MOOC Accessibility from the Educator Perspective

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Abstract. This work presents the universal access design principles and methods for natural language communication design in e-learning for the disabled. It unfolds a theoretical perspective to the design-for-all methodology and provides a framework description for technologies for creating accessible content for educational content communication. Main concerns include the problem identification of design issues for universal accessibility of spoken material, the primary pedagogical aspects that such content implementation should follow upon, as well as look into the state of the most popular e-learning platforms for which educators create and communicate educational content in an e-learning environment. References to massive open online course platform types of content that exist at the moment are examined in order to understand the challenges of bridging the gap between the modern design of rich courses and universal accessibility. The paper looks into the existing technologies for accessibility and a frame for analysis, including methodological and design issues, available resources and implementation using the existing technologies for accessibility and the perception of the designer as well as the user standpoint. Finally, a study to inform and access how potential educators may perceive the accessibility factor shows that accessible content is a major requirement toward a successful path to universally accessible e-learning.

Keywords: MOOC · Universal accessibility · Design-for-all · Speech processing · Interactive e-learning · Technologies for accessibility

1 Introduction

Accessibility and design-for-all apply to extended groups of people seeking knowledge and information from a distance such as the visually impaired, the mobile user, the elderly, etc. These users require special technology in order to access information, collectively

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called Technologies for Accessibility, ranging from underlying design (web accessibility) to specific implementation (voice browsing) and applied technology (screen readers, adaptive interfaces). Educational material in e-learning environments includes textbooks and technical documents that may contain a mixture of textual information, as well as originally designed visual information such as mathematics, line diagrams, pictures, spatial information and navigational parameters. Furthermore, such material includes format-independent pedagogical elements such as instructional (learning) design, cognitive standpoint, behavioural and contextual perspective; all elements contained in the underlying structure of the formatted material and manifested by visual elements [1].

E-learning, from the stakeholders' perspective, is required to address teacher-learner-content interactivity to satisfy the three-dimensional interaction that most contemporary learning theories emphasise upon [2]. The Open University in the UK estimated that about one out of seven learners are disabled [3]. Massive Open Online Course (MOOC) applications and other e-learning platforms are a step forward, towards accessibility through e-learning, by addressing the mobility aspects of disability as well as the social and personal aspects, such as gender, segregation, language, culture, social status and learner age. For the first time, learners may study from home without the need for physical presence at an education institute (mobility), watch lectures at their own time (working students) and with support for their native language (language barriers).

Facing the issue of accessibility in education is not a novel problem, more specifically in e-learning, a domain directly related to computer and technology. Research work is done in order to analyse and access the criteria that should be met in order to achieve universal accessible e-learning environment that can fulfil their pedagogical scopes. Focusing furthermore to e-learning material, several factors may occur that make it difficult to achieve a universally accessible learning environment. In particular, e-learning material differentiates from traditional educational documents by the concepts and educational notions that need to be relayed to students and the respective feedback to the educators. In most cases, the content is much richer, including multimedia, rich text and interactive elements for quizzes, exams and peer grading. While, in many cases, metadata can be omitted or otherwise tacked by screen readers, in the case of e-learning metadata is a crucial, desirable and indispensable component of the learning procedure to provide high-level meta-information to all learners as well as feedback to educators.

This work overviews the state of the art in e-learning methods and applications, examines technologies for accessibility that are or can be utilised and then examines the level of accessibility of major MOOC platforms, such as Udacity and Coursera for reference to the needs and requirements for universal accessibility for educational information communication.

The following sections present the theoretical background to accessibility and human-computer interaction for e-learning, the technologies for accessibility available for the design-for-all approach, the MOOC accessibility status and the conclusion.

2 Accessibility in HCI – The E-learning Paradigm

E-learning deploys multiple information and communication technologies. Most of the current major e-learning platforms utilise Web 2.0 aspects and technologies. Web 3.0

describes how the semantic web, linked data, ontologies and internet of things transform the web from social web to web of data [4]. Accessibility and e-learning are also transforming as the e-learning systems evolve in complexity [5]. The existing accessibility frameworks for e-learning utilise information technologies to the fullest and are expected to adopt the semantic web technologies as well [6].

MOOC platforms made higher education reachable to students all over the world in the recent years [7]. As MOOCs diversify to include new functionalities and technologies, so do the educational resources and delivery methods for the content to the students [8]. Al-Mouh et al. studied the accessibility issues that visually impaired students faced using an earlier version of the Coursera platform [9]. They found that the version of that time failed to comply with all priority levels (A-AA-AAA) of the WCAG 2.0. Similarly, Sanchez-Gordon researched how the EdX platform could conform to the accessibility guidelines, providing prospective course content authors with recommendations on how to achieve accessibility for web and mobile web access [10].

Recent studies show that accessibility is one of the major factors for the adoption of MOOCs [11]. In fact, accessibility has a significant impact on the learner motivation to take a MOOC course [12]. That is a reason that, recently, several works studied MOOC accessibility for specific disability groups that make up a significant percentage of the learner body in the recent years, such as older adults [13] and the elderly [14].

Educational resources are not in abundance and that is also the case for special education resources, where it is especially apparent that the educators do not have many at their disposal [15]. Therefore, researchers argue that if accessibility is considered from the designers and educators during the design process, it would be much easier for them to create accessible content afterwards. In that respect, MOOC accessibility guidelines for the design process is a step towards universal accessibility for both educational technologies, platforms and content [16].

Universal Design for Learning (UDL) is a framework that was conceptualized and elaborated for universal Access through Accommodations and Modifications [17]. UDL provides the framework for creating more robust learning opportunities for all students. It is an inclusive approach to course development and instruction that underlines the access and participation of all students. Rather than waiting to learn that a specific student needs additional or specialized support, the UDL approach encourages educators to plan their curriculum and pedagogy to anticipate broad diversity in student learning needs and proclivities [18]. Recent works have attempted a UDL Implementation for online courses [19]. In conjunction to that, accessibility recommendations for educational games [20] constitute an approach that may be used to handle the type of interaction that educational exam quizzes and other grading tasks require.

3 Technologies for Accessibility

Technologies for Accessibility are used in the broad spectrum of information communication, designed to relay complex information to specific user groups [21]. Such technologies can be applied during the design, implementation or application of specialized systems as well as for the creation or analysis of the actual educational content, in the form of documents, webpages, talking books, etc. An abridged list includes:

- *Web.* Specific web accessibility guidelines are provided by the W3C including recommendations for creating accessible web documents, guidelines and priorities for accessing and manipulating information from existing pages and templates [22]. Moreover, accessibility support is provided by VoiceXML as a means for implementing the above recommendation to the acoustic modality [23].
- *Speech synthesis.* Used widely for the rendition of electronic documents to the acoustic modality. The text-to-speech systems utilize prosodic modelling in order to provide natural rendition of textual information [24].
- *Document-to-audio.* While text-to-speech systems are usually applied to simple text documents, a document-to-audio platform may be used to process visual documents of great complexity and render the visual properties (colours, complex visual structures, spatial information, etc.) to audio [25]. Apart from synthetic speech, there are certain auditory features that are used for proper acoustic representation. Earcons are abstract musical melodies which are symbolic of tasks or objects contained in a document. Auditory icons are real-world sounds used for the interaction of a user with specific objects. Spatial information may be conveyed using specific models that extract the logical representation between sections of text or from visual data structures and rendered to speech using synthetic speech, sometimes assisted by earcons or auditory icons [26].
- *Screen readers* are used for accessing information from a display, supported by screen navigation, synthetic speech or specialized interfaces [27].
- *Adaptive interfaces* offer customization and personalization services for reducing complexity, user modelling and flexible environment for increased efficiency of human-machine communication [28–30]. Such parameters can be used to assist the main rendering modality (e.g. speech) to relay the educational content in a precise and speedy manner [31].
- *Document analysis* is a technology tightly related universal accessibility especially in e-learning environments where the educational material is user specific. The educational material is designed to be presented to specific users or students in a particular way according to the target group social, behavioural and contextual perspective [32]. Therefore, certain content extraction and categorization techniques as well as rendition parameters need to be modelled to accommodate such information provision [33, 34].
- Similarly, *natural language processing*, is utilized during the stages between document analysis and document-to-audio in order to retain meta-information on the semantics of the rendered information [35, 36].
- *Computer vision* methods for the disabled, especially the visually impaired, aim to process the visual world and present the information to the human user or an assistive system or application [37]. Such methods include obstacle detection and scene recognition as well as distance and object size calculation. They can be coupled with voice user interfaces for guidance.
- For user interaction, *spoken dialogue systems* can be used for human-machine communication and several navigation, summarization and accessibility parameters can be implemented in order to increase the place, manner and effectiveness of the accessible data [38].

- *Voice agents*. With the popular adoption of smart mobile devices, intelligent interaction is implemented using interactive agents that communicate mostly via voice but also involve multimodal content such as text, images, videos maps and others. Voice agents are mainly used for personal assistance [39] but also for training and learning [40].

E-learning accessibility initiative guidelines should be followed in all stages of creation and implementation of e-learning content and respective voice interfaces in order to provide means for quality assessment.

4 Accessibility and MOOCs

An aspect that is of interest for this work is the actual perception of educators on the accessibility features for online learning [41]. This translates to a diverse set of features and accommodations that, in essence, describe universal accessibility for both learners and teachers. The educators have the perspective that e-learning platforms as technologies and content providers should strive to create accessible courses that would address the needs of the disabled learners [3, 42].

Tools for automatic accessibility evaluation have been extensively used in the literature [43]. AChecker and WAVE are among the most popular for website accessibility evaluation [19]. For the purpose of this work, we have selected to use WAVE to create reports on accessibility issues for Udacity and Coursera course pages. The webpages that were examined were the following course pages, accessed in January 2020:

- Udacity: Web Accessibility by Google (free course)
- Coursera: An Introduction to Accessibility and Inclusive Design

For starters, it is quite hopeful that specialised accessibility courses are offered by the two e-learning platforms, especially since those are offered by non-other than a top university and the largest web company in the world today.

Figure 1 shows the Udacity course main page as rendered by WAVE. The main course page was reported to contain 17 errors and 24 contract errors. The errors mostly included missing alternative text, missing language and empty headings and links. The contrast errors were all about very low contrast in for several page items. Upon entering the course, for lesson one, only 3 errors and 6 contrast errors were reported. The errors were the missing language and two instances of empty buttons. That is a positive outcome, since the specific errors can be easily corrected. Moreover, standard screen readers may be successful in controlling them. The same number or errors was reported for the quiz section of the lesson.

The same testing was followed for the accessibility evaluation of the Coursera course main page. Figure 2 shows the visualized distribution of issues for the webpage, as reported by WAVE. A total of 69 errors and 3 contrast errors were reported. All errors were broken ARIA references. Visiting lesson one, 38 errors and 5 contrast errors were identified. Four errors were empty buttons and the rest were broken ARIA references. Low contrast issues are important to people with low sight, travelers that access a page from small and mobile screens and other learners with visual disabilities.

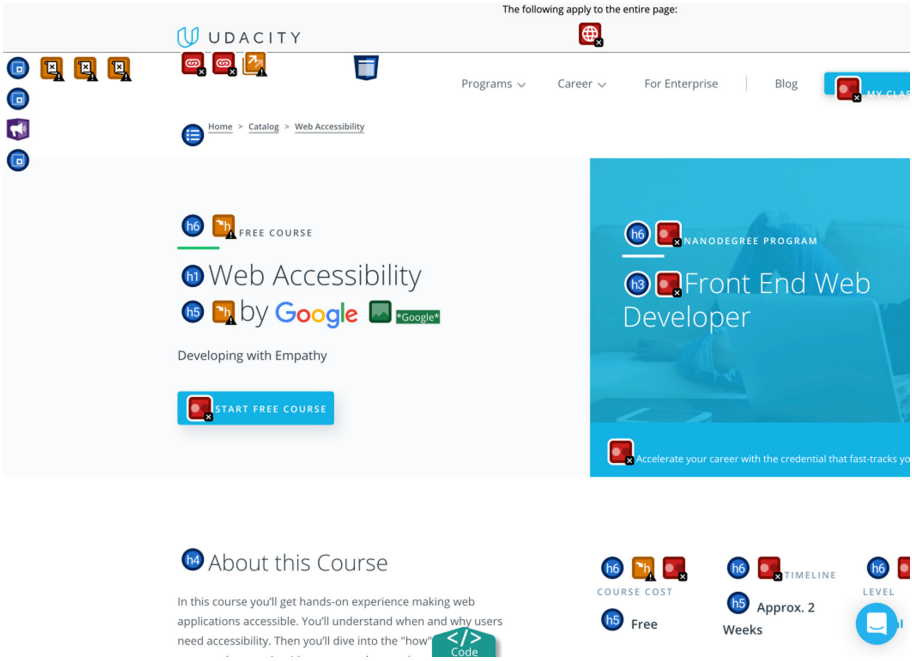

Fig. 1. A Udacity course accessibility test report visualization

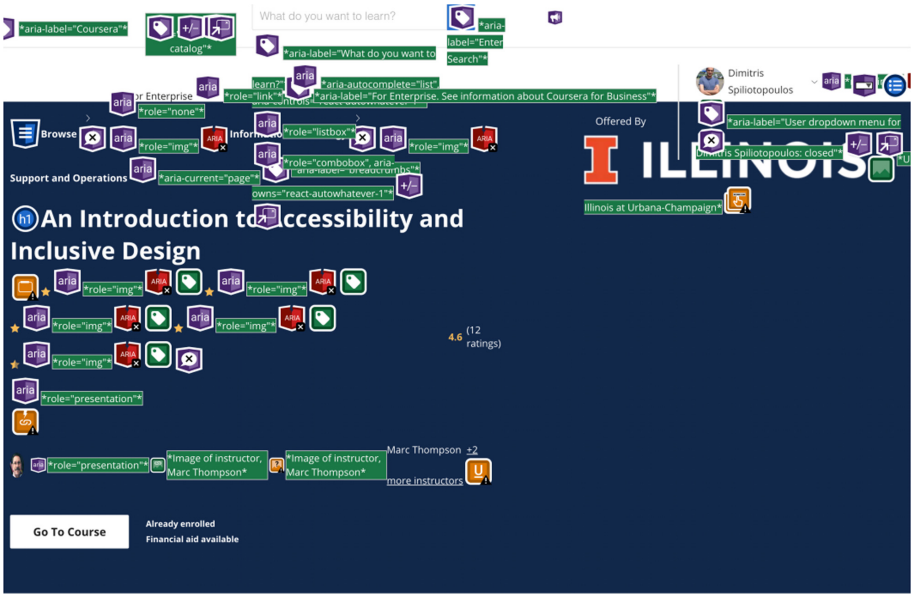

Fig. 2. A Coursera course accessibility test report visualization

The reported alerts and other information from the WAVE evaluation are not discussed in this paper. Reports are used as standard indicators of potential accessibility issues. However, reports cannot fully identify all accessibility issues as successfully as human users can when interacting and accessing the content.

5 The Educator Perspective

Educators and prospective educators generally find that MOOCs are one of the most prominent methods for teaching and learning. However, most of them consider the fully abled teacher and learner. In order to assess the perspective of potential educators, we asked four postgraduate students to access the aforementioned courses using a screen reader. The participants were between 23–29 years, 2 female and 2 male. They all have postgraduate degrees in computer science or equivalent and were pursuing a PhD degree at the time of the study. All had reported that they have used Udacity and Coursera as learners and they were planning to use them as educators, too.

The study setup had all four participants use Safari on a MacBook Pro 15" mid 2019, accessing the two courses in random order, using the MacOS built in Voice Over reader. The purpose was to provide the participants – prospective educators and users of the MOOC platforms – with the experience of the disabled learner. The formal justification for the introduction to the study was that, in real life, any abled person may be temporarily disabled due to situation or health related factors.

During the recruitment, about three months before the study took place, the participants filled in very short questionnaires on their opinion and feedback form the use of the MOOC platforms in the past. After the experience with the screen reader, they reported again on the same questionnaire.

Figure 3 depicts the user feedback on the accessibility impact as comprised of their perceived acceptance, friendliness, motivation to use and social morality (is universal accessibility the moral thing to do?). Before the experience with the screen reader, all participants agreed that the two MOOCs were very friendly and acceptable (usability),

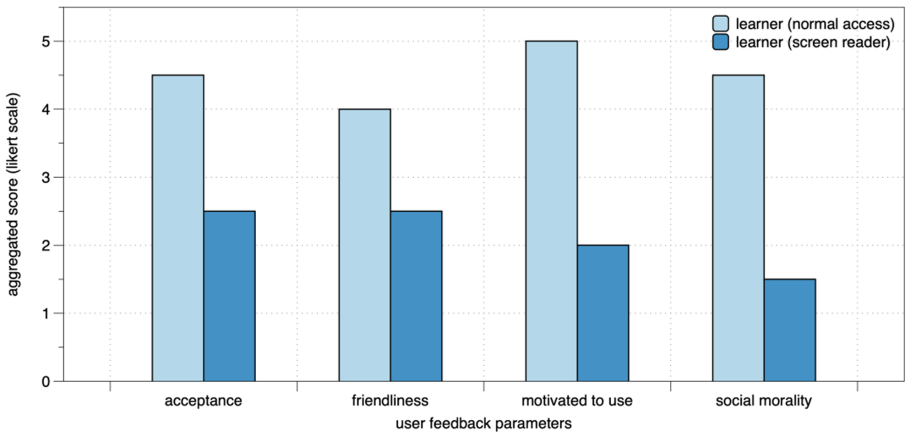

Fig. 3. Educators as learners, user feedback on accessibility impact

they were very motivated to use and that is was suitable for everyone. After the experience, being in the position to appreciate the difficulties that accessibility non-compliance or partial compliance presents to the disabled learners, the users responded that the platforms and the courses were not acceptable since they are still not fully accessible to all students and that it is a societal issue for everyone.

6 Conclusion and Future Work

An e-learning-for-all approach requires that all content should be accessible to all user groups with a firm and loyal devotion to the educational perspective. In this context, design parameters of conversational agents for accessibility are modelled according to specific needs. The methods used for creating and rendering universally accessible information are formed according to design parameters and associated resources. The resource management includes exclusive analyses stages of the information source content, structure and target modality. Each analysis stage is performed by applying specific models for document browsing, section identification, navigation hierarchy, contextual analysis and categorization.

This paper presented the theoretical framework for accessible online e-learning, the current state of the research in accessibility and the technologies for accessibility that may be applied to ensure accessibility. The state of research on the content created for e-learning was analysed. Then, two typical course pages from Udacity and Coursera were evaluated for accessibility using the WAVE voice renderer. Finally, human participants experienced the websites using a screen reader and reported how their perspective on the use of the MOOC platforms has been affected.

Given the fact that even the special education online websites struggle to meet the accessibility compliance levels and directives [44], content should be a top priority for universal accessibility for e-learning. Future work includes the use of the proposed methodology with recommender systems [45–47] and especially combination with collaborative filtering techniques [48–53]. Finally, we are planning the proposed approach to be incorporated in social related recommendation applications [54–58].

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