Accessibility of Educational Multimedia: in Search of Specific Standards

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***Abstract*— This paper deals with the issue of the accessibility of multimedia educational software. The problem is tackled from the viewpoint of standards, that is of the rules to be adopted at institutional level in order to guarantee access to educational software to all students, including those with special needs. The key question to be answered is if regulations in force for ICT tools also fully cover educational software accessibility requirements.**

***Index Terms*— Education, Educational Technology, Software standards, User interfaces.**

I. Introduction

The Charter of Fundamental Rights of the European Union states[1]: "*Any discrimination based on any ground such as sex, race, colour, ethnic or social origin, genetic features, language, religion or belief, political or any other opinion, membership of a national minority, property, birth, disability, age or sexual orientation shall be prohibited*". Accessibility can therefore be seen as an "*interpretation of* "*non-discrimination*" since accessibility actually means 'barrier removal': "*barriers are a greater impediment to participation in society than are individual people's functional limitations. Barrier removal through legislation, provision of accommodations, universal design and other means, have been identified as the key to equal opportunities for people with disabilities*" [9].

In the framework of full inclusion of people with disabilities in our society, 'Universal Access' is now considered a fundamental objective for most developed countries [1] to meet in the near future, and this concept refers to almost all aspects of social life, including education [2].

The idea of 'access' was originally linked to the effort to provide and facilitate physical access to the built environment (e.g. buildings, streets, landscapes etc.) for all people with functional disabilities.

Today, derived terms such as 'accessibility' and 'universal access' have a broader meaning, which is not limited to specific contexts and specific tools but interprets "*the global requirement of coping with diversity*" and applies to all fields of modern social life, including Information and Communication Technology (ICT): "*[…] in the context of the emerging Information Society, Universal Access resurfaces as a critical quality target*" since, in this framework, "*disadvantaged or excluded groups, including the unskilled, disabled and the elderly, face the danger of further marginalization […]*"; I n fact, "*with the advent of the digital computer, and its broad penetration […], disabled and elderly people face serious problems in accessing computing devices*" [8].

Accessibility and high-quality interaction with ICT products, applications, and services by anyone, anywhere, and at any time are fundamental requirements for Universal Access in the emerging Information Society, which touches all aspects of modern life, including education.

In the field of education, the problem of the accessibility of ICT products is considered very important: accessible information technologies can facilitate students' independent learning and information retrieval (e.g. by accessing multimedia dictionaries, encyclopaedias, websites). Consequently, a shared definition of accessibility requirements for ICT educational products is required.

In the following, the issue of the accessibility of educational multimedia software is discussed and a tentative answer is proposed to the question "What are the main requirements to be met for an educational software product to be considered accessible?"

II. Educational Multimedia Software: Accessibility Issues

Universal Access to education entails "*the ability of all students to have equal opportunity in education, regardless of their background or physical disabilities*"[2]; students with disabilities have the right to expect the same standard of education as their schoolmates. Therefore, they also have the right to access and use mainstream educational tools of any kind, including ICT based ones. However, "*while these technologies are beneficial and have been shown to help with educational tasks, their design and usability are an issue*" [5].

From a strictly technical point of view, software applications used for educational purposes can be divided into two different categories: *web-based programs* and *programs installed and executable locally on the user's machine*.

Web-based programs are necessarily implemented by means of markup language (HTML) and are therefore directly available on the web using any internet browser. These programs generally do not call for any kind of installation process on the user's computer.

[1] Charter of Fundamental Rights of the European Union Article 21-1 "non discrimination" retrieved August, 2006 at http://www.europarl.europa.eu/comparl/libe/elsj/charter/default_en.htm

[2] From Wikipedia www.wikipedia.org (retrieved August, 2006)

The expression "*programs installed and executable locally on the user's machine*" refers, in general terms, to software applications available on supports like CDs and DVDs (but also downloadable from the web) that usually need to be installed locally on the user's machine.

Web-based educational programs are subject to the technical assessment and accessibility requirements of Internet-technology applications. While a large number of studies and tools[3] are devoted to this area, the field of accessibility requirements for other multimedia educational software has received far less attention and few specific initiatives are known[4].

In the following, we refer only to stand alone multimedia educational software, excluding web based products.

Although it is acknowledged that these products constitute a significant means for fostering learning [6], it is not universally known that they can also present accessibility problems to some users [3].

To take an example, Fig. 1 shows a screenshot of a well known multimedia educational software for foreign language learning[5], which presents a number of accessibility problems to students with disabilities:

- it is not compatible with assistive technology applications such as text-to-speech (TTS) screen readers[6],
- the interface only allows interaction via a mouse. There is no keyboard access and alternative input devices other than mouse emulators cannot be used.

Blind users face particular barriers using this software, not only because it is incompatible with screen readers, but also because the position of the target words is not text labelled, making them extremely difficult to locate.

Motor impaired students may also encounter problems because the 'drag and drop' movement required to perform the exercise is incompatible with limited motor control and because the use of devices other than the mouse (or mouse emulator) is not allowed.

Accessibility presents a range of different issues and problems that the non-specialized teacher or educator may find it difficult to appreciate and understand until they emerge during enactment of education processes involving students with disabilities.

The situation underlines the need for specific standards in the field of accessibility of ICT-based educational tools [4] and of specific documentation/information systems. In this way, potential users (not only final users, that is students, but also teachers, educators, parents etc.) can gain understanding about the accessibility level of individual products and consequently be able to make an informed decision when selecting a product to meet their needs.

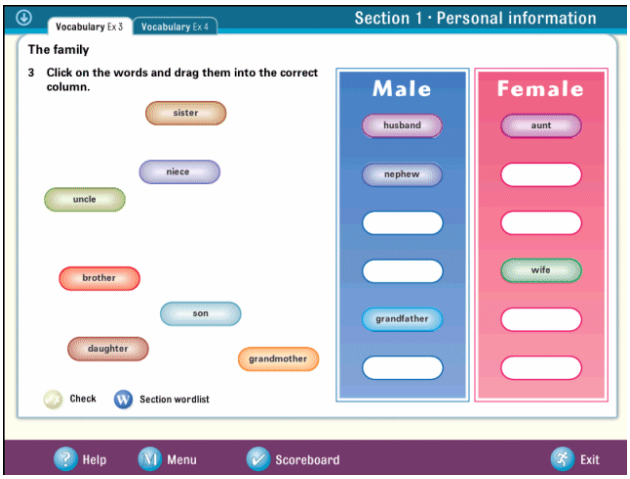

Figure 1. Screenshot of the educational software "Horizon 1" by Oxford University Press

III. ACCESSIBILITY STANDARDS

At present, considerable attention is being dedicated worldwide to the question of accessibility standards for ICT tools. Both in European and elsewhere policy makers are showing increasing interest in how to define accessibility requirements[7].

One question that remains open in this field is whether general accessibility standards for software applications are sufficient or whether ICT products conceived for educational purposes need 'education-specific' accessibility requirements. The situation in Italy appears to be emblematic of latest trends and is used here as an example to explore this issue.

In Italy, the accessibility of ICT tools is regulated by the recently passed Law n. 4/2004, also known as "The Stanca Act"[8] . The subsequent Ministerial Decree of July 8th 2005[9] defines the standard as "*Technical Rules for the Accessibility of ICT Tools*"; this document establishes eleven requirements for non web-based software applications, following the main requirements outlined in Section 508 of the Rehabilitation Act of the US Federal Government (see Table 1).

[3] Web Accessibility Initiative (WAI) http://www.w3.org/WAI/; The International Webmasters Association (IWA) http://www.iwanet.org/

[4] Martec accessibility toolkit http://www.temple.edu/martec/onlinetools/checklist.html (accessed August, 2006)

[5] Horizons 1 (2003) by Oxford University Press (UK)

[6] For example Jaws (7.1) by Freedom Scientific http://www.freedomscientific.com/

[7] European Commission - Information Society Factsheet: "An information Society open to All" (September 2005) http://europa.eu.int/information_society/doc/factsheets/012-eaccessibility.pdf#search=%22An%20information%20society%20open%20to%20All%22 (Accessed August, 2006)

[8] CNIPA, "The Stanca Act Law n. 4, January 9, 2004 - Provisions to support the access to information technologies for the disabled" http://www.pubbliaccesso.gov.it/normative/law_20040109_n4.htm (retrieved August, 2006)

[9] CNIPA, Decreto del Ministro per l'innovazione e le tecnologie, 8 luglio 2005 "Requisiti tecnici e i diversi livelli per l'accessibilità agli strumenti informatici".Allegato D: Requisiti tecnici di accessibilità per l'ambiente operativo, le applicazioni e i prodotti a scaffale http://www.pubbliaccesso.gov.it/normative/DM080705.htm

TABLE I.
ANNEX D. TECHNICAL ACCESSIBILITY FOR THE OPERATING SYSTEM, APPLICATIONS AND RETAIL PRODUCTS
(DM. 8TH OF JULY 2005, LAW NO. 4/2004)

Requirement No 1 **Terms:** The functions provided by the user interface must be able to be activated by means of keyboard commands in cases where a description of the function or the result of executing it can be provided. **Section 508:** 1194.21 (a)	**Requirement No 7** **Terms**: Animations, graphic or sound elements and differences in colour must not be used alone to provide information or indicate or request actions. **Section 508**: 1194.21 (i) (h)
Requirement No 2 **Terms:** Commands and functionalities of the user interface must not limit or disable the accessibility characteristics and functionalities of the operating system, made available by the manufacturer of the operating system. **Section 508:** 1194.21 (b)	**Requirement No 8** **Terms**: Applications must not overlap selections made by the user with regard to contrast or colour levels and other display attributes. **Section 508**: 1194.21 (g)
Requirement No 3 **Terms:** The application must provide sufficient information, such as identification information, operations possible and status, on objects contained in the user interface so that the assistive technology can identify them and interpret their functionalities. **Section 508:** 1194.21 (d)	**Requirement No 9** **Terms**: The user interface must not contain flickering text elements, objects or other elements with a intermittent frequency greater than 2 Hz and lower than 55 Hz. **Section 508**: 1194.21 (k)
Requirement No 4 **Terms:** Where graphic symbols are used to identify controls, status indicators or other programming elements, the meaning assigned to these symbols must be consistent within the framework of the whole application, including the user interface. **Section 508:** 1194.21 (e)	**Requirement No 10** **Terms**: The active "focus" element of a user interface must be clearly identifiable. Identification and variation of the focus must be indicated at the application programming interface (API) level, so that the assistive technology can manage them. Other elements that require action by the user must also be adequately indicated. **Section 508:** 1194.21 (c)
Requirement No 5 **Terms:** Textual information must be provided using the functionalities of the operating system provided to display text. In particular, textual content, the location of the insertion point and the text attributed must be available. **Section 508:** 1194.21 (f)	**Requirement No 11** **Terms**: Supporting documentation for the product and accessibility characteristics must also be made available in accessible electronic form. **Section 508**: 1194.41
Requirement No 6 **Terms:** Applications that use audio signals must provide an equivalent visual functionality, in accordance with any conventions of the operating system. **Section 508:** 1194.31 (c)	

The accessibility requirements described in Annex D of the decree can be summarized as pertaining to four main areas: *keyboard access, legibility of on-screen information, compatibility with assistive technologies, non-unique method to convey information and allow communication.*

Keyboard access. The Stanca Act requires that there should always be keyboard access to a program's controls and features. This is because other means of input, particularly pointing devices such as mouse or tracker ball, may not be usable by people with special needs. For example, a person with a physical disability may find it impossible to move or hold a pointing device with enough accuracy to activate desired features. The same difficulties also apply to users with visual impairments (either partially sighted or blind) who rely on assistive technologies such as text-to-speech or large-character displays and depend on keyboard access to run a program since they are unable to determine what is being pointed at and cannot guide a mouse pointer around the screen. For such users, standard keyboard access is therefore of prime importance.

Legibility of on-screen information. For many visually impaired users (i.e. the partially sighted) it is very important that information displayed on the screen be presented in a clear, uncluttered manner. Consequently, users need to be able to personalize a number of display settings such as colour coding, background, contrast, screen and text colours, and font size and type.

Most operating systems allow users to select the preferred settings. However, it is crucial that those settings be maintained even when the software application is running. The law requires, therefore, that applications shall not disrupt or disable features activated by users in the operating system; alternatively, software applications should permit a user to adjust colour and contrast settings to accommodate individual needs and preferences.

In addition, software applications need to limit as much as possible the use of flashing or blinking - in texts, objects and other elements - particularly if the flashing has a high intensity and is within a certain frequency range. Blinking and flashing displays can cause photosensitive epileptic seizures in susceptible individuals and can reduce legibility for users with some kinds of visual impairment.

Another important aspect is enabling users to identify the current on-screen focus point at any given time: this often corresponds to the active on-screen cursor[10].

More precisely, the position of the program's focus point needs to be expressed in code that is made available to any assistive technologies in order to

[10] As opposed to the mouse pointer, the term "cursor" is often used to describe both objects.

guarantee that individuals with a physical disability, or who are partially sighted or blind, can easily move and navigate around the screen. Users who operate a computer using a screen enlargement program must be able to magnify the focus area to perceive focus point details; individuals who use screen readers and reading assistant technologies must receive precise feedback so that they know where they are at all times; users who use alternative pointing devices must be able select and access the information presented in an efficient manner and to move objects around the screen.

Compatibility with assistive technologies. As mentioned earlier, assistive technologies enable users with impairments to gain independent access to information. Ensuring complete compatibility of software applications with these technologies means providing access to all the available contents. Providing text descriptions (labels) of all graphic objects presented on the screen (such as icons, buttons, bitmap images) allows people with visual impairments using assistive technologies to make out and perceive the information conveyed.

Specifically, these text labels read out by screen readers need to be coherent and consistent throughout the whole application. If the label associated to a given object changes during interaction with the program, it is no longer valid and can create confusion (e.g. "cut" *vs*. "delete" or "leave/exit" *vs.* "home"). Interface elements such as buttons, checkboxes, menus and any other features for performing actions are required to have text labels stating their identity, operation and current state so that users of assistive output technologies can perceive these objects and act on them. If a checkbox is present, a text label must indicate what is being checked, and whether the checkbox is presently checked or unchecked.

Finally, screen reader may not be able to interpret information that applications display in the form of textual schemes or graphics; therefore, text content, text input caret location and text attributes must always be provided through standard operation system functions. Images in motion also often reduce text legibility.

Non-unique method to convey information and allow communication. Using multiple communication codes to convey all the information presented is the only way to ensure that it will be perceived by all users: visually impaired people may rely (totally) on audio output to perceive information conveyed in text and graphics, while users who are deaf or hard of hearing may need visual representation/transcription of any audio material in an application. Programs in which buttons for activating different functions are practically identical in all aspects except for colour can pose problems for partially sighted users; thus, some other method of identification needs to be adopted, such as text labels.

Audible information also needs to be considered with special attention. When audio outputs are used to alert the user to an event (e.g. an error beep) or for providing feedback (e.g. a countdown, a timer, a spoken encouragement), a visual or textual equivalent should be available to convey the same information. .

IV. ARE SPECIFIC ACCESSIBILITY REQUIREMENTS NEEDED FOR EDUCATIONAL PRODUCTS?

As well as establishing general requirements for ICT tools, the Stanca Act explicitly puts forward the need to define specific rules for "*gli strumenti didattico-formativi*" (educational multimedia products).

In the following, on the basis of the research work carried out by the authors, some reflections are proposed leading to the idea that when dealing with educational ICT tools the list of accessibility requirements for standard ICT tools should be modified and integrated.

First of all in this case, for each requirement, the addressed disabilities (not mentioned in the Stanca Act, nor in Section 508) needs to be explicitly mentioned and taken into account; some products, in fact, that pose access problems to some categories of students with disabilities nonetheless present educational content which is, per se, meaningful to that category.

In principle, for instance, products which are difficult for dyslexic students to access can be suitable or even valuable for mainstream students, and adjustments made to meet dyslexic students' needs may result in a loss of educational potential for other students: e.g. activating a spelling checker for exercises with written answers will help dyslexic students but result in a loss of educational value for others, especially where the actual learning goal of the activity is to practice spelling.

As another example, one of the basic provisions of both the Stanca Act and Section 508 states that software products must take colour blind students into account and suggests avoiding the use of colour alone as a means for conveying information. This requirement cannot be applied to educational products devoted to developing the basic ability of colour recognition or to discover optical phenomena (e.g. some of the basic properties of light), where the educational tasks itself are colour based. To take a further example, Fig. 2 shows the screenshot of an educational software application where coloured pigment squares can be mixed by students in order to discover the properties of mixing pigments.

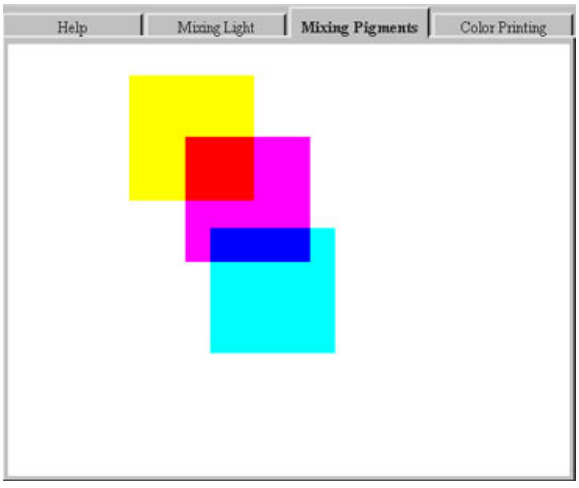

Figure 2. Screenshot of the educational software "Colour and Light" by Phillip Dukes of Brigham Young University.

As a further example, one of the basic accessibility principles entails the labelling of all software audio elements. However, products aimed at teaching foreign languages that present unlabelled dialogues should not be rejected out of hand as they can be used by all disabled students other than the hearing impaired. It is evident that, from a strictly educational perspective, the learning of pronunciation (and listening comprehension) is strongly supported by audio presentations mainly if they are not backed with specific labels.

Accessibility evaluations of educational products, in the case of lack of perfect compliance with the accessibility requirements should clearly indicate 'for whom' each product is not fully accessible, otherwise modification in compliance with accessibility requirements would result in a loss of educational value for most students.

Consequently, coming back to the general requirements for ICT tools, such examples suggest that a '*minus*' sign should be added to the presented list of accessibility requirements for ICT tools when dealing with products which are expressly conceived and designed for educational purposes. This entails a conscious decision to overlook some requirements when evaluating software in which accessibility problems are limited to aspects with specific intrinsic educational value.

Looking at the matter starting from a different viewpoint we, conversely, should also add a *'plus'* sign to the above mentioned list, that is further requirements should be added.

Indeed, in the case of educational products, the word 'accessibility' refers not only to the possibility of physically using (accessing) the tool, but also to the possibility of learning by using the tool, namely accessing, comprehending and learning the educational content presented.

Educational products, for instance, often need specific customizations in order to guarantee full access to all the educational contents: this is the case of timed reading tasks for practising writing and spelling or even reading comprehension. Fig. 3 shows a screenshot of an educational program where the student must read the word that appears and then rewrite it. In this case, the reading time can be personalized by moving the blue slider on the left-hand side (getting longer towards the turtle, or shorter towards the hare). Such a possibility to customize the time constraints appears to be very important since here the problem is not only 'accessing the page to be read' but also and mainly 'reading the word/s, grasping the meaning and using it to perform the final task.

As further examples for the need of some additions to the list of accessibility requirements we can consider that:

- educational programs that ask students to input new texts should also provide a spell checker feature that suggests additional spelling choices before negative feedback is given on the whole activity; this could have significant impact on users with language and learning difficulties, such as dyslexia and, in many cases, the actual availability of a spell checker represents the only possibility for them to perform the same tasks as their schoolmates;
- educational programs that entail the writing of complex notation (e.g. software applications for physics, mathematics, chemistry) should also provide text features for easy input of non-standard character types or graphics read out by assistive technologies (this might be relevant to users with visual or physical impairments).

Figure 3. Screenshot of the educational software "ELSE" (Didael) showing a timed reading task.

V. Conclusions

Examples and field experience support the idea that there is a need for specific accessibility standards applied to educational ICT tools.

Leaving aside the point of view of software producers and creators and taking that of teachers/educators who need to choose accessible products for classroom use, we better understand that such products show a meaningful number of specific aspects.

In order to choose effectively from the range of products available to them, educators must take into account the compliance of each product with mainstream accessibility requirements but, in addition, they also need to consider the addressed target population, the type of educational content conveyed and the global educational meaning, impact and effectiveness of the product.

When gauging the accessibility of educational products, compliance with the requirements for mainstream ICT tools should be considered, but attention should be also paid to evaluate this in the light of the educational objectives to be met. For instance, it needs to be made clear to potential users that a conflict[11] between one of the accessibility requirements and a product's specific educational objective does not influence the educational effectiveness of the product itself for students other than those addressed by the specific requirement (e.g. any exercise of colour recognition is, per se, in conflict with requirements

[11] 11 Educational Issues for Students With Disabilities - Educational Software
http://ncam.wgbh.org/publications/adm/education.html

addressing the needs of colour blind students, but nonetheless has an intrinsic educational value).

Undoubtedly, consideration also needs to be made of the extent to which non-compliance with one of the requirements affects overall product accessibility for students with disabilities (i.e.: "Is it a minor aspect limited to few functions / pages / exercises, on that is didactically irrelevant, or does it seriously and deeply affect product use?").

Furthermore, additional non 'mandatory' features which may give added value to educational products should also be regarded as important (such as the possibility to customize timed presentations, character size, access to instructions, personalized hints, etc.).

Existing standards are mainly focused on technical aspects and have been expressly conceived to address design and implementation priorities. Embracing the point of view of educators seems to open up new perspectives and there is a strong case for modifying standards to take account of these concerns.

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