Information and Universal Design
in Online Courses

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Abstract. This paper aims to identify how the interface design of a Massive Open
Online Course can incorporate the seven Principles of Universal Design. In order
to do that, this paper begins with a literature review on Universal Design and
interface design. This review is followed by a review on the WCAG 2.0 and a
verification instrument is designed. The verification is then performed on a
Coursera Course and aims to identify how the seven Principles of Universal Design
are applied in this environment. The results suggest that the Coursera platform is a
good example of Universal Design because the guidelines were followed. There-
fore, Universal Design is a challenge that is possible to be implemented.

Keywords: Universal Design · Online course · Information design

1 Introduction

According to the UN there are 7.2 billion people in the world and 10 % of this
population has at least one disability. In addition, the World Health Organization
(WHO) addressed that this percentage tends to increase due to population growth and
the advances in medicine that prolong the aging process. Furthermore, the report of the
United Nations Regional Information Center [1], points out that in countries where life
expectancy is over 70 years, each individual will live with a disability for eight years on
average. This is 11.5 % of his/her lifetime. These data emphasize the importance and
magnitude of a greater dissemination of Universal Design (UD) [2].

Universal Design allows the products and environments to be used without the need
for adaptation or specialized design. Therefore, Universal Design should be considered
an efficient approach for distance learning environments because the users come from a
wide variety of social backgrounds and there are increasing numbers of students with
disabilities pursuing education [3]. Meyer and Rose [4], for example, addressed
questions about understanding learner differences and how technology can augment
and streamline a teacher's ability to give students timely, personalized, balanced and
varied attention. In addition, a broad range of users requires a high quality interface [5].

Thus, this paper aims to identify how the interface design of a Massive Open Online Course can incorporate Universal Design.

This paper begins with a literature review on Universal Design and interface design. This review is followed by a review on the WCAG 2.0 guidelines and the design of the UD verification instrument. This instrument is then used to identify how the Principles of Universal Design[1] could be applied in the design of this environment. Finally, this paper discusses how Universal Design can assist users with disabilities using a distance learning environment. This paper highlights the importance of research about Inclusive Design and Universal Design, especially in the context of information design because it is a duty and an act of social justice to make information accessible to all people. In addition, it is an attitude of respect to others considering the differences between users in terms of their capabilities.

2 Universal Design and Accessibility

Toward the design of an instrument to verify the Universal Design in an interface this paper begins by establishing the relationship between Universal Design and accessibility. According to the definition of Mace [6] the intent of Universal Design is to generate environments, products, services, programs, and technologies available to meet the greatest number of people, to the largest extent possible, without the need for adaptation or specialized design.

On the other hand the Brazilian Federal Decree no. 5,296/2004 (1), in its Article 8, I, establishes a definition for accessibility as being "… condition for use, with security and autonomy, total or assisted, of spaces, furniture and equipment urban, of buildings, in transport services and device, systems and communication media and information, for a disabled person or person with reduced mobility".

Based in these definitions this paper assumes that the Universal Design encompasses accessibility since this focuses on designing for people with some kind of disabilities while UD focuses on designing for a greater number of people (including people with disabilities). The seven Principles of Universal Design are as follows [6]:

1. **Equitable Use:** The design is useful and marketable to people with diverse abilities;
2. **Flexibility in Use:** The design accommodates a wide range of individual preferences and abilities;
3. **Simple and Intuitive Use:** Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level;
4. **Perceptible Information:** The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities;
5. **Tolerance for Error:** The design minimizes hazards and the adverse consequences of accidental or unintended actions;

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[1] The Principles of Universal Design were conceived and developed by The Center for Universal Design at North Carolina State University. Use or application of the Principles in any form by an individual or organization is separate and distinct from the Principles and does not constitute or imply acceptance or endorsement by The Center for Universal Design of the use or application.

6. **Low Physical Effort:** The design can be used efficiently and comfortably with minimum fatigue;
7. **Size and Space for Approach and Use:** Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

Focusing on learning, the so called Universal Design for Learning (UDL) is a new way of thinking about education that has the potential of curricular reform and makes learning experiences more meaningful and accessible to all students. The recommendations and current specifications available that involve online learning are the W3C Web Accessibility Initiative (WAI), the IMS and DublinCore [7].

3 Information and Interface Design of UDL

The significance of the interface design of learning environments has been documented in several studies, which seek to establish how the design can support learning [8] contribute to user satisfaction [9] or develop design methods [10]. Similarly, there are many research that stress qualities of Information Design (ID) and learning materials, such as the design principles addressed by Pettersson [11]: Functional Principles, Administrative Principles, Aesthetic Principles, and Cognitive Principles. These principles might add depth to the Principles of Universal Design because they seek for clarity of communication. For example, Simple and Intuitive Use – UD might benefit from Providing Clarity and Simplicity principles (Functional Principles – ID) and Harmony principle (Aesthetic Principles – ID; or Low Physical Effort – UD might benefit from Facilitating Attention, Perception, Mental Processing and Memory principles (Cognitive Principles – ID).

In addition, the effects of implementing universal design in systems that are dedicated to education are object of many studies [3, 12]. For Gregga, Chenga and Toddb [3] the Principles of Universal Design are one of the key factors for the success of the BreakThru (platform of teaching at a distance from the University of Georgia) in addition to the virtual access, tools for social contact, e-mentoring, encourage persistence, resources for reasoning based on cases. In BreakThru, the UD was related to the shortcomings of literacy and for each deficiency detected it was chosen to apply the principles that could help to overcome this deficiency.

For Rose and Meyer [13] there are three principles of a universal design that can be applied to educational technologies (UDL). These principles are based on the idea of flexibility in relation to the means of representation, forms of expression and engagement and are summarized below.

1. Multiple means of representation - to present the content using different modes of representation enables the students to choose the mode that most favors them. In addition, the more senses are stimulated better the assimilation of content.
2. Multiple forms of engagement strategy - it is well known that students learn better if they are actively engaged in an activity [14]. Then the system needs to offer key concepts and provide guidance to students to think independently.

3. Multiple means of expression - the system must offer different ways for students to express themselves, whether through multimedia projects, texts, or different forms of assessment.

Similarly, Rose, Hernándeza and Hilera [15] listed the main accessibility standards for the preparation of courses in virtual learning environments. These standards were established by agencies such as AENOR (2003, 2009, 2012), ANSI (2008), CAN-CORE (2009), IMS (2003, 2004, 2005), ISO (2008), ISO/IEC (2008), W3C (2000, 2008, 2009). Based on some of these standards, Akoumianakis and Stephanadis [16] reported the efforts of the scientific community to bring universal design for the area of interaction human-computer. After analyzing these efforts the authors reported that the universal design applied to interfaces is more a challenge than a utopia.

One of these challenges is to understand the criteria that are used by these standards. For example, the WCAG 2.0 (standard that specifies accessibility for web) reports criteria, which are presented as testable statements that, according to the document, are not for a specific technology. Due to the complexity of applying the criteria, it is possible that there is some difficulty in understanding the operation of the document. This is because the WCAG 2.0 introduces several levels of approach, which include principles, recommendations of a general nature, testable success criteria and a large set of techniques. In addition, the document shows common failures documented with examples, links to resources and source code [17].

At the top of this hierarchy are four principles that represent the foundation of Web accessibility: noticeable, operable, understandable and robust. For each one of these principles there are recommendations that gather 12 basic objectives that Web designers must achieve in order to make your content accessible.

In addition, for each recommendation there are testable criteria of success, which can be used when there is a need for compliance tests. The document provides three levels of compliance depending on the group to be answered (A to the lowest, AA and AAA for the highest level).
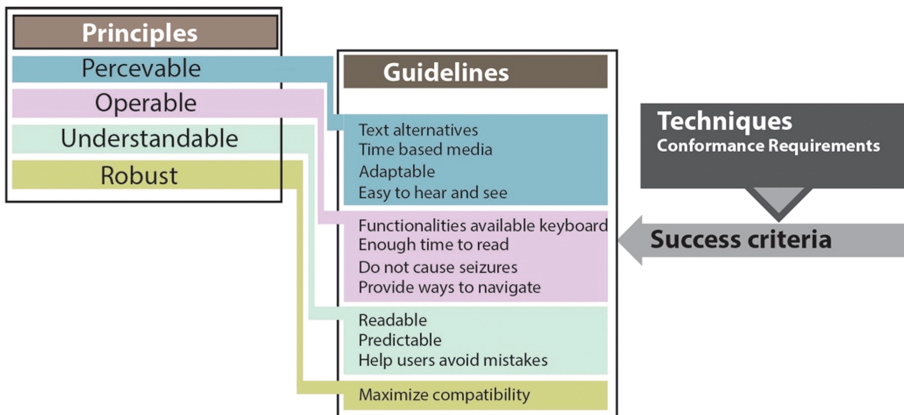

Fig. 1. Levels of approaching - WCAG 2.0 (based on [13])

In addition to the recommendations and success criteria, the W3C documents techniques of an informative character into two categories: Sufficient techniques and techniques are advisory. The sufficient techniques meet the criteria of success established by WCAG 2.0; the type recommended go beyond what is required in each one of the criteria for success and allows authors to a better compliance with the recommendations, approaching the barriers of accessibility not yet covered by the testable criteria of success (see Fig. 1). The Center for Universal Design has also established guidelines for each Principle of Design [2]. These guidelines are shown in Fig. 2 associated with the WCAG 2.0 guidelines.

4   MOOCs

For Grunewald, F. et al. [18] the origin of the concept Massive Open Online Course (MOOC) is commonly assigned to an experiment in 2008 carried out by educational researchers from Canada, George Siemens and Stephen Downes. They developed a theory for the digital age, called connectivism, which conceives learning as the creative and social process of connecting nodes of knowledge. This means that all material created by the professors was optional with students free to choose their path. Because of the large class size it is expected that a bigger connectivist "class" emerge with a greater potential for the quantity and variety of modal connections. David Cormier, another Canadian and manager of web communications and innovations at the University of Prince Edwards Island and the host of the weekly EdTechTalk webcast coined the term "MOOC". He came up with the name during an EdTechTalk interview with Siemens and Downes in 2008 [19].

"The course content and instructions frequently are hosted on different platforms, such as EdX, Coursera, Udacity, Udemy, MOOC^{2}Degree, from online learning, such as BlackBoard Learn, Moodle" [20].

This paper chose the Coursera platform as the object of study. This is a non-probabilistic and intentional sample. Coursera is an online education platform founded at Stanford by Andrew Ng and Daphne Koller [21]. This platform was accessed on 26 October 2014 and the course was called Design: Creation of Artifacts in Society by Karl T. Ulricht.

5   Close Reading of a Massive Open Online Course

This paper aims to identify how the interface design of a Massive Open Online Course can incorporate the seven Principles of Universal Design. In order to that, a close reading of the course was performed to allow detailed notes to be taken about the interface design. Close reading is a detailed examination, deconstruction and analysis of a media text and adapted to other media forms such as interface design [22]. For Inman [23] close reading of digital media implies that reading is much about the "shape of the page" as it is about any other element.

Thus, a verification instrument was designed based on the Principles of Universal Design and the guidelines of WCAG 2.0. Figure 2 shows how each UD principle was
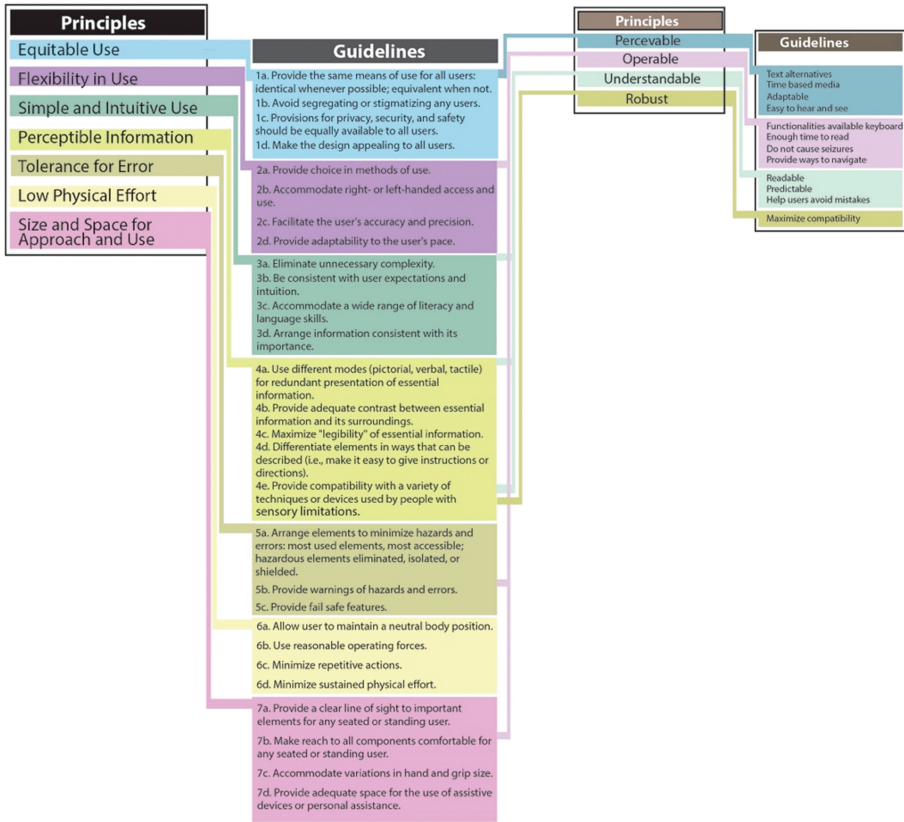
Fig. 2. UD's guidelines (Copyright 1997 NC State University – The Center for Universal Design) and WCAG 2.0's guidelines (based on WCAG 2.0)

linked to the correspondent WCAG 2.0 principle. The content analysis of each principle created this correspondence.

The notes taken from the close reading analysis were tabulated among with the Principles of Universal Design and WCAG 2.0. A total of 9 tables were designed to investigate if the Principles of Universal Design and the guidelines of WCAG 2.0 were supported by the interface design. The first 5 tables correspond to the first 5 Principles of Universal Design and the last 4 tables correspond to the 4 principles of WCAG 2.0. Principles 6 and 7 of Universal Design neither were considered because they deal with physical interaction, which does not pertain to the scope of this paper. In addition, this paper restricts the investigation to the visual design of the interface. Thus, the final instrument is composed of a list of interface elements that are designed to support the Principles of Universal Design and the guidelines of WCAG 2.0.

This paper argues that providing simplicity on interface design might support Universal Design, which will create an environment for a greater number of people. As declared by Pettersson "simplicity in a message will result in a easier and more efficient

perception, processing and memory of that message" [11]. For Pettersson simplicity is achieved through readability of text, pictures and graphic forms (layout, symbols, numerical values, maps, color). Readability is determined by content and formulations and how well they are adapted to a greater number of readers.

The tables were filled out looking for elements of Coursera interface that could establish whether the guideline was followed or not. It was considered the following legend:

✔ - Observed on pages | x - Not observed on pages | NA - Not Applicable, because the functionality was not implemented.

Tables 1 and 2 show the results for the first Principle of Universal Design – Equitable Use and for the first principle of WCAG 2.0's - Perceivable. The others 7 tables follow the same structure and were omitted because of space constrains.

Table 1. Results of principle Equitable Use

**UD	Principle 1- Equitable Use**: The design is useful and marketable to people with diverse abilities. Equitable means just and impartial	Results
Provide the same means of use for all users: identical whenever possible; equivalent when not; so that it can be changed into other forms people need	✔
Content based on text	✔
Video with close caption	✔
Avoid segregating or stigmatizing any users	x
Pictures with description	x
Provisions for privacy, security, and safety should be equally available to all users	✔
Login	✔
Make the design appealing to all users.	✔
Interface design simple	✔
Good contrast	

Next session discuss the results and explores how simplicity is applied to support Universal Principles.

6 Discussion

The results suggest that the Coursera course named Design: Creation of Artifacts in Society by Karl T. Ulrich follows the Universal Design guidelines. This is based on the analyses of the interface that supports the principles 'Equitable Use', 'Flexibility in Use', 'Simple and Intuitive Use', 'Perceptible Information' and 'Tolerance for Error'. The result of the principle Equitable Use pointed out that pictures did no have description, which might create difficulty for some users. The principles 'Flexibility in Use', 'Simple and Intuitive Use', and 'Perceptible Information' had al their guidelines supported by the interface design. But the principle 'Tolerance for Error' could have

Table 2. Result of principle perceivable

WCAG 2.0 Principle 1: Perceivable - Information and user interface components must be presentable to users in ways they can perceive.	Results	
Text Alternatives: Provide text alternatives for any non-text content so that it can be changed into other forms people need	50	
Non-text Content		✓
Controls, Input	✓	
Time-Based Media	✓	
Test	NA	
Sensory	NA	
Decoration, Formatting, Invisible	NA	
Time-based Media: Provide alternatives for time-based media.	x	
Audio-only and Video-only (Pre-recorded)	NA	
Pre-recorded Audio-only and Video-only	NA	
Pre-recorded Audio-only	NA	
Captions (Pre-recorded)		✓
Pre-recorded Video-only		NA
Audio Description or Media Alternative (Pre-recorded		NA
Captions (Live)		x
Audio Description (Pre-recorded)		x
Sign Language (Pre-recorded)		NA
Extended Audio Description (Pre-recorded)		x
Media Alternative (Pre-recorded)		NA
Audio-only (Live)		NA
Adaptable: Create content that can be presented in different ways (for example simpler layout) without losing information or structure		
Info and Relationships		✓
Meaningful Sequence		✓
Sensory Characteristics		NA
Distinguishable: Make it easier for users to see and hear content including separating foreground from background.	100	
Use of Colour		✓
Audio Control		✓
Contrast (Minimum)		✓
Large Text	✓	
Incidental	✓	
Logotypes	✓	
Resize text	✓	✓
Images of Text		✓
Customizable	NA	
Essential	NA	
Contrast (Enhanced):		✓
Large Text:	✓	
Incidental	✓	
Logotypes	✓	
Low or No Background Audio:		✓
No Background:	✓	
Turn Off:	✓	
20 dB	✓	
Visual Presentation:		✓
Foreground and background colours can be selected by the user.	✓	
Width is no more than 80 characters or glyphs (40 if CJK).	✓	
Text is not justified (aligned to both the left and the right margins).	✓	

		Line spacing (leading) is at least space-and-a-half within paragraphs, and paragraph spacing is at least 1.5 times larger than the line spacing.	✔	
		Text can be resized without assistive technology up to 200 percent in a way that does not require the user to scroll horizontally to read a line of text on a full-screen window.	✔	
	Images of Text (No Exception)			✔

been applied in to a broader approach because it was not found evidence of warnings of hazards and errors.

The last two principles 'Low Physical Effort' and 'Size and Space for Approach and Use' were not applicable because they refer to physical interaction, which were not in the scope of this paper.

The results of the accessibility based on the guidelines of WCAG 2.0 suggest that the principle "perceivable" that recommends that "the information and the components of the user interface has to be presented to users in ways that they can understand" is being met in almost all guidelines but miss to provide text alternatives for any non-text content.

The results of the principle "operable" indicate that only the option to use the keyboard to act on the functionality of the interface does not seem to have been accomplished.

The results of the principles "understandable" and "robust" indicate that both principles are in accordance with the guidelines.

The elements of interface that support many of these guidelines are: text, pictures, layout and colors with a good readability. The readability of these elements supports simplicity as discussed next.

Readability of text is achieved by using clear contrast, clear hierarchy, balance between text and white space, and balance among length of words, sentences and paragraph.

Readability of pictures is achieved because the few pictures complete the ideas explained in the text. They miss legends though.

Readability of layout and text are the most impressive in this work. The layout follows a specific pattern, where heading, paragraphs, pictures and general concept of the structure is clear.

Readability of colors is used to emphasize links, or to show differences and similarities. Few colors with a clear contrast were used.

Simplicity is achieved by focusing on the essential to inform and elementary form. The result is a dynamic form language with all the elements having a clear reason to be in the page. The interface design design returns to the basic [24] with a sophisticated aesthetic. This supports the Akoumianakis and Stephanadis [16] statement that Universal Design is more a challenge than a utopia. The challenge resides on understanding the principles and most of all implementing them.

References

1. United Nations Regional Information Center (2013). http://www.unric.org/
2. Centre for Excellence in Universal Design. http://universaldesign.ie/What-is-Universal-Design/The-7-Principles/
3. Gregga, N., Changa, Y., Toddb, R.: Social media, avatars, and virtual worlds: re-imagine an inclusive learning environment for adolescents and adults with literacy barriers. Procedia Comput. Sci. **14**, 336–342 (2012)
4. Meyer, A., Rose, D.: Universal design for individual differences. Educ. Leadersh. **58**(3), 39–43 (2000)
5. Lidwell, W., Holden, K., Butler, J.: Universal Principles of Design. Rockport Publishers, Gloucester (2003)
6. Mace, R.: About UD. Retrieved Junho 12, from the Center for Universal Design (2014). http://www.ncsu.edu/ncsu/design/cud/about_ud/about_ud.htm
7. Macedo, C.M.S.: Diretrizes para criação deobjetos de aprendizagem acessíveis. Tese para obtenção do título de Doutor no programa Pós Graduação em Engenharia e Gestão do Conhecimento –PPEGC, da Universidade Federal de Santa Catarina, Florianópolis (2010)
8. Ramakrisnana, P., Jaafarb, A., Razaka, F.H., Rambaa, D.A.: Evaluation of user interface design for leaning management system (LMS): investigating student's eye tracking pattern and experiences. Procedia Soc. Behav. Sci. **67**, 527–537 (2012)
9. Izzo, M.V.: Universal design for learning: enhancing achievement of students with disabilities. Procedia Comput. Sci. **14**, 343–350 (2012)
10. Wong, M., Khong, C., Thwaites, H.: Applied UX and UCD design process in interface design. Procedia Soc. Behav. Sci. **51**, 703–708 (2012)
11. Petterson, R.: It Depends: ID - Principles and Guidelines. Institute for Infology, Tullinge (2007). http://www.iiid.net/PublicLibrary/Pettersson-Rune-ID-It-Depends.pdf
12. Türk, Y.A.: Planning-design training and universal design. Procedia Soc. Behav. Sci. **141**, 1019–1024 (2014)
13. Rose, D., Meyer, A.: Teaching Every Student in the Digital Age: Universal Design for Learning. Association for Supervision and Curriculum Development, Alexandria (2002)
14. Csikszentmihalyi, M.: Flow: The Psychology of Optimal Experience. Harper Perennial Modern Classics, New York (1991)
15. Rose, H.R., Hernándeza, R., Hilera, J.R.: Implementation of accessibility standards in the process of course design in virtual learning environments. Procedia Comput. Sci. **14**, 363–370 (2012)
16. Akoumianakis, D., Stephanidis, C.: Universal design in HCI: a critical review of current research and practice. Universal Design: Towards a Universal Access in the Info Society (2001)
17. Web Content Accessibility Guidelines. https://www.w3.org/WAI/intro/wcag
18. Grunewald, F. et al.: OpenHPI-a case-study on the emergence of two learning communities. In: 2013 IEEE Global Engineering Education Conference (EDUCON), pp. 1323–1331. IEEE (2013)
19. Harber, J.: MOOCS. The MIT Press, Caparral (2014)
20. Tu, C.-H. et al.: A cycle of online education ecstasy/agony: to MOOC or not to MOOC. In: IEEE 63rd Annual Conference International Council for Educational Media (ICEM) (2013)
21. Midha, A.: Credit crisis: the need for student inclusion in MOOC decision making. The Stanford Review (2013). Retrieved from http://stanfordreview.org/article/credit-crisis-the-needfor-student-inclusion-in-mooc-decision-making/

22. Bizzocchi, J., Tanenbaum, J.: Well read: applying close reading techniques to gameplay experiences. In: Davidson, D. (ed.) Well Played 3.0. ETC Press, Pittsburgh (2011)
23. Inman, J.: Electronic texts and the concept of close reading: a Cyborg anthropologist's perspective. In: Walker, J.R., Oviedo, O.O. (eds.) TnT: Text and Technology. University of Toronto Press, Toronto (2003)
24. Hellers, S.: Less is More: The New Simplicity in Graphic Design. NorthLight, Cincinnati (1999). Anne Fink