

Is Moodle accessible? An analysis through experiences in scientific literature and a case study

Antonio Giovanni Schiavone

IEEE, Italy

Abstract

For several decades, both the development of E-learning platforms and the definition of methodologies and guidelines for web accessibility's evaluation have been important research topics in the field of Information Technology. In last years, numerous researchers have carried out various works, proposing different solutions for the accessibility evaluation of online learning platforms, contributing to provide a wide range of experiences in the scientific literature. In this paper, we will focus on Moodle, one of the most popular E-learning platforms, providing an overview of the most recent works present in the literature regarding the accessibility of this platform. Furthermore, we will make an active contribution to the discussion about this topic, carrying out the analysis of the accessibility of some existing Moodle installations. Through these experiences, we will provide a general assessment of the accessibility of Moodle, highlighting that, despite the improvements made over the years, this platform, like other similar E-learning solutions, can not yet be considered fully accessible.

Keywords: Web Accessibility, E-learning, WCAG, Moodle, Accessibility Evaluation.

Introduction

The term 'E-learning' indicates "the use of new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration" (Commission of the European Communities, 2001).

The origins of the term E-learning are not certain, but, according to Moore, Dickson-Deane & Galyen (2011), the term probably originated during the '80s, in order to indicate concepts and theories already elaborated in the previous decade. Although the concepts related to the use of telecommunications as a means of promoting and enriching the training of individuals date back to more than two decades ago, only in the last decade this model of training has become a concrete, widespread and constantly expanding reality. The success of this model was made possible by the widespread diffusion of Internet throughout the world and to the contemporaneous growth of the functionalities offered by Web technologies.

The success of online training is certified both by the proliferation of various E-learning models and by numerous statistics: for example, few years ago the Global Industry Analysts (2015) estimated that the entire global E-learning industry would generate revenues of \$ 107 billion, with an annual growth rate of 23%.

Nowadays, the panorama of online training is fragmented into a varied set of solutions, characterized by various functionalities available. In fact, they vary from courses limited to a defined set of participants to MOOC (Massive Open Online Courses) freely usable by a very high number of students, from courses available on proprietary platforms to courses hosted through open source platforms.

Moreover, they vary from courses based exclusively on digital hand-outs to those that include audio / video content, from those that provide synchronous training (i.e. in real time) to those based on

asynchronous training (i.e. flexible hours), from those based on webinars to those that provide different types of interactive training (Gamification, Social media learning, Mobile learning).

In this jagged landscape of solutions, where often the available features are combined and it is not easy to identify the boundary between different online training platforms, the only common element to all solutions, in addition to the formative purpose, is the use of Web standards and technologies.

The variety of solutions proposed is, at least from the students' point of view, one of the strengths of this training model: in fact, each student can choose the platform whose characteristics best meet his/her needs and preferences, and, therefore, the one that can guarantee the best training experience. The students who can benefit most from this new model of training are those who, for various reasons, find it difficult to take advantage of traditional models of training. Among these, a significant portion is made up of disabled students, who through distance learning, multimedia content and the flexibility offered by many E-learning platforms, can find a training model that suits their special needs. Therefore, for this type of users, the accessibility of online training platforms is a key element in accessing this model and increasing their personal development.

In this paper, we present the results of a literature review, which covers from the years 2011 to 2017, on the topic of the accessibility of Moodle, one of the most popular E-learning platforms. Moreover, we will perform an evaluation of three existing Moodle installation through the usage of some accessibility validators: the result of our analysis will confirm the findings present in most of the works present in literature.

Web Accessibility: Definition, Guidelines and Methodologies

Human-Computer Interaction (HCI) is a field of study focusing on the design of computer technology and, in particular, the interaction between humans (the users) and computers. Within this field of study, one of the most important research topic is *Accessibility*, which can be defined as:

"The capability of computer systems, in accordance with the attained technological knowledge and its limits, to supply services and to provide information which can be availed of, without discrimination, also by those who need supporting technologies or special configurations because of some disability" (Stanca Act 2004).

If the referred computer system is a website or a web application, this capability is called *Web Accessibility*. According to Tim Berners-Lee, Director of W3C and inventor of the World Wide Web, accessibility is an intrinsic feature of the Web and its essential aspect. (W3C, s. a.). It follows that accessibility must be a fundamental aspect of every Web project, including the web platforms dedicated to the delivery of E-learning courses (defined as Learning Management System or LMS).

During last decades, several countries enacted national laws on the accessibility of information systems, which, among other things, oblige public institution to make accessible their website and their web applications in compliance to some accessibility guidelines (Paternò & Schiavone 2015). In many countries, this obligation applies also to public educational institutions, such as colleges and universities: therefore, in many cases, ensuring the accessibility of E-learning systems is not just a way to encourage the training of disabled students, but it is also a legal obligation.

In most cases, these laws (or technical documents associated with them) defined their own guidelines for web accessibility. In recent years, many countries updated such laws in order to embrace WCAG 2.0 as a standard for web accessibility.

The Web Content Accessibility Guidelines (WCAG) are the accessibility guidelines promoted by the international non-governmental organization World Wide Web Consortium (W3C), and aimed at providing of contents and to web developers, indications, both general and technical, on the creation of accessible websites and web applications. The WCAG 2.0, i.e. the version released in 2008 (W3C 2008a), have subsequently also become an ISO standard (ISO / IEC 40500: 2012). Few months ago, these guidelines have been updated to WCAG 2.1, including new mobile-oriented accessibility guidelines. These guidelines are organized according to 4 inspiring principles (Perceptible, Usable, Understandable and Robust) and further categorized according to three compliance levels (A, AA and AAA), respectively from the most basic and therefore fundamental level, to the most advanced and therefore less compulsory level.

Regarding the evaluation of the accessibility of websites and applications, both in scientific literature and in common practice, three distinct methodologies are applied (Paternò & Schiavone 2015):

- Analysis by accessibility experts, i.e. practitioners who are expert in the verification of accessibility of information systems. Depending on the needs, they can refer directly to certain accessibility guidelines or perform the assessment according to their experience.
- Analysis through Evaluation Groups, i.e. groups made up by people with various types of disabilities, who have the task of accessing the website in question in order to test its functionalities. These tests can be performed both in informal environments (home, work environment), and in specifically designed environment s (laboratory environment), both in free form (without specific tasks), and task-driven (with predefined tasks).
- Analysis through accessibility validators, i.e. automatic tools that can verify the compliance of a site or a web application with respect to the criteria established by certain accessibility guidelines. Commonly their evaluation is based on the source code's analysis of the of the web application under consideration.

In conjunction with WCAG 2.0, W3C (2008b) also released *Techniques for WCAG 2.0*, a document that provides guidance for web content authors and evaluators on meeting WCAG 2.0 success criteria.

Moodle and Accessibility Research

Web Accessibility and E-learning

For several decades both the development of E-learning platforms and methodologies and the definition of guidelines for web accessibility's evaluation have been important research topics in the field of Information Technology. Consequently, many researchers from all over the world have conducted several studies regarding the accessibility of various E-learning platforms. For example, in scientific literature, there are works regarding the analysis of some E-learning platforms (Sánchez Gordón & Luján Mora 2015) or comparisons of different MOOCs platforms (Bohnsack & Puhl 2014), or comparative analysis of specific features offered by LMS, such as for example collaborative chats (Calvo 2013). Due of its great popularity, especially among universities, many researchers have focused their analysis on Moodle.

Moodle

Moodle (from the acronym of Modular Object-Oriented Dynamic Learning Environment) is an E-learning platform “*designed to provide educators, administrators and learners with a single robust, secure and integrated system to create personalised learning environments.*” (Moodle HQ, 2018).

The first version of Moodle was created in 2002 by Martin Dougiamas, a network administrator at Curtin University in Perth (Australia), and it is currently developed by the Australian company Moodle HQ, with the support of a large global community of developers. The platform is usually updated every six months: the latest release currently available is 3.5.0. Moreover, the basic features of this LMS can be further extended by installing some of the more than 1300 plugins available.

According to the US research and advisory firm Capterra (2017), Moodle is currently the E-learning platform with the largest number of users in the world and in second place for number of installations: in fact, this platform is widely used by universities from all over the world. In literature there are numerous E-learning experiences carried out in several universities: for instance, at University of Turin in Italy (Barana et al. 2016), at University of Education of Winneba in Ghana (Hanson & Asante 2014), at University of Jordan in Jordan (Almarabeh 2014) and at University of Antioquia in Colombia (Uribe-Tirado & Castano 2016).

Web Accessibility in Moodle

Few years after the release of the first version of Moodle, the scientific community has begun to have an interest in this platform, and, in particular, to investigate the accessibility of this technological solution and its impact on distance learning for people with disabilities (Nedeva 2005).

Due to this interest, nowadays there are several papers in the scientific literature concerning the accessibility of Moodle. However, in order to limit the length of the discussion and make it consistent with the evolution of the platform over the last few years, we decided to limit the scientific review regarding the topic of Moodle's accessibility to papers published after 2011. According to this set of scientific papers, the analysis of Moodle's accessibility has been conducted along three lines of research: accessibility evaluation of Moodle or of some of its specific components, comparison of Moodle's accessibility with the accessibility of other similar platforms, and the analysis of customized solutions based on Moodle.

Accessibility of Moodle and its components.

Regarding the first line of research, Calvo, Iglesias & Moreno (2011) carried out the accessibility's evaluation of a Moodle installation (ver. 1.9), limiting their analysis to difficulties encountered by users affected by visual disabilities. The evaluation took place in two phases: in the first one, they simulated the access of a group of blind users to the Moodle Installation through two different Screen Readers, while in the second phase an expert performed an accessibility's assessment of the same Moodle installation in compliance with the WCAG 2.0 guidelines. In this paper, researchers highlighted several accessibility issue: most serious detected issues were the usage of tables for the definition of webpage's layout, lack of effective tools for the control of navigation, unsatisfactory support for keyboard navigation and the lack of an editor that natively includes support for the accessibility of generated content. Subsequently, same authors (Calvo, Iglesias, & Moreno 2014) carried out a similar analysis, but using updated versions of the screen readers and providing a set of predefined tasks to be carried out within the Moodle installation. The conclusions were identical to previous work, with the addition of the lack of accessible tools for searching text in generated content.

Recently Casadei et al. (2016) assessed the accessibility of Moodle accessing an installation via mobile devices. In this work, a group of young university students without disabilities accessed to a Moodle installation through its official app, annotated in real time any difficulties encountered during its usage and finally fill in an evaluation questionnaire. Subsequently, authors reprocessed the annotations and the questionnaires from the point of view of accessibility assessment: here again, they detected some

accessibility problems, related to the use of infinite lists, of toggle menus and of icons as an element of communication of relevant information.

In following year, Armano et al. (2017) explored the accessibility of Moodle (ver. 2.7), with particular reference to users affected by visual disabilities and in relation to pages containing formulas and mathematical notations. The analysis was carried out involving a group of users with different types of visual disabilities: they accessed a Moodle installation through some screen readers and performed a set of predefined activities, some of them related to the creation and fruition of mathematical content. Subsequently, authors analysed the recording of the interactions and of the detected errors, in order to provide an evaluation of the accessibility of the platform. The authors' conclusions establish that, while the used version of Moodle was characterized by a good general accessibility, there were numerous issues related to the management of mathematical content, mainly due to the use of the markup language LaTeX, which causes accessibility issues.

Finally, Acosta, Luján-Mora & Acosta-Vargas (2017) investigated the capability of two online content editors to generate accessible contents, and in particular, to produce accessible headings. The two analysed content editors were Atto and TinyMCE, the Moodle's default editors since its 3.3.1 version. In order to evaluate the two content editors, authors selected the subset of WCAG 2.0's and ATAG 2.0's success criteria which refers to headings accessibility, for a total of 15 success criteria. Subsequently, authors manually validated the content generated by Atto and TinyMCE in compliance with the aforementioned success criteria subset. According to authors' evaluation, TinyMCE and Atto comply respectively with 20% and 33% of the considered success criteria: consequently, authors stated that these results demonstrate the lack of accessibility of Moodle's default editors in the production of accessible content.

Comparison with other E-learning platforms.

Regarding the second line of research, Iglesias et al. (2014) compared the accessibility of Moodle (ver. 1.9.4) with accessibility of two other E-learning platforms: the evaluation was carried out by some accessibility experts with the support of some automatic validators and in compliance with the guidelines WCAG 1.0. According to this analysis, Moodle was not the most accessible platform among the analysed ones, mainly due to the lack of an accessible default theme, the impossibility to use the platform with the browser's Javascript engine disabled and the lack of an editor that included native features to support the accessibility of the generated contents.

In a recent paper, Acosta and Luján-Mora (2016) compared the accessibility of Moodle (ver. 2.3), with another similar open source platform and a research project having the same purpose: the analysis was carried out by two experts but without the reference to standard guidelines. Authors' conclusions highlighted accessibility issues in all the considered platforms, even if the two open source solutions had better results than the research project. In particular, authors reported Moodle's good performances in generating webpages' titles, navigation bars and menus, links and labels for form fields. Conversely, they criticized the homepage's accessibility, the handling of the session's time-out, the tooltips, and the accessibility of the internal chat.

In the same year, Sanchez-Gordon, Estevez, & Luján-Mora (2016) focused their research comparing the accessibility of eight E-learning platforms, both open source and proprietary: in this case the accessibility's assessment was limited to content editor's features for image management. The analysis was carried out listing 20 sub-functionalities useful for guaranteeing accessibility (a priori defined from various technical guidelines and standards), and subsequently verifying their presence within the

considered E-learning platforms. According to authors, Moodle (ver. unknown) was the most accessible of the considered platforms.

Finally, Calvo, Iglesias, & Castaño (2016) carried out a comparative analysis of the accessibility of Moodle (ver. 2.7) and of two other online training platforms: the accessibility's assessment was limited to the internal chat. Authors performed their analysis through two distinct methodologies: the first evaluation was performed through some accessibility validators in compliance to the WCAG 2.0 guidelines, while the second one was performed through the manual inspection of some accessibility experts, according to a set of self-defined guidelines. The two methodologies showed discordant results. In fact, only the evaluation performed through automatic validators indicated Moodle as the most accessible platform among those considered: however both analyses highlighted several accessibility issues in all the analysed chats.

Analysis of custom solutions based on Moodle.

Regarding the third line of research, Iniesto, Rodrigo & Moreira Teixeira (2014) compared the accessibility of two custom MOOC platforms, respectively based on OpenMooc and Moodle (ver. 2.4). In this work, authors selected a set of Web pages considered particularly relevant for the average user: subsequently, authors used two separate automatic validators in compliance with the WCAG 2.0 guidelines in order to perform the accessibility validation of the selected webpages. Both platforms have shown several accessibility problems: in particular, the solution based on Moodle presented links with the same text but different destinations, form fields without associated labels, incorrect use of headings and CSS properties.

More recently, Batanero et al. (2017) proposed a case study on an installation of Moodle (ver. unknown) customized through two plugins and an ad hoc infrastructure, with the aim of creating an adaptive online training platform, which adapts to the preferences of users with disabilities. The proposed solution is structurally very different from a standard Moodle installation, but demonstrates how such platform has the potential for expanding the complexity of its features and improving the user experience also from the point of view of accessibility.

Finally, Díaz et al. (2017) extended an installation of DSpace, an open source repository software, integrating it with Moodle (ver. unknown): the accessibility of the resulting platform has been evaluated in compliance with the WCAG 2.0 guidelines both through some accessibility validators and by an expert's manual validation. Moreover, a group of blind and deaf users performed a set of predefined activities in order to highlight usability issues. Again, all three methodologies detected several accessibility issue, which have been manually fixed by the authors.

A Case Study

In order to bring an active contribution to research on Moodle's accessibility, we carried out an accessibility evaluation of three Moodle installations. In particular, we selected the installation "Mount Orange School" (Moodle ver. 3.3.1), one of the three demo installations available on the official Moodle website, the E-learning platform of Sapienza University of Rome (Moodle ver. 2.7.13) and the E-learning platform of University of Siena (Moodle ver. 3.1.3). The rationale for this selection was to evaluate both a basic and minimal installation of Moodle (Mount Orange School) and installations used in a real context of use (the two university installations). Regarding the themes used, the Mount Orange School installation uses a customized version of the standard theme "More" (Moodle HQ, 2014), the Sapienza University of Rome (2017) uses a proprietary theme, and the University of Siena (2017) uses the BCU theme developed by Birmingham City University (2015).

For each installation, we selected five different web pages, each of them belonging to a different functional category (home page, user login page, list of available courses, list of courses related to a specific thematic category, lesson of a specific course). Since we do not have a valid student account for the two Italian universities, for those Moodle installation the page relating lesson of a specific course presented an unauthorized access message instead of the course contents.

In order to carry out the evaluation of the selected installations, two different accessibility validators were used: Total Validator (2018), a commercial software for which a free version is available, and MAUVE (Schiavone & Paternò 2015), an online validator resulting from a research project of the Institute of Science and Information Technology of the National Research Council (2018). The evaluation was performed in compliance with the WCAG 2.0 guidelines (Level AA). Both the validators report detected issues in reference to the W3C's *Techniques for WCAG 2.0*.

Table 1. Results of the analysis of the accessibility of the selected web pages.

Web Pages	Mauve		Total Validator	
	Errors	Warnings	Errors	Warnings
Orange School Demo - Home	14	0	6	3
Orange School Demo – Login	15	0	4	0
Orange School Demo - Course List	18	0	9	5
Orange School Demo - Course Categories	29	0	5	7
Orange School Demo - Course Lesson	24	6	4	11
E-learning Sapienza - Home	53	20	17	0
E-learning Sapienza – Login	26	0	6	0
E-learning Sapienza - Course List	20	0	13	1
E-learning Sapienza - Course Categories	13	0	1	1
E-learning Sapienza - Course Lesson	26	0	6	0
USiena Integra - Home	93	6	21	18
USiena Integra – Login	57	0	9	1
USiena Integra – Course List	46	1	7	1
USiena Integra – Course Categories	62	7	7	1
USiena Integra – Course Lesson	49	4	7	0

Table 1. shows the results of the evaluation, divided by the used accessibility validator, and subsequently distinguished between errors and warnings. The obtained results highlight that some accessibility issues were detected in all the analysed installations: however, both validators detected a small number of errors and warnings for the Orange School Demo, while the two university installations presented a much higher number of accessibility issues. Consequently, these results seem to indicate a good (even if not complete) accessibility of Moodle basic installation, while in the two considered real contexts of use, particular configurations and / or the usage of specific themes have worsened the general accessibility of the installations.

Regarding the most frequently detected accessibility issues, the evaluation of all the installations highlighted issues both in CSS, mainly concerning the unit of measurement used to define the size of the text (referenced Techniques: C12 and C14), and in the use of the headings (referenced Techniques: F43 and H42). Moreover, university E-learning platforms have highlighted problems in texts and textual link alternatives (referenced Techniques: F30 and H30) and in the separation of information from presentation aspects (referenced Technique: G140).

The results obtained from our analysis agree with the conclusions of some of the papers referenced in Section 3.3, in particular with the conclusions of Iniesto Rodrigo & Moreira Teixeira (2014), who conducted their evaluation with methodologies and purposes similar to ours.

Conclusions

We have reported the most relevant and recent works in the scientific literature regarding the accessibility of Moodle, one of the most popular and widely used E-learning platform. Although the referred works are different from each other, both for their purposes and the proposed technical solutions, and although some of them may seem inconsistent in their evaluations, it is possible to draw interesting conclusions and identify clear trends in the Moodle's development process.

In the first place, it is possible to notice a clear improvement in Moodle accessibility in its last versions. In fact, while older papers, which refer to older versions of Moodle, provided a negative evaluation of platform's accessibility, the most recent papers, which refer to more recent platform's versions, generally provide a moderately positive judgment.

Moreover, it is worth to note that the most recent papers highlight a general good accessibility of Moodle, but indicate some criticalities within specific features of the platform (such as chat or content editor). Based on these indications, Moodle development community should concentrate its efforts to improve those specific features and adjust the platform in order to comply the most important accessibility standards.

Finally, quite all the cited authors agree in pointing out a general lack of attention to accessibility on the part of LMS developers. This finding should not be an alibi for a lower commitment in this area, but on the contrary, it must be an incentive to a greater common effort by all stakeholders in the sector, including disabled users.

A further analysis, carried out evaluating the accessibility of three distinct installations through some automatic validators, has substantially confirmed the indications obtained from the experiences in the literature: this analysis has however also highlighted how particular configurations or the use of certain themes can further influence the accessibility of a specific Moodle installation.

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