Adaptive Content Presentation Extension for Open edX

Enhancing MOOCs Accessibility for Users with Disabilities

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***Abstract*—In this paper, we propose a three-layer architecture to extend the Massive Open Online Courses (MOOCs) platform Open edX to enhance course content accessibility for users with disabilities. Because of their open nature and global scope, MOOCs are a great opportunity for people with disabilities that might not be able to engage in learning otherwise. The goal of the proposed extension is to enhance MOOCs' accessibility by adapting course content to student needs, preferences, skills and situations. In this approach, the user does not need to know what adaptations should be applied to the MOOC to make it more accessible for them. The user only needs to keep updated their accessibility preferences in their user profile. The extension automatically applies all the necessary adaptations as commanded by the adaptive engine and provides the presentation layer with the content best suited for the user.**

Keywords-massive open online course; MOOC; accessibility; adaptive content presentation; Open edX.

I. INTRODUCTION

With a brief six-year history, Massive Open Online Courses (MOOCs) constitute a relatively new model of e-learning. From the educational perspective, a MOOC is an online course with no entry requirements, no participation limits, and free of charge. Due to their open nature and global scope, MOOC courses can potentially benefit hundreds of thousands of diverse users. The first MOOC to get really massive was "Introduction to Artificial Intelligence", offered in 2011 by Sebastian Thrun of Stanford University and Peter Norving of Google, with an enrollment of 160,000 participants [1]. The success of this course promoted the development of more courses and the emergence of MOOC platforms to host new courses. Currently, the main MOOC platforms are Coursera (10.5 million students), edX (3 million students), Udacity (1.5 million students), MiriadaX (1 million students) and FutureLearn (800.000 students) [2].

In 2014, Bohnsack and Puhl [3] conducted a study that determined that none of the current MOOC platforms is fully accessible: most lack of correct HTML syntax (e.g., language definition, heading structure, and labels in input fields) and accessible design (e.g., clean interface, keyboard navigation, links to skip to main content). This study concluded that accessibility was not in focus when these platforms were built, thus excluding people with disabilities and not fulfilling the goal of MOOCs being open to everyone.

In 2013, edX opened sourced its platform so developers worldwide can build enhancements [4]. At the time of writing this paper, several organizations worldwide have adopted Open edX to launch their own MOOC initiatives [5]. According to Shah, Open edX is becoming the "de facto platform for organizations and groups who are looking to host their own MOOCs" [3].

Open edX provides an opportunity for developing an extension to enhance accessibility applying adaptive user interface techniques. In the literature review, regarding adaptive user interfaces for users with special needs we highlight a classical work from Stephanidis et al. [6], a follow-up work by the same author about Universal Access [7], and the works of Liu et al. [8] and Sloan et al. [9]. Regarding the developing of extensions for Open edX, we found only a proposal to develop a learning analytics extension [10]. So far, we have not been able to find research on applying adaptive user interface techniques to content delivered to MOOC users according to their particular accessibility needs. With an adequate architecture, future MOOC platforms will be able to overcome content accessibility barriers for the benefit of learners, both able and disabled.

The rest of this paper is organized as follows: Section II describes MOOC users accessibility needs. Section III explains the proposed three-layer architecture to develop an adaptive content presentation extension for Open edX. Section IV presents conclusions and future work.

II. MOOC USERS ACCESIBILITY NEEDS

Not only users with permanent disabilities (e.g., blindness, low vision, deafness, hard of hearing, motor and cognitive issues) can benefit from accessible MOOCs. All of us could potentially experiment a temporary or environmental disability at some point in our lives. For example, difficulties distinguishing colors due to lighting conditions (low vision) and impediments to hear due to lack of headphones in noisy environments (low hearing) or must-be-quiet places such as hospitals or libraries (deafness). Moreover, most of us will develop combined disabilities as we age naturally. Also, in the context of a MOOC, people learning in a language different from their own might face difficulties due to their level of proficiency in the course language (e.g., non-native speakers read at slower speed, which leads to information overload and cognitive issues)

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[11]. This is significant, since 2014 statistics from the MOOC aggregator Class Central indicates that 80% of MOOCs are offered in English and in distant second place is Spanish with 8.5% [3]. Finally, the typical age range of MOOC students is 16 to 88 years old, with a growing tendency of elderly users engaging in lifelong learning for intellectual stimulation and social engagement. Elderly students face several accessibility barriers to access course content due to diminishing capacities such as vision decline, hearing loss, decremented motor skills and cognition issues [12].

To promote accessibility, the World Wide Web Consortium (W3C) created the Web Accessibility Initiative (WAI) to develop guidelines for web content (WCAG), authoring tools (ATAG), and browsers and other user agents (UAAG) [13]. These guidelines are a good starting point to understand users' accessibility needs.

Although currently there are accessibility options in most operating systems, special-purpose applications and assistive technologies for several disabilities, most of them require the user to explicitly invoke them. Also, the potential negative psychological effects caused by the introduction of an assistive technology that change how a user interacts with a computer may lead to the user rejection of that assistive technology or computer use altogether [7][9]. In this work, we propose meeting the MOOC users accessibility needs with an approach based in user profiling and the use of questionnaires that combines explicit user-invoked adaptations with automatic adaptations.

III. ADAPTIVE CONTENT PRESENTATION ARQUITECTURE

Adaptive content presentation involves personalizing the contents delivered to the user to enhance their accessibility and usability [6]. To successfully achieve this, it is necessary an accurate detection of the user accessibility needs through user profiling and a mechanism that allows transparent selection and presentation of the appropriate adaptations according to the registered needs [9].

The proposed extension will provide functionality for both MOOC authors and users. On one hand, the solution will allow course authors using the extended platform to configure parameters and define features so the course can adapt to diverse potential learners. On the other hand, the extended platform will allow users of MOOCs hosted in it to manage their accessibility user profile by selecting a combination of accessibility issues that best suit their current life situation and optionally taking quick questionnaires to define specific accessibility preferences (e.g., text size, color contrast, line spacing). The use of an accessibility user profile represents an improvement compared with current approaches used in websites and web applications, where the user must manually select specific technical adaptations. Nevertheless, the Accessibility Preferences user interface has an "Advanced Options" feature that provides more savvy users with freedom to select specific adaptations if desired. Figure 1 shows a user interface prototype to select accessibility preferences.

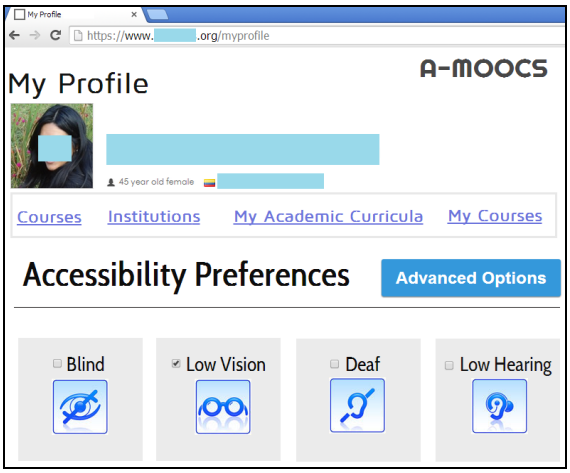

Figure 1. User interface prototype to select accessibility preferences

In this approach, the user does not need to know what adaptations should be applied to the MOOC to make it more accessible for them. User needs to know only their reality and keep it updated in their profile. From that, the proposed adaptive content presentation extension automatically applies all the necessary adaptations.

The architecture of the adaptive content presentation extension is composed of three layers, as illustrated in Figure 2.

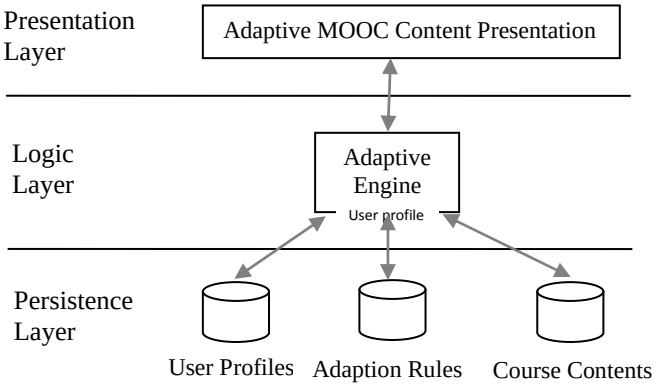

Figure 2. Three-Layer Architecture for the Extension

The Presentation Layer receives the course content in the appropriate format from the Logic Layer, where the adaptive engine resides. To select the appropriate content format, the adaptive engine scans the user profile and applies the necessary adaption rules, as explained by Stephanidis et al. [6]. Figure 3 shows an extract of the adaption rule sequence to be executed if the user accessibility preferences profile indicates dyslexia, based on the guideline developed by De Santana et al. [14]

```
FOR UserPreference[i]
{IF UserPreference[i] EQUALS dyslexia THEN LineSpacing=1.5
AND TextFont=Serif.Arial AND TextSize=12 AND
TextJustification=Unjustified AND …} NEXT i
```

Figure 3. Extract of adaption rule sequence for dyslexia

The Persistence Layer contains three databases for storing user profiles, adaptation rules and course contents. The course contents' database must contain several alternative formats for the same content, as illustrated in Figure 4. The user must be able to access any of the available alternative formats for any course content if desired.

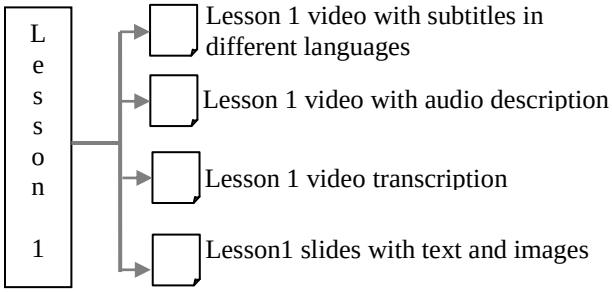

Figure 4. Example of alternative formats for same course content

Also, the extended platform must support different use scenarios, such as a student with combined disabilities (e.g., elderly student) or several students with different disabilities accessing the MOOC together. Figure 5 shows a lesson adapted to users with dyslexia, low vision and blindness.

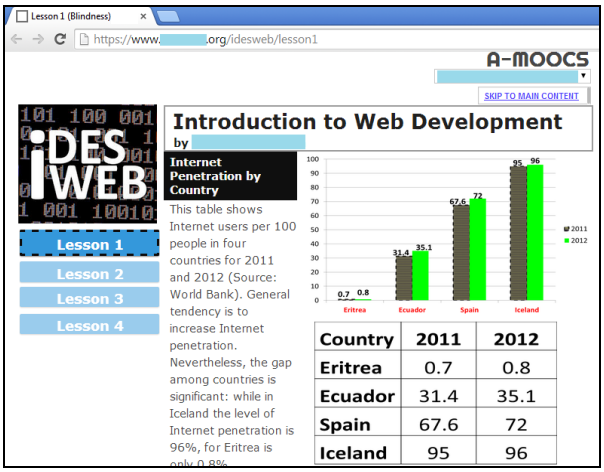

Figure 5. Lesson interface adapted for dyslexia, low vision and blindness

In this case, three adaption rules sequences have been applied: the dyslexia rule sequence explained earlier; the low vision rule sequence (i.e. text with contrast ratio of 4.5:1, border pattern to indicate current focus, data on top of graph bars); and the blind rule sequence (i.e. link to skip to main content, graph with alternative text, table readable by a screen reader containing the graph data).

IV. Conclusion and Future Work

Software solutions must adapt to users, not the other way around. This is the best cost-effective way to design a solution, especially in scenarios where large numbers of diverse users are expected, as is the case in MOOCs. That is why, in this paper, we proposed an adaptive content presentation extension for Open edX that will allow MOOCs hosted in this extended platform to adapt to the specific needs, preferences, skills, and situations of learners, both able and disabled. More important, with this extended platform the particular situation of a person with disabilities may go unnoticed for both instructors and peer students, so the person with disabilities can be treated truly equally, hence assuring real inclusiveness.

Continuing research is essential for increasing accessibility of MOOCs. As future work, we intend to develop a detailed design of the proposed architecture, create a prototype of the extension for Open edX, and perform both user-based and expert-based evaluations.

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