H04, CG01, CG02, CG14.

H. Cultural considerations

MOOCs usually are culturally bound and need to be revisited to meet cross-cultural and local cultural needs of international learners. Table IX summarizes main characteristics and web accessibility requirements for cultural considerations.

TABLE IX. ACCESSIBILITY REQUIREMENTS FOR CULTURAL CONSIDERATIONS

Characteristics	Difficulties arising from cultural and religious factors.
Accessibility Requirements 	CU01. Select content, examples and learning activities that are not strange or offensive to learners with diverse cultural and religious backgrounds. From other categories:P01, P03.

VI. WEB ACCESSIBILITY REQUIREMENTS FOR NON-PERSONAL DISABILITIES

We define non-personal disabilities as those associated to situations in the environment surrounding the human being including external conditions, internet access and technology availability, as illustrated in Fig.3. A non-personal disability can occur at any point in a person's life and it is generally temporary.

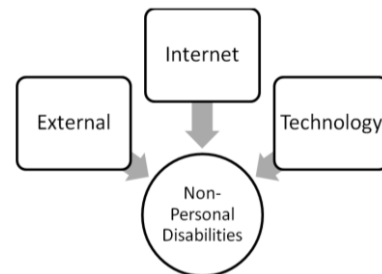



Fig 3. Non-Personal Disabilities

A. External conditions

External conditions include light conditions that impede visibility of screen, noise conditions that impede hearing, and silent places where volume must be muted such as libraries, hospitals, late night at home. Learners and instructors with external conditions that impede hearing might use headphones. Table X summarizes main characteristics and web accessibility requirements to mitigate external conditions


TABLE X. ACCESSIBILITY REQUIREMENTS FOR EXTERNAL CONDITIONS

Characteristics	Light or noise conditions that impede visibility of hearing.
Accessibility Requirements 	E01. Provide a mechanism to set brightness level. E02. Provide a mechanism to set volume level. From other categories: V01, V02, V03, H01, H03

B. Internet access

Only around one-third of the total population of the world has access to Internet. Whereas in Europe, United States or Canada, the number of Internet users is above 80%, in countries such as Burundi, Ethiopia, Guinea or Niger is less than 2% [27]. Table XI summarizes main characteristics and web accessibility requirements for limited Internet access.


TABLE XI. ACCESSIBILITY REQUIREMENTS FOR INTERNET ACCESS

Characteristics	Difficulties arising from the limitation or lack of internet access.
 Accessibility Requirements	<p>I01. Course content should be downloadable, so learners can work offline.</p> <p>I02. Offline work should be able to be synched back to the MOOC.</p> <p>I03. Avoid heavy content in the web pages.</p> <p>I04. Provide an option to enable loading only text content in the web pages.</p> <p>I05. Learning activities should not require timed answers</p> <p>I06. Learning activities should not require downloading or uploading big volumes of data.</p>

C. Technology availability

Includes outdated or low capacity devices such as black and white printers and monochrome monitors; software such as operating systems and browsers; and MOOC platforms. Table XII summarizes main characteristics and web accessibility requirements for technology availability.

TABLE XII. ACCESSIBILITY REQUIREMENTS FOR TECHNOLOGY

Characteristics	Difficulties arising from limitations of the hardware devices, base software and MOOC platforms.
 Accessibility Requirements	<p>T01. Include portability consideration in the content and structure of web pages.</p> <p>T02. Select a MOOC platform that complies with accessibility requirements.</p> <p>From other categories: V01, V03.</p>

VII. CONCLUSIONS

In this paper, we have defined two categories of disabilities: personal and non-personal. For each category, we have proposed a characterization and preliminary web accessibility requirements. MOOCs should comply with these requirements. Otherwise, a MOOC might discriminate and discourage potential participants just for having disabilities.

Both MOOC's platforms and contents must meet web accessibility requirements. If contents are accessible but not the platform, or vice versa, the MOOC is not accessible. Multiple disabilities might present themselves in combinations, which multiplies the challenges since there are conflicting requirements among disabilities. Continuing research is essential for increasing accessibility of MOOCs, including accessibility testing and validation.

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