IS INTERNET AN ACCESSIBLE LEARNING RESOURCE FOR SIGHT-IMPAIRED STUDENTS?

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Abstract

The importance of Internet use in education is widely recognized. Advanced net-technologies can well improve the quality of learning by facilitating access to educational resources and services and also by providing new and enlarged opportunities for interpersonal communication thus allowing for meaningful, content-rich and educationally effective exchanges.

Online learning environments offer to students interesting, flexible and highly customizable learning solutions and, generally speaking, are characterized by a high degree of usability and ease to use. Despite this, if we take into account students with disabilities, we see that a number of accessibility issues often arise that make web use highly problematic for them with the upshot that the differences are exacerbated rather than smoothed out.

In this paper we take the viewpoint of sight-impaired students and try to answer the research question whether can Internet be considered an accessible learning resource for them and/or to what extent. In particular, we explore the specific difficulties that pupils with visual impairment encounter when surfing the net with the aim of exploring, retrieving and using web- based educational material.

In the light of the accessibility principles of the Web Content Accessibility Guidelines (WCAG), the specific requirements for low vision and blind students are examined and possible solutions are envisaged and discussed.

Keywords: Accessibility, Universal Access, Technology Enhanced Learning, Collaborative learning.

1 INTRODUCTION

The importance of ICT tools and Internet use in education is widely recognized.

Educational research provides strong evidence that: “ICT is both a medium and a powerful tool in supporting inclusive practice. It provides wide-ranging support for communication, assisting many learners to engage with learning, including those who are hard to reach, and helps to break down some of the barriers that lead to under-achievement and educational exclusion” [1]. Observations about the positive impact of ICT on inclusive education appear to be even more well-grounded if we think in terms of “user centred” philosophy, seems better suited to the idea of “inclusion”, where all students should be considered as being at the heart of the school system [2].

The possibility of customizing and personalizing learning paths is also an important aspect of what ICT technologies offer to enhance the effectiveness of today’s educational systems [3].

The educational potential of the Web is enormous and we see that nowadays it plays an important role in both informal and formal education, at all levels. In recent years the concepts of Web 2.0 and e-learning 2.0 have led to a radical changes in the type and use of ICT tools web technologies for education. According to Downes [4], the Web is, in fact, evolving, “shifting from being a medium, in which information is transmitted and consumed, into being a platform, in which content is created, shared, remixed, repurposed, and passed along”. E-learning is also evolving, together with the World Wide Web: the traditional model of e-learning based on “a type of content, produced by publishers, organized and structured into courses, and consumed by students, is turned on its head [5].This makes the web a far more important learning arena, where teachers and students are both involved in innovative learning processes grounded on the concepts of exchange, collaboration and shared knowledge.

What makes the Web an increasingly effective and essential learning resource is mainly the possibility it offers to access extensive information; nevertheless, more importantly, it also offers the ground for communicating with other actors in the learning process (teachers, pairs…) and, as a consequence, it

allows and supports the sharing of ideas, information and, more generally, of knowledge. In particular, the adoption of collaborative learning strategies is fostered by net- based tools such as e-learning platforms, wikis blogs etc. …, and these features provide students with significant added value from the cognitive as well as from the motivational [6,7] and relational point of view.

With the coming of social networks, blogs, wikis, discussion forums, and the possibility to create their own web space to operate independently, it is possible to associate the formal learning that takes place through the delivery of lectures and checks with the benefits from informal learning, allowing a more active participation of the learner.

Collaborative learning, which is strongly based on internet use and facilities, represents an important step towards overall increasing the effectiveness of learning processes and this is true at all school levels and also for vocational in-service training and in the field of informal education [8].

Students share resources, carry out common learning activities and sometimes also play together (or against each other) to reach common learning objectives [9].

In a wider vision collaborative learning entails the acquisition by each single student of specific knowledge, abilities and attitudes but the learning process of each individual is mediated, sustained and made possible by and through group work [10].

The educational value of collaborative work and study is widely recognized for all students in that it also fosters meta-cognitive abilities and the perception of own results with respect to those of pairs. This is true also for students with disabilities [11] who can benefit from recognizing themselves as active contributors to a common endeavor and part of a learning team.

Access to the internet is to some extent mandatory to be able to carry out such collaborative learning activities.

Despite this, if we take into account students with disabilities, we see that a number of accessibility issues often arise that make web use highly problematic for them with the upshot that the differences are exacerbated rather than smoothed out.

In this paper we take the viewpoint of sight-impaired students and try to answer the research question whether, presently Internet can be considered an accessible learning resource for them and/or to what extent. In particular, we explore the specific difficulties that pupils with visual impairment encounter when surfing the net with the aim of exploring, retrieving and using web- based educational material.

2 STUDENTS WITH VISUAL DISABILITIES: A VARIEGATED POPULATION WITH DIFFERENT NEEDS

In contrast with the widespread principle of e-inclusion and of Universal Access to education [12] the use of digital resources is mostly challenging for students with visual disabilities. Their impairment is becoming increasingly relevant, since the newest software products rely more and more on images, motion, voice, special effects, three-dimensionality. This is an issue because the overwhelming use hence preventing students with special needs from using the same materials as their schoolmates [13].

When talking about visual impairments, first of all, it is important to distinguish among different types of impairment and in particular between blind and low vision students, because the two categories have different types of problems. As a matter of fact, in order to fully to access the digital contents displayed by computers (including those available via the net), the first category of students has no possibility to “read” the screen so they necessarily need to rely on screen readers or other tools (such as braille devices) that can display the content in a non-visual way (calling for the vicarious use of other senses such as touch or hearing). The second category, instead, thanks to specific assistive technologies, optical aids and/or to specific customization options, has the possibility access the screen contents so that a much wider variety of software applications is available for them, including, often, applications and systems with graphic interface.

Also, low-vision students cannot be considered a fully homogeneous population and the wide variety of visual impairments they may have, has also an impact on the educational resources they can effectively use [14].

The word “low vision” incorrectly suggests the idea of generalized visual problems while actually the term comprehends a variety of very specific different visual problems such as:

- the lack of visual acuity, that is a deficit affecting the ability to perceive the borders and the

internal details of the objects,
- a “limited or narrow visual field” when subjects have a quite good vision of objects situated in the centre

Together with these two main kind of impairments that greatly affect vision other less common deficits exist that still hinder learning and make the use of computer tools hard and difficult; among these:

- the lack of contrast sensitivity, that is a deficit affecting the ability to perceive differences between an object and its background,
- the difficulty to distinguish colors, or/ and to perceive the relieves,
- the lack of resistance to the dazzle,
- the reduced ability to follow movements,
- the stereopsis or binocular vision, that is the power to perceive the depth on the basis of the difference in points of view of the two eyes,
- the "nystagmus" which produces involuntary, rhythmical, repeated oscillations of one or both eyes.

If we carefully look at some features of the last generation educational digital material and, more in general, of the net contents, we easily find out that the interface often presents problems to students with low-vision: small characters, images in motion, confusing background, extra-crowded pages. The global perception of the educational contents is often seriously compromised; very often, as a result of this situation, the educational effectiveness of these products appears to be limited and a sense of frustration may also arise in partially sighted students [14].

Since “low visions students” cannot be considered a homogeneous category, it is necessary to take into account the needs of each individual and to provide them with the appropriate assistive technologies/aids. This means also that the majority of low- vision students, if appropriately sustained by properly tuned tools, and also depending on the gravity of the impairment can access digital resources and, to some extent, also net contents thus also being enabled to retrieve information from the net, share contents with other students and collaborate in a learning group.

Anyway, unfortunately, we must acknowledge that the difficulties that people with visual impairments may encounter when surfing the net in search of valuable educational information/material and for carrying out collaborative learning activities are many and of many different kinds. In the following, we explore the issue by referring to the concepts of “accessibility” and “usability” [12, 15] and, first of all, by casting a glance to existing legislations in the field.

3 ACCESSIBILITY STANDARDS

Considerable attention has been dedicated in recent years to defining of accessibility standards for ICT tools, and in particular for web access. This is true at international level and policy makers also in most European countries are showing increasing interest in providing specific laws regulating the matter.

The Web Accessibility Initiative (WAI), which is part of the World Wide Web Consortium (W3C), develops Web accessibility guidelines, technical reports, and educational resources to help make the Web accessible to people with disabilities. In particular WCAG 2.0 (Web Content Accessibility Guidelines 2.0) is a stable, technical standard widely used as a reference in the field. It has twelve guidelines for each of which testable success criteria are also proposed, which are scaled as: A, AA, and AAA.

In Italy, the accessibility of ICT tools is regulated by the Law n.4/2004, also known as "The Stanca Act". The subsequent Ministerial Decree of July 8th 2005 defines the standard as “*Technical Rules for the Accessibility of ICT Tools*”; this document establishes twenty-two requirements for websites, following the control points of the WCAG and the main requirements outlined in Section 508 of the Rehabilitation Act of the US Federal Government.

So far, no specific European standard/legislation exist in the field but the European Union in November 2010 has launched the European Disability strategy[1] stating that “*Persons with disabilities have the right to participate fully and equally in society and economy*” and that: “*denial of equal opportunities is a breach of human rights*”.

[1] http://ec.europa.eu/justice/discrimination/disabilities/disability-strategy/index_en.htm

Furthermore, the EU has signed the United Nations' “Convention on the Rights of Persons with Disabilities[2] and in 2013 it has also promulgated the European Accessibility Act[3].

The Act is meant to “improve the inclusion and participation of persons with disabilities in society and economy” and it is also intended “to promote access to products and services that are central to ensuring the wellbeing of persons with disabilities and to enable them to enjoy their fundamental rights”.

Among these fundamental rights, we can certainly include access to instruction and learning and the possibility to use standard educational tools (even those ICT-based) is certainly part of the inclusive strategy to be followed.

As a matter of fact, proper legislations exist and it needs to be fully applied in all countries.

4 ACCESSIBILITY FEATURES IN CURRENT MAIN OPERATING SYSTEMS

If, from the one side, we have seen that consistent efforts are being done to provide a legislation supervising and protecting the rights of people with disabilities, from the other side we also assist to the fact that most service providers and ICT operators are conscious of this necessity. All the newest operating system encompass significant and relevant features assisting the interaction of people with disabilities with software applications. This is true both for standard and mobile applications.

The following table provides an overview of existing facilities addressing the needs of visual impaired users (and therefore also students) subdivided according the different types of operating systems.

Target	**Windows 8**	**OS X**	**Linux Ubuntu**	**I OS**	**Android**
Blind and low vision users	Voice assistant	Voice over	Orca screen reader	Voice over	TalkBack
Blind and low vision users	Speech recognition	Possibility to pronounce single items	Speech recognition	Dictation Siri	
Blind and low vision users	Turn off of useless animations				
Low vision users	Magnifying glass	Zoom	Text size	Zoom Larger Font Bold Text	Font size
Low vision users	High contrast	Contrast Enhancement	Contrast	Increases contrast Invert colors	
Low vision users	Provision of acoustic signals when turning on/off specific functions.				SoundBack
Low vision users	Increases the thickness of the bounding box				
Low vision users	Change color and size of the mouse pointer	Cursor Size		Cursor Size	
Low vision users	Remove background images				

Table1 - Accessibility functions available x operating system.

As to blind students, based on personal practice we can affirm that the availability of a proper screen reader is key to allow access to web contents. Vocal recognition functionalities are also very important.

[2] http://www.un.org/disabilities/convention/conventionfull.shtml

[3] http://www.epc.eu/documents/uploads/pub_3393_the_accessibility_act.pdf

As to low vision students, all the functions allowing a better vision are of major importance: magnifying lenses, high contrast settings, possibility to modify aspect, dimension and color of the pointer…

As it should be evident from the above table, despite the different names, all the major operating system provide the most important functionalities and, what is even more important, they are also available from the start as soon as one turns on the device or the computer.

While testing the above functionalities with Italian users we found that the most relevant differences among the tested operating systems are related to screen readers availability and performance. As a matter of fact, the Italian language is an issue and not all the existing screen readers can suitably deal with it: in Windows 8, at present, it is not available while in OS X e iOS it is available and also basically works properly. Both Ubuntu and Android offer the screen reading functionalities for the Italian language but it is not always working properly.

Another important feature is the one regarding the Zooming possibilities and, in this respect, we must observe that Ubuntu lacks this important facility while all the other operating systems have it and allow good and suitable ad hoc enlargements of selected portions of the screen. Ubuntu nevertheless allows proper enlargements of textual characters.

In a global perspective, the Apple operating systems appears to better meet the needs of sight impaired users and students. This is what thinks Tamara who has a severe visual deficit: she uses everyday for work a MAC OS and is perfectly comfortable with it. Elisa, on the contrary, who is also severely sight impaired, uses Windows and, while describing the efforts she has done to become fully able to use the screen reader, illustrates the potentialities of the system that are great for her. She also tells that internet use is for her much more difficult in respect to the use of traditional programs since the contents available through the net are not always compliant with existing legislation and therefore not fully accessible.

Accessibility and usability issues both affect the possibility to make a proper and effective use of the contents available through the net and to access it for communication and collaboration with pairs.

5 SURFING THE NET AND SIGHT IMPAIRED STUDENTS: MAIN ISSUES AND CHALLENGES

What are exactly the problems that a student may encounter while surfing the net and which solutions can be found for enhancing and making easier net use for educational purposes?

In the following table 2, partially adapted from the Webaim website[4] the main challenges are outlined with reference to the type of sight impairment involved (distinguishing among the three main impairments: blindness, low vision, color blindness).

In the table, an X identifies that the category is proper to the specific category of users, a Y identifies that the specific challenge can possibly affect the specific category of users.

Challenges	**Blind users**	**Low vision users**	**Color blind users**
Users generally cannot use a mouse	X	Y	
Images, photos, graphics are unusable	X		Y
Users should listen to the web pages using a screen reader	X	Y	
Users should jump from link to link using the **Tab** key	X	Y	
Users should understand where links take them	X	Y	
Frames cannot be "seen" all at once. They must be visited separately, which can lead to disorientation	X	Y	
It may be difficult for users to tell where they are when listening to table cell contents	X	Y	

[4] http://webaim.org/intro/

Complex tables and graphs that are usually interpreted visually are unusable	X	Y	Y
Not all screen readers support image maps	X		
Messages conveyed uniquely by means of colors are meaningless	X		X
Text in graphics does not enlarge without special software, and looks pixilated when enlarged		X	
The combination background -colours of the screen contents (e.g. text) may hinder full vision and reading		X	
Screen magnifiers reduce the size of the available window		X	
Reds and greens (as well as possibly other colors) cannot be distinguished	X		X

Table 2 - Main challenges encountered by sight impaired students as to Internet use (adapted from the WEBAIM website).

Trying to summarize we see that the main problems involve the use of screen readers and keyboards.

Screen readers are quite robust in their capabilities, but they do have limitations. They cannot completely replace the visual experience: screen readers cannot survey the entirety of a web page as a visual user might do. A visual user can look at a web page and quickly realize how the page is organized, then zero in on the most important content. A screen reader is not able to do this. It reads in a linear fashion, one word at a time. It cannot always intelligently skip over extraneous content, such as advertisements or navigation bars. Screen readers allow users to navigate through web content in many ways but they can hardly avoid content such as advertising or navigation bars. The user can simply let the screen reader read everything from top to bottom, one line at a time, or the user can use the tab key to navigate from link to link. The user can also navigate from one heading to the next (if the web content has headings), from one frame to the next (if there are frames).

Then, screen readers per se cannot describe images. The only way that a screen reader can convey the meaning of an image is by reading text in the document that serves as a substitute, or alternative, for that image. If there is no alternative text, then the screen reader cannot accurately convey the needed information about the image at hand.

Another problem is the fact that screen reader users use their keyboard as their primary means of navigating the web while the functionalities of some programs only allow mouse use.

As to low vision users, we see that this term encompasses a variety of different impairments. Furthermore, the visual acuity of people with low vision varies a lot; in general, low vision is defined as a condition in which a person's vision cannot be fully corrected by glasses, and this interferes with daily activities such as for instance reading and driving. Low vision is more common among the elderly, but it can occur in individuals of any age as a result of such conditions as macular degeneration, glaucoma, diabetic retinopathy, or cataracts. Each of these conditions causes different types of effects in a person's vision, however, in general, we can say that the key problem is perception since such users cannot perceive (see) contents that are too small, does not enlarge well, or which does not have sufficient contrast.

The most common technology that people with low vision use is the screen magnifier. These software programs zoom on a small area of the screen, allowing people with low vision to see it more clearly (Fig.1).

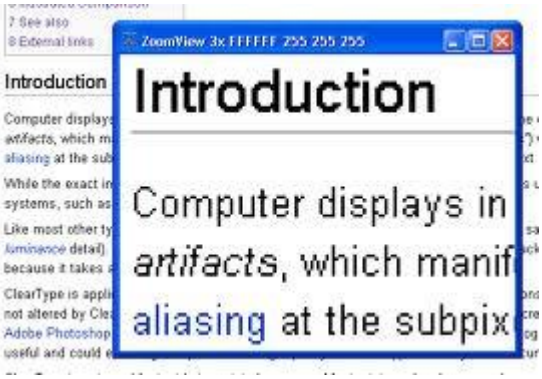

Fig.1 - Example of magnification of a screen portion from Wikipedia.

Some kinds of content are anyway difficult to interpret when enlarged. For example, graphics that contain text can become blocky and pixilated, making the text difficult to understand.

Another effective support is the high contrast, but some poorly designed sites on the web have bad color combinations such as blue links on black backgrounds, red text on green backgrounds, or other combinations that are not easy on the eyes for anyone, but especially not for people with low vision (Fig 2). There are not specific rules as to how much contrast is enough, but usually it is not too difficult to tell when color combinations do not contrast adequately. The most common settings useful to avoid these problems are black background with white or yellow texts, and white or yellow background with black text.

Fig 2 - Examples of different color combinations hindering (left inted) or enhancing (right -all) reading.

As to color-blind users the key principle of web accessibility for users with color-blindness is to consider and enhance perception which can be severely hindered because such users cannot perceive (see) the difference between colors, when used in combination.

The colors which color blind users may have difficulty to distinguish are varied depending on the type of color-blindness, but red-green deficiencies are the most common; this doesn't mean that only black and white images can be appropriate, because the difference among some colors can anyway be detected. The point is that colors should not be the only method of conveying important, relevant information such as the one reported in Fig.3 showing the lines of the Milan Underground.

Fig 3 - Milan Underground map: an example of how the color is the only means to convey relevant information.

If the purpose of an image is to communicate something relevant by means of colors exclusively, then it is important that the website provides some other way for understanding the information so to supplement the color-dependent method of conveying information.

6 FROM PRACTICAL ISSUES TO BASIC PRINCIPLES FOR ACCESSIBILITY

The W3C Guidelines[5] define four basic principles for the due characteristic of web- based environments. According these principles they should be:

- perceivable, with reference to the availability to the senses, either through the browser or through assistive technologies;
- operable, with reference to the full possibility of interaction through controls and interactive elements (mouse, a keyboard, assistive devices…);
- understandable thanks to the presence of clear content, not ambiguous and confusing;
- flexible i.e. providing possibility to access the content through a wide range of technologies, be they innovative or traditional.

If we look at these principles from the perspective of blind users we see the importance of all of them as a matter of fact contents should be:

- Perceivable: because blind users cannot perceive (see) visual information such as graphics, layout, or color-based cues
- Operable: because blind users usually depend on a keyboard to operate (navigate) web content functionality, rather than a mouse
- Understandable: because blind users cannot understand content that is presented in an illogical linear order, or which contains extraneous text not meant to be read word for word or character by character (such as long web addresses), etc.
- Robust: because the assistive technologies used by the blinds are not always capable of accessing a broad range of technologies, especially if those technologies are new.

Translated into practice, these principles give rise to the following twelve guidelines.

Perceivable	**Operable**	**Understandable**	**Robust**
• Provide text alternatives for non-text content. • Provide captions and other alternatives for multimedia. • Create content that can be presented in different ways, including by assistive technologies, without losing meaning. • Make it easier for users to see and hear content.	• Make all functionality available from a keyboard. • Give users enough time to read and use content. • Do not use content that causes seizures. • Help users navigate and find content.	• Make text readable and understandable. • Make content appear and operate in predictable ways. • Help users avoid and correct mistakes.	• Maximize compatibility with current and future user tools.

Table 3 - List of the twelve W3C Guidelines.

[5] http://www.w3.org/TR/WCAG/

7 CONCLUSIONS

In this paper we have taken the perspective of students with disabilities, in particular those with visual disabilities and have investigated the actual possibilities for them to access the educational material available on the net and to collaborate with pairs for learning purposes.

This was done with the primary aim of enhancing teachers' and educators' knowledge and comprehension of the actual difficulties that these categories of students may encounter.

A preliminary distinction among the different types of visual disabilities has been done to set the stage for further individual observations and reflections.

The examination of the present laws in force has offered an overall view of what the ideal situation could be if all the websites were fully compliant with existing legislations. A short excursus on the facilities offered by different operating system for enhancing universal access to ICT tools and web-based (standard and educational) material.

Examples from experience and basic accessibility principles set in W3 guidelines have hopefully provided food for thoughts while also leading to define a number of existing challenges (presented in table 2) that we hope all the information providers and all the educators will take into account before producing (the formers) and selecting for adoption (the latters) dedicated educational material.

What we have tackled and discussed in this paper, far from being exhaustive for defining the overall situation, also point out a core matter the relationships between the two concepts of "accessibility" and "usability". Both the terms usability and accessibility deal with (and potentially act on) the improvement of web interfaces but actually important differences exist between the two, from a methodological viewpoint.

As a matter of fact, while the implementation of accessible web sites is mainly linked to their compliance with existing standards, the creation of usable web sites necessarily needs the interpretation of behavioral models. Most importantly, while the evaluation of accessibility can be carried out by means of automatic or semi-automatic tools, the usability evaluation necessarily involves potential users in person and cannot be limited to an automatic process. The overall involvement of final users in the processes of creation, evaluation and deployment of ICT based tools and material, especially for those that are meant to be adopted in educational contexts. Here teachers and educators (to whom this paper is mainly addressed) have a important role because in a genuine user centered perspective their awareness of the actual issues and challenges faced by all students is key to allow all students' participation in school life thus actually ensuring Universal Access to education.

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