

Accessibility in Virtual Communities of Practice Under the Optics of Inclusion of Visually Impaired

Luís Felipe Cândido Marques^(✉), Daniela Freitas Guilhermino,
Maria Eduarda de Araújo Cardoso, Rafaella Aline Lopes da Silva
Neitzel, Larissa Albano Lopes, José Reinaldo Merlin,
and Giovanne dos Santos Striquer

Center of Technological Sciences,
State University of Paraná, PR Bandeirantes, Brazil
lfelipecm@hotmail.com, {danielaf,mariaeduarda,
rafaella,larissa,merlin,giovanne}@uenp.edu.br

Abstract. Accessibility aims to ensure better quality of life to people, specially people with disabilities. Thus, it is possible to break down barriers and allow everyone, independently its specificities, have access to the same contents, materials and places equally. Many barriers are still encountered in terms of the accessibility of computing environments for the visually impaired. However, the accessibility should assume a requisite role in the quality of software to enable the inclusion of people with different types of visual impairment in these environments. The Virtual Communities of Practice (VCoPs) are important computing environments that promote interaction and collaboration between people, however, these areas also have many limitations to the inclusion of people with disabilities, including the visually impaired. Thus, this research investigates the visually impaired needs to access the VCoPs, analyzing the main existing guidelines with the aid of some accessibility evaluation tools. With the analysis of the results in accessibility evaluations it is intended to support the design process of inclusive VCoPs for the visually impaired.

Keywords: Accessibility · Visually impaired · Virtual communities of practice

1 Introduction

The [32], defines the web accessibility as people with different sensory conditions can use the web in a process of understanding, interaction, navigation, perception and contribution to the web.

Visual impairment is the disability of higher incidence worldwide. About 285 million of people worldwide have some kind of visual impairment, considering that 39 million are blind and 246 million have low vision [31].

During the construction of an accessible interface to visually impaired are necessary some adaptations that can attend the different types of disabilities, such as: low vision, colour-blind and blind. However, some web accessibility standards are available to assist designers in building their interfaces.

The W3C makes clear through researches that many barriers related to accessibility for the visually impaired are still found in computing environments. However, some recommendations are presented in order to make the web an equal access environment for everyone. Some of these recommendations are: to make a great html mark up, non-text content should have a text alternative, the colour may not be used as a visual resource to convey information and make all features available through the keyboard.

Amidst the great technological advancement and the indispensable search for the information and knowledge, the way in which is treated the access and inclusion of the visually impaired to web systems is not often a concern. Among the web systems, virtual communities of practice (VCoPs) have been shown important spaces, mediated by computer, which promote interaction and collaboration between people. Nonetheless, these spaces still present many limitations to the inclusion of people with disabilities, including the visually impaired.

Communities of practice (CoPs), basically, are groups of people who gather to share a common interest. According to [30], the community of practice is made up of people who engage in a process of collective learning, they share concerns and or passion for something they do and they learn how to improve. In CoPs, the experiences are shared over the time and there is a commitment to share knowledge [8].

In this context, this paper aims to investigate the difficulties encountered by visually impaired when accessing VCoPs. In this work, the main accessibility problems will be identified; moreover, improvements and adjustments will be proposed in order to turn communities more accessible for the visually impaired.

2 Community of Practice

Community of Practice is defined by [29] as a group of people who share an interest or passion for a subject and they interact regularly to improve their knowledge on this topic. [17], states that the CoPs have always existed, scattered in various types and with different names. Therefore, it is apparent the importance of these communities in recent times. CoPs are becoming environments that support the exchange of information and cooperation process.

Three characteristics are crucial in any type of CoP [30]: (i) The Domain- the area of knowledge where each member is inside. In this area, the identity of each member and the keys issues that will be addressed in the CoP are defined; (ii) The Community- place where the interaction is proposed. This interaction can be related to interests, learners, or even directed toward a goal; and (iii) The Practice: a process in which people learn with the group how to put in practice the things that they are interested with the aid of tools, stories and experiences. The Table 1 provides a comparison of a CoP to other types of groups, communities and organizations.

In collaborative environments such as CoP, it is of fundamental importance an interaction between the members in order to reach some attributes, whether tools or past experiences that may assist in the construction of learning or problem solving.

In order to seek improvements in individual and collaborative learning, a research work was performed by [23]. The Table 2 presents a summary made by [24] about the research of [23], and demonstrates the main elements of the CoPs and their

Table 1. Comparison between CoPs and other organizations

	What is the objective?	Who participates?	What they have in common?	How long does it last?
Community of practice	To develop members capabilities to build and exchange knowledge	Member who select themselves	Passion, commitment, and identification with the group's expertise	As long as there is interest in to be part of the group
Formal work group	To develop a product or service	Everyone who reports to the group's managers	Work requirements and common goals	Until the next reorganization
Team	To accomplish a specified job	The members are assigned by senior manager	The goals and project's milestones	Until the project has been completed
Informal network	To collect and transmit business information	Friends and business acquaintances	Mutual needs	As long as people have a reason to keep in contact

Source: Adaptation of [30]

interrelations (objectives, characteristics, possible roles and skills that actors can present) that can be used in the learning process of the CoP.

A Virtual Community of Practice (VCoP) is a Community of Practice (CoP) mediated by a computer. [30] states that new technologies, such as internet, have allowed

Table 2. Main concepts and their relationships inherent in CoPs

CP – Main concepts		Authors
COMMUNITY	Motivation; domain; practice	[30]
	Field; goal; structure; composition; cultural diversity	[23]
		[12]
MEMBERS	Personal characteristics; type of involvement; role; peripheral role	[15], [23]
COMPETENCE	Type of competence	[23]
COLLABORATION	Collaboration goals; collaborative activities; roles involved; geographic dimension; temporal dimension; collaboration resources; communication means; types of interaction	[25]
	Engagement; coordination	[6], [28]
DECISION-MAKING	Decision-making resources; results; actors; strategies	[23]
CP RESOURCES	Record of interaction; CP tools	

Source: Adapted from [23]

the interactions go beyond the geographical limitations of the traditional communities. The facility, speed and low cost of communication through the internet contribute to the creation of VCoPs [7].

The members of VCoPs can benefit themselves with experiences from others members of the community, obtaining information, answers and solutions to problems not solved yet inside their local community or work environment [3].

The VCoPs may present some different functions when compared to CoPs, according to [3]: the sent messages are automatically saved, allowing a person to interact at any time; moreover, it is possible to consult past information; the interactions can be instant, however, most cases do not happen in real time; most often there is no knowledge about the people whom are interacting, and, in this case, it is not necessary to know the people as individual, the goal is to know the knowledge that this person is able to share. It is important to highlight that the ontology proposed by [23], presents the elements and the semantic annotations (objectives, characteristics, possible roles and responsibilities) that may also be related to VCoPs.

3 Accessibility: Under the Perspective of Visual Impairment

The visual impairment can be briefly defined as the partial or complete loss of vision, and, this loss can be acquired throughout life or it can also be acquired from birth. The causes of these deficiencies can be the most varied, from infectious and traumatic causes, to genetics and degenerative causes. According to [11], considering all the disabled people in Brazil, 48,1 % have visual impairment, and considering the whole Brazilian population, 18.8 % have some type of visual disability. In terms of global data, about 285 million people have some kind of visual disability, wherein 39 million are blind and 246 million have low vision [31].

According to [31] the visual function can be classified in 4 levels: (i) Normal vision; (ii) Moderate visual impairment (iii) Severe visual impairment; (iv) blindness. Moderate visual impairment and severe visual impairment are defined by the term low vision. Therefore, the low vision (visual acuity between 0.3 and 0.05 in the best eye, with the best optical correction) and the blindness (the visual acuity is equal or less than 0.05 in the best eye, with the best optical correction) represent the visual impairments which can be caused by different diseases, including the most common ones: near-sightedness, farsightedness, astigmatism, cataracts, glaucoma, colour blindness.

Accessibility aims to ensure better quality of life to people, especially to people with disabilities. Thus, it is possible to break barriers and allow everybody, regardless their difficulties, have access to the content, materials and places equally. The web accessibility means that people with some kind of disability can understand, navigate, perceive and interact with the Web [4]. Also, when the accessibility becomes a requisite in the quality of software, it enables and encourages the inclusion of people in the digital world through related principles, thereby facilitating navigation, the layout and presentation of information [16].

The World Wide Web Consortium (W3C), the main standard organization World Wide Web, has a group targeted to accessibility, the Web Accessibility Initiative (WAI). The WAI has developed the Web Content Accessibility Guidelines (WCAG),

which are guidelines that should be followed to turn a website more accessible. With these guidelines, it is possible to turn the content more accessible to all types of people with disabilities, such as visual, auditory, motor, speech or any kind of difficult, and, thus, developing a more useful content for everyone.

The accessibility for the visually impaired is gaining more importance every day. The information, in general terms, must be transmitted and understood by any type of people, and in this way, appears the concern if the means of transmission of messages are able to reach everyone. According to [19], it is important that each person put itself in place and imagine the life of a visually impaired, in order to act in an appropriate and inclusive way with the disabled.

Accessibility for visually impaired is not a simple issue, and, to build a successful interface, it is necessary to follow some logical and functional rules and different ergonomics that can be adapted to the different types of visual impairments such as: blind, low vision, colour blindness [18]. For the visually impaired, some tools that can facilitate their access to information were already developed such as [19]: keyboards in braille, speech synthesis system, and computer screen magnification software.

These tools are only aid mechanisms for access to information. Remembering that for the visually impaired only these tools are not enough for an ideal navigation. The developers must be aware of the standards required in the development and design of interfaces in order to allow the inclusion of people with disabilities.

Regarding the access the information, according to [13], the main difficulties faced by visually impaired who have low vision are: reading texts with small or a colour in particular; distinguish different types of letter; distinguish chromatic colours of contrast or depth and locate and/or follow the cursor and manipulate graphic objects. These can be considered just some of the difficulties faced by people with low vision problems. The W3C, through its major groups related to accessibility, demonstrates that many other difficulties may be encountered; however, these difficulties can be minimized or even solved once its recommendations are followed.

4 Accessibility Recommendations

The WCAG arise in May 1999, with the WCAG 1.0, presenting the simple goal of making the web contents accessible to people with disabilities [27]. In December 2008, it was implemented the WCAG 2.0, with the same goals, but with a more solid basis and updated recommendations, which have been implemented nowadays. Within the WCAG 2.0 it is possible to find guidelines, which are divided into the principles shown in Table 3. These guidelines have no separation by type of disability, however, in a process of analysing them, it is possible to infer which are applicable to visually impaired, whether for blind or low vision people.

The principles are used for better organization and understanding of the guidelines and each one is related to a specific area. The non compliance with these principles turns difficult or impossible the web access for people with disabilities. Therefore, it is of major importance that all websites get adapted to these guidelines during the development and maintenance steps of its websites.

Table 3. Adaptation of principles and guidelines WGAG 2.0

PRINCIPLES	GUIDELINES
Perceivable	Provide alternative text for all non-text content so that it can be changed into other forms, according to the users needs, such as large print, braille, speech, symbols or simpler language.
	Provide alternatives for time-based media.
	Create contents that can be presented in different ways (e.g., A simpler page layout) without losing information or structure.
	Make it easier for users to see and hear content including separating foreground from background.
Operable	Make all the functionality available from the keyboard.
	Provide users enough time to read and use content.
	Do not design content in a way that is known to cause seizures.
	Provide ways to help users navigate, find content, and determine where they are.
Understandable	Make text content readable and understandable.
	Make Web pages appear and operate in predictable ways.
	Help users avoid and correct mistakes.
Robust	Maximize compatibility with current and future user agents, including assistive technologies.

Source: Adaptation of [27]

The WCAG guidelines are very important and considered throughout the world, however there are other kinds of models, guidelines and laws, they can be created in a determined region or country. These guidelines do not flee from WCAG standards, however they may have some different standards, or they can also be complementary to WCAG guidelines, helping further the accessibility process for everyone. Some of the most popular models are: E-MAG (Electronic Government Accessibility Model, model created by the Brazilian government) [9]; Sect. 508 (Standard created by United States applicable to types of software, hardware, mobile applications and other information systems) [20]; BITV (Barrierefreie Informationstechnik-Verordnung, accessibility model created in Germany) [2]; Stanca Act (Law passed by the Italian parliament in order to provide information to make the systems more accessible) [21].

5 Accessibility Evaluation in VCoPs for Visually Impaired

When conducting the evaluation, the following methodological steps were considered necessary: (i) selection of accessibility evaluation tools; (ii) selection of VCoPs to be evaluated; (iii) assessment of VCoPs in terms of accessibility requirements, with the support of the selected evaluation tools; (iv) compilation of accessibility requirements for visually impaired; (v) combination of the results obtained from the analysis of recommendations identified in the literature review and also from the evaluations performed.

5.1 Evaluation Tools

From several tests performed it was possible to identify and select the most appropriate accessibility evaluation tools to the objectives of this research, they are: TAW¹, EXAMINATOR², ACHECKER³ e WAVE⁴. These tools are based on the accessibility guidelines recommended by W3C, making an evaluation of web pages and demonstrating possible oversights inadvertencies of the pages related to accessibility.

The Taw, Achecker and Wave tools are included among the most complete tools for accessibility in a survey conducted by [14]. In [14], the work of the different areas of expertise of the evaluation tools are detailed through a comparison; it is possible to understand the particularities of each tool. The Examiner tool was chosen because it was used in [5] work and presented satisfactory results.

The Examiner is an automatic evaluation tool created by UMIC – Agency for Society and Knowledge, IP that is a public institution with legal personality in Portugal. It follows the Web Content Accessibility Guidelines Web (WCAG 1.0) that have as objective, overcome several limitations of the other validators and it can be used to evaluate accessibility of all pages of a site. This tool provides detailed and organized results of evaluations analyses according to 3 levels of priority. The total number of tests that are performed in a web page by this tool are 61 [10].

The Taw tool was created by Fundación CTIC (Technological Centre of Information and Communication) based in Spain and its aim is to encourage, to stimulate and to disseminate web accessibility. It is an online validator based on the Web Content Accessibility Guidelines Web, and, therefore, the validation of a URL generates a HTML report with information about the outcome of the review. The Taw is part of a tools groups, all of these tools follow the same line, in addition these tools are always updating themselves to collaborate as much as they can to web accessibility [22].

The Achecker is an open source accessibility evaluation tool, developed in 2009 by the Adaptive Technology Resource Centre at the University of Toronto in Canada. This tool performs completes evaluations by separating the problems into 3 types: known problems, possible problems and potential problems. During the make an evaluation, the user can chose the desired guidelines and also the final report format [1].

The Wave is an evaluation tool developed by WebAIM (Web Accessibility In Mind) that has its base in United States. This tool was launched in 2001 and has already made millions of web pages evaluations. It has a different way of reporting error when compared to the other tools by showing a copy of the page with errors and warnings found instead of generating a long report with the data. The recommendations are also made in the page copy, which greatly facilitates the visual point and also for analysts, developers and novice researchers in the web accessibility field [26].

¹ <http://www.tawdis.net>.

² <http://www.acessibilidade.gov.pt/webax/examinator.php>.

³ <http://achecker.ca/checker/index.php>.

⁴ <http://wave.webaim.org>.

5.2 VCoPs Evaluation

In order to assist in the identification of satisfactory and critical points of the communities of practice accessibility, the accessibility recommendations were organized on aspects of accessibility. As a result, for each aspect was assigned a relevance parameter regarding to accessibility. Thus, for each aspect was assigned a relevance parameter regarding to accessibility (Table 4). The parameters were defined based on the W3C recommendations and also from a data collection related to the needs of the visually impaired.

For the blind, it is necessary the a screen readers support (the screen readers are responsible for going through all the content, providing to the blind user a spoken version of everything that is on the website), thus, the alternative texts in images and elements are essential, and the readers can identify on a page these elements and comprehend its contents. It is also important to have all the features and shortcuts available in the keyboard to make it easier for screen readers.

There were selected 4 communities of practice of large spread and different contexts. These 4 VCoPs were analysed by 4 accessibility evaluation tools, with focus on aspects related to the visually impaired. In the Table 5, the negatives points that were identified in the VCoPs are described. The columns 1, 2, 3 and 4 represent, respectively, the negative points found in the VCoP 1, VCoP 2, VCoP 3 and VCoP 4.

The lack of use of alternative text in images was the main problem found and one of the most worrying ones, this aspect is of extreme necessity for an accessible navigation to visually impaired users.

Within the aspects of texts for images and elements, worth highlighting the following issues: images that do not have an alternative text, images with invalid alternative text, and forms without label or alternative text. These problems are very common within the VCoPs and may even preclude the visually impaired understanding of the content. The visually impaired that is blind needs alternative texts to make possible the reading of contents by a screen reader. The screen reader is a software used to read the screen and make sounds about the contents. Lack of use of alternative texts for elements of a page or the misapplication of these texts is the same as omitting information for visually impaired users.

Another problem frequently encountered was the poor structuring of headers. The headers have a high priority within the contents language; therefore, their poor structuring can greatly complicate the interpretation of the content. To have a great structure is strongly recommended the content to be organized, simplified and comprehensible, thereby facilitating the understanding and do not requiring much effort from the user.

A point to highlight is that the tool that pointed more accessibility problems considering the evaluated aspects was the Taw tool, (19 problems) while the tool that less detected problems was the Examiner (10 problems). The Taw tool is part of an accessibility tools group, and was created as a way to encourage web accessibility; this tool makes its evaluation taking as base the new accessibility guidelines WCAG 2.0, dividing the problems neatly according to 4 principles: perceivable, operable, understandable, robust. The Examiner evaluates according to 3 levels of priority bringing the results in an organized manner. Furthermore, it is noteworthy that the Examiner has a differential; beyond pointing out the negative points, it also brings the positive

Table 4. Relevance of each accessibility aspect for visually impaired in VCoPs

Evaluated aspects	Environmental implication	Relevance
Content language	A simpler and clear language helps the visually impaired interpret the content in an easier way. The structuring and segmentation of the texts using titles, headers, paragraphs and lists are important, because information blocks in excess turns the reading of the visually impaired more difficult.	High
Alternative texts	The visually impaired with blindness needs subtitle to identify the images; these subtitles are of paramount importance for the blind to know where they are accessing. The lack of alternative texts and elements can preclude the comprehension of the content by the blind.	High
Keyboard utilization	It is important to have all the features and shortcuts available in the keyboard. In this way, the user can imagine the contents of the page and can navigate easily. The pages that cannot have their features totally accessed by the keyboard are not accessible for blind.	High
Destination addresses of links	The links should clearly and succinctly indicate where they point. The users can not differentiate the links if they are glued to another without any mark or printable character not “linked” to separate them. It should be available in navigation bars, constituted of lists of links to cluster, thereby facilitating its location.	Medium
Visual representation	It is important to provide way to help the visually impaired user to navigate on the website and find contents easily. The visually impaired with low vision has difficulties in interpreting plans, so the page layout table must be easily visible to the user become familiar with the structure quickly. Also, it is important to differentiate colours between contents and links already accessed and split the words into blocks of information.	Medium
Technologies adopted in videos	The criteria to use videos is to ensure that their quality meet the maximum rate of understanding to a deficient with low vision, and, thus, containing a great visual motion detection if they can pass some kind of information, but only it does not solve the problem because for blind people understanding it is necessary pass all possible information of the video through its audio.	Medium
Media duration	Must provide control over the executions of the media such as: stop, resume, cancel, start, rewind, forward and others. The visually impaired needs enough time to read/listen, interpret and use the contend so they can have control over the execution.	Medium
Language	When the site does not indicate the language to the user, they are not able to recognize the site language.	Low

points of the page. The fact whereby the Examiner detected fewer errors are linked to the type of evaluation that is made, because this tool still evaluates using the old guidelines of WCAG 1.0. Currently, the guidelines WCAG 2.0 are already used, and they contain some changes and inclusions compared to the old guidelines.

Regarding to the VCoPs the evaluated aspects generated an average of approximately 14 accessibility problems per VCoP page. It is noteworthy that the chosen tools have not evaluated the technological aspects utilized in its videos and media duration, even though these aspects are of great importance in terms of accessibility for visually impaired. As the used tools only evaluate the code of web pages, these aspects are not evaluated, however, they can be manually detected by the annalist or programmer without difficult.

6 Conclusion

This paper presented an investigation about the main accessibility problems in VCoPs. After conducting an evaluation of 4 VCoPs using the tools Taw, Examiner, Achecker and Wave, it was possible to identify the main problems faced by the visually impaired when accessing a VCoP.

With the results obtained, becomes evident the aspects that should be improved to have an environment more accessible to the visually impaired. Some of the main weak aspects identified in the analysed VCoPs were problems with alternative text in images and elements, and the poor structuring of headers, which can preclude the user to see, to hear and consequently to understand contents.

Regarding the evaluation tools, we can observe that they present distinct characteristics, each tool has different evaluation mechanisms, and, so they can detect different problems. The interesting fact in use more than one evaluation tool is that, sometimes, a flawed aspect with regards to accessibility that was not detected with a tool can be detected by another, thereby, maximizing the probability of finding accessibility problems.

The tools used showed up significant instruments to support the evaluation of the accessibility and they have identified some accessibility requirements for the visually impaired that can support the design of inclusive VCoPs to these communities. A limitation found in the used tools was the fact that they do not evaluate the technologies adopted in video and media duration. As a future work, we intend to conduct further analysis to improve results and also extend this analysis to other types of online communities.

Acknowledgments. The authors would like to thank Araucaria Foundation for the support in this research.

References

1. Achecker: <http://achecker.ca/checker/index.php>. Accessed 17 October 2015
2. Bitv: <http://www.bitvtest.eu/footer/accessibility.html>. Accessed 19 December 2015

3. Correa, M.P.L.: Aprendizagem e compartilhamento de conhecimento em comunidades virtuais de prática: estudo de caso na comunidade virtual de desenvolvimento de software livre debian-br-cdd (2007)
4. Da Silva, F.R., Zschornack, F.: *Análise de Acessibilidade em Redes Sociais* (2009)
5. De Araújo, C.M.E., Trindade, C.M.E., Da Silva, D.F.G., Garcia, R.A.L., Elero Junior, L.S.: Accessibility in E-Commerce Tools: An Analysis of the Optical Inclusion of the Deaf. In: Antona, M., Stephanidis, C. (eds.) UAHCI 2015. LNCS, vol. 9175, pp. 162–173. Springer, Heidelberg (2006)
6. Deaudelin, C., Nault, T.: *Collaborer pour apprendre et faire apprendre – La place des outils technologiques*. Presses de l'Université du Québec (2003)
7. De Gouvêa, M.T.A., Paranhos, C., Da Motta, C.L.R.: *Comunidades de Prática* (2008)
8. Eckert, P.: Communities of practice. *Encycl. Lang. Linguist.* **2**(2006), 683–685 (2006)
9. e-MAG: Modelo de acessibilidade em governo eletrônico (2011). <http://www.governoeletronico.gov.br/acoes-e-projetos/e-MAG>
10. Examiner: eXaminer Validador de Acessibilidade Web. <http://www.acessibilidade.gov.pt/webax/examiner.php>. Accessed 16 October 2014
11. IBGE: Instituto Brasileiro de Geografia e Estatística Pessoas com deficiência visual (2010). http://www.ibge.gov.br/estadosat/temas.php?sigla=rj&tema=censodemog2010_defic
12. Langelier, L., Wenger, E. (eds.): *Work, Learning and Networked*. Cefrio, Québec (2005)
13. De Macedo, M.K.B. et al.: *Recomendações de acessibilidade e usabilidade para ambientes virtuais de aprendizagem voltados para o usuário idoso* (2009)
14. Mifsud, J.: 10 Free Web-Based Web Site Accessibility Evaluation Tools (2011). <http://usabilitygeek.com/10-free-web-based-web-site-accessibility-evaluation-tools/>
15. Miller, G.A.: WordNet: a lexical database for English. *Commun. ACM* **38**(11), 39–41 (1995)
16. Moreira, J.R.: *Usabilidade, Acessibilidade e Educação a Distância* (2011)
17. Nichols, F.: *Communities of Practice. A Startup Kit* (2003)
18. Reinaldi, L.R., De Camargo Júnior, C.R., Calazans, A.T.S.: Acessibilidade para pessoas com deficiência visual como fator de inclusão digital-doi:10.5102/un.gti.v1i2.1331. *Universitas: Gestão e TI*, vol. 1, no 2 (2011)
19. Santos, A.P.A., Carli, B., Cano, P.F.: A Acessibilidade da Informação para Deficientes Visuais e Auditivos. *Anagrama: Revista Científica Interdisciplinar da Graduação*, vol. 4, no 4 (2011)
20. Section 508: <http://www.section508.gov>. Accessed 18 December 2015
21. Stanca Act: <http://www.agid.gov.it/agenda-digitale/pubblica-amministrazione/accessibilita>. Accessed 20 December 2015
22. TAW: <http://www.tawdis.net>. Accessed 15 October 2015
23. Tifous, A., Ghali, A.E., Dieng-Kuntz, R., Giboin, A., Evangelou, C., Vidou, G.: An ontology for supporting communities of practice. In: K-CAP, pp. 39–46 (2007)
24. Trindade, D.F.G., Garcia, L.S.: Framework Conceitual de apoio ao Design de Ambientes Colaborativos inclusivos aos Surdos. In: *Anais do Simpósio Brasileiro de Informática na Educação* (2013)
25. Vidou, G., Dieng-Kuntz, R., Ghali, A.E., Evangelou, C.E., Giboin, A., Tifous, A., Jacquemart, S.: Towards an ontology for knowledge management in communities of practice. In: Reimer, U., Karagiannis, D. (eds.) PAKM 2006. LNCS (LNAI), vol. 4333, pp. 303–314. Springer, Heidelberg (2006)
26. Wave: <http://wave.webaim.org>. Accessed 18 October 2015
27. WCAG 2.0: Web content accessibility guidelines. Web Accessibility Initiative (WAI) (2013). <http://www.w3.org/TR/WCAG20/>

28. Weiseth, P.E., Munkvold, B.E., Tvedte, B., Larsen, S.: The Wheel of Collaboration Tools: A Typology for Analysis within a Holistic Framework. In: CSCW 2006, Banff, Canada, pp. 239–248 (2006)
29. Wenger, E.: Communities of practice: a brief introduction (2011)
30. Wenger, E.: Communities of Practice. Cambridge University Press, New York (2000)
31. WHO: World Health Organization (2014). <http://www.who.int/mediacentre/factsheets/fs282/en/>
32. W3C/WAI: Web Accessibility Initiative (WAI). WAI guidelines and techniques. <http://www.w3.org/WAI/guid-tech.html>

Universal Access in Human-Computer Interaction.
Methods, Techniques, and Best Practices
10th International Conference, UAHCI 2016, Held as
Part of HCI International 2016, Toronto, ON, Canada,
July 17-22, 2016, Proceedings, Part I
Antona, M.; Stephanidis, C. (Eds.)
2016, XXX, 498 p. 145 illus., Softcover
ISBN: 978-3-319-40249-9