Bridging the concepts of Educational Software and Assistive Technology

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ABSTRACT

The paper looks at the educational resources available for students with disabilities. It aims at defining the boundaries and interconnections between the concepts of assistive technologies and educational software, starting from the consideration that students with disabilities could highly benefit from the adoption of both these categories of tools. Here the question arises of whether educational software products can be considered *per se* as assistive devices or, if not, under which conditions. The paper explores the matter, with the specific objective of providing teachers and educators with a conceptual key to properly explore the specific databases containing information on the educational available tools and, finally, to find the needed, suitable material for students with disabilities. The creation of the European ETNA portal for assistive technologies represented the occasion for starting the reflections reported in this paper and for defining a specific methodology for the introduction of educational software in disability-related databases. The ETNA portal itself, whose aims and foundations are also briefly described, coherently instantiates the adopted methodology by referring to the emerging concept that educational software can be considered and adopted as an assistive device for learning, provided that it meets key accessibility requirements and/or that specific practices with disabled students are fully documented and reported.

Keywords: Educational software, Assistive Technology, Inclusive learning, Documentation system, Disability.

1. INTRODUCTION

It is very important that teachers and educators of students with disabilities are able to take an informed decision about the products to be adopted in their educational practice (Ribeiro et al., 2010). To this aim, they have at their disposal a variety of educational databases and catalogues that can provide them with suitable and exhaustive information about the available products and, their relevant features. But guidance on how to make this choice is still needed and some inter-related concepts are to be clarified; for instance, a clarification on the concepts of Educational Software and of Assistive Technologies (AT) is required (Stumbo et al, 2009). Are these concepts fully detached and divergent or to some extent overlapping? Should we consider all educational software products as educational aids able to help, sustain and foster learning? For which types of students with disabilities this is true? Should the teacher of students with disability solely rely on the use of educational software products or should they also look for assistive technologies allowing the use of software packages?

From the very beginning (around years 1995-98) of the EU community efforts to build up a database of assistive technology products with the HANDYNET database in the framework of the

"HELIOS programme[1]", educational software products were included in the archives and fully considered assistive devices for education.

As a matter of fact, the use of appropriate educational software products (i.e.: all ICT-based products expressly designed for educational purposes, aimed to sustain and enhance learning/teaching processes) can highly enhance the learning possibilities of students with disabilities (Dettori & Ott, 2003).

Unfortunately, in contrast with the widespread principle of e-inclusion (UNESCO, 2005) and of Universal Access to education (Ott, 2011), the use of such digital resources can be challenging for some students with disabilities (Klironomos et al., 2006). Nowadays this aspect assumes increased relevance, since the newest software products rely more and more on images, motion, voice, special effects, three- dimensionality, leaving aside the basic principles of Universal Design (Burgstahler, 2006), hence preventing students with special needs from using the same materials as their schoolmates. This dramatically limits their educational opportunities and, finally, contributes to their "exclusion" (Benigno, Bocconi, Ott, 2007). The availability of dedicated tools and devices such as special keyboards, screen readers, speech synthesizers, etc. plays major role in widening access to software products but *per se* doesn't completely solve the problems related to the huge variety of different accessibility problems that can be encountered (Croasdaile et al., 2011; Hitchcock & Stahl, 2003).

Actually, the accessibility of e-tools is a multifaceted, complex issue that calls for an in-depth examination not only of the software features but also of its educational contents, interaction methodology and cognitive implications. Several authors have tried to capture and model the different accessibility dimensions. Dettori and Ott (2003) argue that three different areas of accessibility should be taken into consideration, concerning material (or physical), cognitive and socio-cultural accessibility. In a seminal paper, Kelly and colleagues (2004) argue that there is a need for assuming a wider perspective that goes far beyond existing approaches and specific guidelines. These authors propose a holistic model for e-learning accessibility which takes into account the usability of e-learning, pedagogic issues and student learning styles. Cullen and colleagues (2009) maintain that a key factor promoting positive learning outcomes is how well the needs of users and the technological and pedagogical choices made fit together. This last point has been further discussed by Bottino and colleagues (2011) who highlight the need to support teachers in the setting-up of pedagogical plans, which both serve the purpose of describing educational itineraries and understanding conditions under which the educational use of ICT-based products can be genuinely meaningful and productive for all the students. Foley and Ferri (2012) put forward this perspective by offering a vision of *accessible technology*, as opposed to assistive technology and highlight the need to understand disability and technology more fluidly and responsively, thinking about technology for *people* rather than for disability.

Coming back to our central point: if it is true that the concept of Assistive Technology encompasses "any item, piece of equipment, or product […] used to increase, maintain, or improve functional capabilities of individuals with disabilities" (Berhmann, 1998) can educational software can be considered to all intents and purposes as Assistive Technology supporting learning?

In the following it is argued that this is true when two conditions are in place: either the educational software is accessible (i.e. meeting accessibility requirements); or, alternatively, detailed descriptions of significant experiences and best practices focusing around the use of educational software products as a means of supporting inclusive practices are available.

Within the context of the ETNA project – a European Thematic Network aimed at implementing a EU-wide Portal devoted to ICT-based assistive technologies, an innovative approach has been adopted in order to combine the two concepts of educational software and AT for learning. In the ETNA portal only those educational software products that meet the most relevant e-accessibility

[1] http://europa.eu/rapid/press-release_IP-91-179_fr.htm and http://www.politicheeuropee.it/banche-dati/10411/helios?print=1

requirements and/or whose effective adoption by students with disability has been proved and reported.

In the following, we begin with a brief description of the ETNA project, which provides the context of the present work. We then discuss around the accessibility of educational software by reflecting on aspects to be taken into consideration. Subsequently, we present and discuss a methodology for fully documenting the features that make educational software an AT for learning and finally, we present an example of a suitable methodology for documenting experiences of use of educational software with students with disabilities.

2. ETNA: A EUROPEAN NETWORK ON ASSISTIVE INFORMATION TECNOLOGIES AND E-ACCESSIBILITY SOLUTIONS

ETNA is a thematic network funded by the European Commission under ICT PSP action of the Competitiveness and Innovation Framework Programme (CIP). Started in January 2011, ETNA aims at implementing – over a period of three years – a *European Web Portal* providing information on *ICT-based Assistive products* and *e-Accessibility solutions* which are available in Europe. The intended audience includes various stakeholders, such as end-users, professionals, manufacturers/suppliers, researchers/developers and policy-makers (http://www.etna-project.eu). In particular, main objectives of the ETNA projects include:

- Providing transparent and easily available information on AT and accessibility products and services offered across Europe, thus empowering citizens with a disability in relation to the knowledge and the choice of assistive technologies;
- Initiating an interdisciplinary and trans-national community of expertise involving academics, industrialists, professionals in health care and education, end-users, researchers and developers, with a great potential to improve exchange of knowledge, ideas and thus boosting the development of assistive solutions at various levels (especially open source software);
- Promoting a unified AT and accessibility market, thus helping companies - especially SMEs, who dominate in this area - to benefit from huge market potential.

Co-ordinated by the Centre for Innovation and Technical Transfer (CITT) of the Don Carlo Gnocchi Foundation (Italy), the project consortium currently involves 23 leading Organizations in the ICT-AT area at national or international level, across 13 European Countries. Given that knowledge and expertise in the field of ICT-AT are often scattered throughout highly specialized Centres, ETNA also works in collaboration with ATIS4All (*Assistive Technologies and Inclusive Solutions for All* project, another Thematic Network belonging to the same cluster) in order to ensure a wider circulation of information on the products available among different stakeholders.

The ETNA Portal – expected to be released at the end of 2013, will evolve from the current EASTIN system (www.eastin.eu) with the name *EASTIN 2.0 portal*. It will include the ETNA information system – a search engine that aggregates information from various providers and repositories – and a community connecting all stakeholders. Implementing the information system is responsibility of ETNA, while the community is responsibility of ATIS4ALL. The first prototype of the ETNA information system (http://test.eastin.eu) has been released on January 31, 2013 and it is currently being under validation within the ETNA Consortium.

Some unique features of the ETNA/EASTIN engine will be instrumental in ensuring outreach across Europe. These include full multilingualism for all EU languages; the ability to integrate an unlimited number of different information systems, and the flexibility to cope with the temporary unavailability of any such system (Figure 1). On the other hand, the ATIS4all Consortium is developing Web 2.0 applications to generate an active online community, including tools for open discussion among users, professionals and all stakeholders involved, and a facility for rating and commenting products.

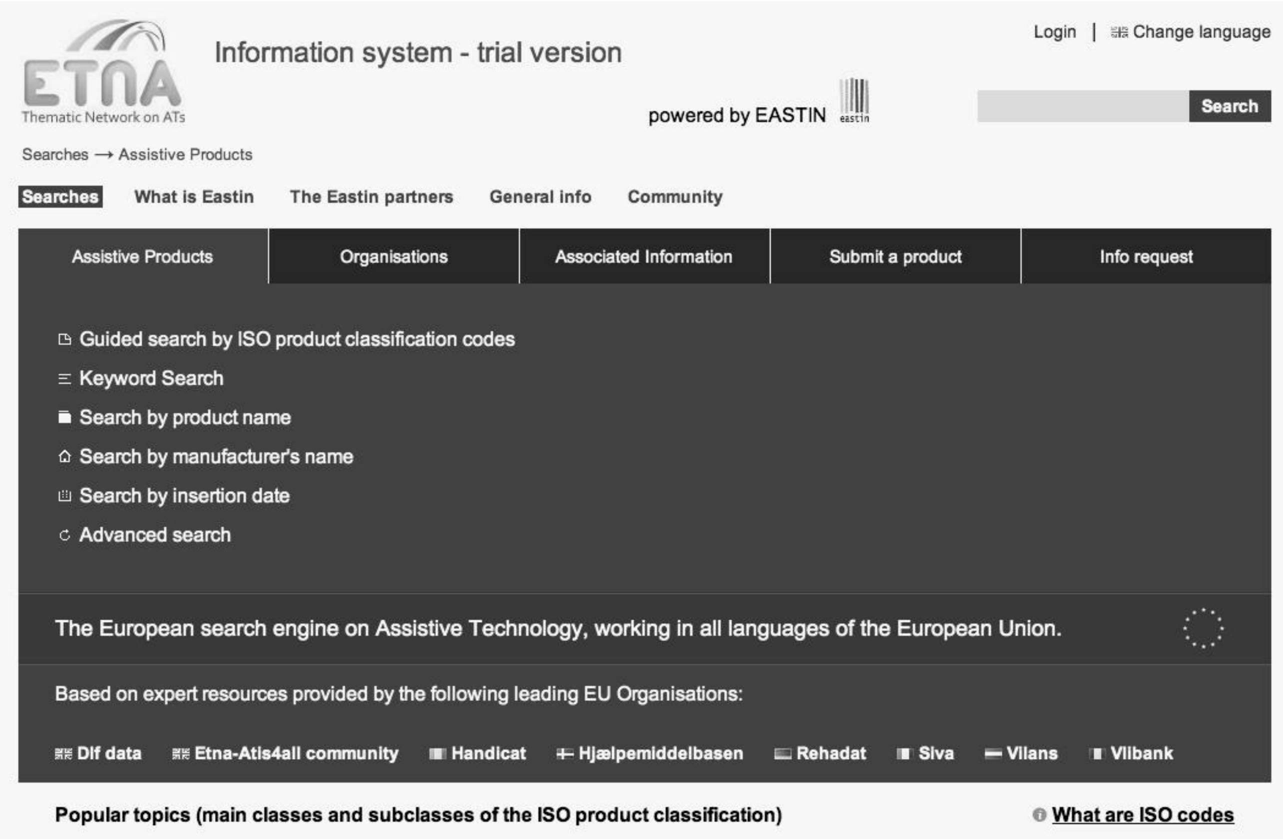


Figure 1. The ETNA Information system - First prototype

As the success of the Portal strongly depends on how far it will meet the various actors' information needs, this calls for a detailed understanding of the specific topics to be covered, as well as of the type, depth and format of the information to be provided (Andrich, Gower and Vincenti, 2012). To this end, the ETNA consortium has developed a map of the information needs of all the stakeholders concerned with ICT-based assistive and e-accessibility solutions. The target groups range over a wide variety of actors, dealing at various levels with ICT AT: end-users, family members and primary caregivers; professionals in health care, social services and education; assessment centres, agencies and officers involved in service provision; researchers and developers; manufacturers and suppliers; policy makers; etc. The multiplicity of actors involved also reflects the variety of topics within the ICT-AT domain and fulfilling.

In this perspective, in the framework of the ETNA project, a discussion emerged about whether the educational software should be regarded as Assistive Technology for learning and thus included in the ETNA portal, in order to fulfill the above mentioned needs.

The key idea underpinning the proposed approach is that educational software can be considered as AT for learning when two conditions are in place: either the educational software is accessible (i.e. meeting accessibility requirements); or, alternatively, detailed descriptions of significant experiences and best practices focusing around the use of accessible software products are available as means to support inclusive practices.

In the following, main issues of the accessibility of educational software are discussed and a tentative answer is proposed to the questions "How can the accessibility of educational software be evaluated? What are the main requirements to be met for an educational software product to be considered accessible?".

3. CHOOSING THE APPROPRIATE EDUCATIONAL SOFTWARE PRODUCTS FOR STUDENTS WITH DISABILITIES

When facing the task of choosing the educational software products to be adopted by students with disabilities, three elements should be taken into consideration (Bocconi, Dini and Ott, 2012): the *educational goals*, the *accessibility requirements* and the *type of disability* (Figure 3).

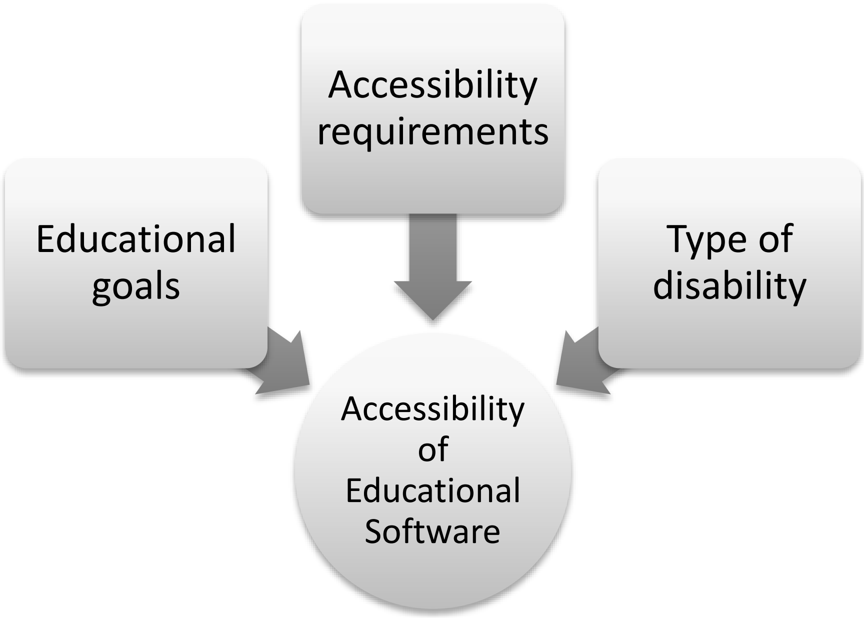


Figure 3. Key elements to be considered when adopting educational software for supporting the learning of students with disabilities

Educational goals. As pointed out before, one of the key specificity of educational products lies in the fact that they include activities that are meaningful in a cognitive perspective and that should result in the attainment of specific objectives (in term of knowledge, skills, competences, etc.). No kind of evaluation of educational products should fail to carefully consider the intended learning goals of each proposed activity. As an example, educational products which present accessibility problems for students with learning disabilities in the field of reading can be suitable or even valuable for most students, and, in turn, adjustments made to meet the needs of students with learning disabilities (e.g. activating a spelling checker for exercises with written answers) may result in a loss of educational value and potential for other students, especially where the actual learning goal of the activity is not respected. The case also exists that the actual lack of accessibility is due to a conflict between legal requirements and software educational goals (Bocconi et al., 2007); for instance, those software products aimed at teaching colour recognition or shape sequencing, propose specific tasks and educational goals that for blind users are *per se* meaningless.

Accessibility legal requirements. In concrete terms, what accessibility problems educational software may present? To take an example, Figure 2 shows a screenshot of a well known multimedia product *Cabri Gèométre II Plus*[2], a dynamic interactive software to learn geometry in the classroom*;* it is meant to involve the learner in a wide a range of various activities, which are, unfortunately, not easily accessible for a wide range of students with disabilities:

- those with motor or visual impairments cannot access the program by using the keyboard or any other alternative input devices different from mouse emulators;
- those with low vision may encounter problems when using some facilities such as magnifiers AT; since such features are not built in the program, they will be able to access

[2] http://www.sd2.itd.cnr.it/cnr_sd2/index.php?PHPSESSID=1bc415a43cd69b7f1f101ce40bf06640&modul=detail&ID=3973

software contents only partially, that is h/she will only see a specific portion of the screen thus missing the overall perspective which is fundamental to reach the educational goals set by the software. Hence, low vision students will be limited in using this software, and consequently their possibilities to reach expected learning goals will also diminish.

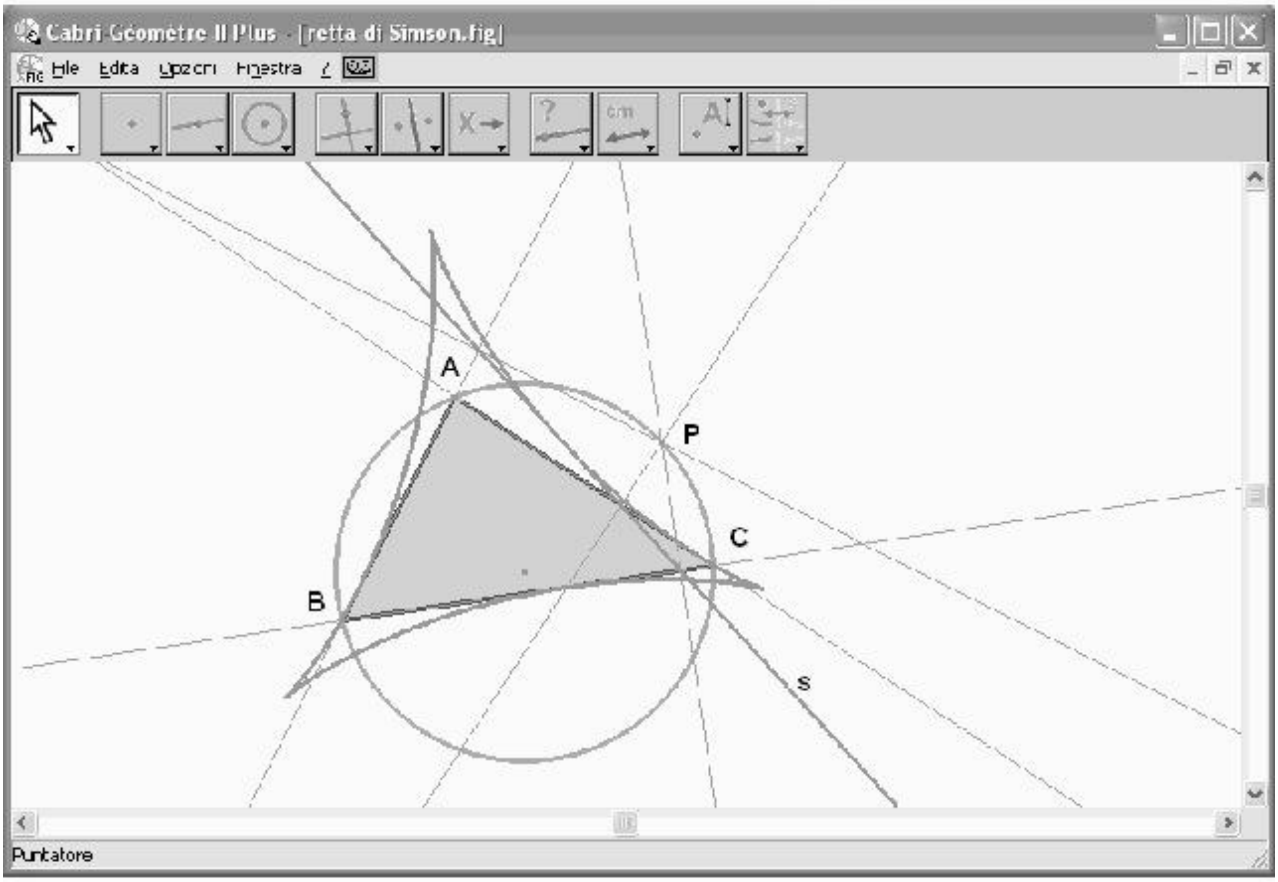


Figure 2. Cabri Gèométre II Plus

In addition, the extensive classroom use of such educational products (which are not fully accessible) prevents students with special needs from using the same materials as their schoolmates; it also limits their educational opportunities and, finally, contributes to their “exclusion” (Benigno, Bocconi and Ott, 2007).

The issue of the accessibility has been addressed at international level, receiving increasing attention and priority in many countries and across multiple scientific disciplines, including education. Accessibility guidelines and legal provisions firstly appeared in Section 508 of the Rehabilitation Act (USA Access Board, 2011) that has strongly contributed to form the legal backbone of accessibility in the American information and communications technology environment. In broad terms, Section 508 specifically directs Federal agencies to provide access to information to people with disabilities equally to the access available to individuals without disabilities (TEITAC, 2008). Concurrent with the development of the Section 508, other international standards and guidelines were inspired by this framework and adopted in many countries. This is the case of the Italian law in force that is fully consistent with Section 508 (CNIPA, 2004). The approach proposed here is framed within the Italian regulation (Stanca Act Law n. 4/2004) about the accessibility of ICT tools. Following the main requirements outlined in Section 508, the Italian law establishes eleven requirements for stand-alone software applications that will be detailed hereunder.

Specific type of disability. It is also important to consider the different types of disabilities one may encounter. This impacts also on law requirements. Table 1 displays the relations between Law 4/2004 requirements and the different type of students' disabilities including: motor disabilities, hearing disabilities, visual (blindness and low vision) disabilities, learning disabilities and cognitive disabilities. As Table 1 shows, the majority of the Law requirements (with the exception of Requirements No.11 dealing with associated printed material) are relevant only to specific types of disabilities. Additionally, in order to facilitate the testing process and to harmonize assessment descriptions, the accessibility aspects to be checked can be grouped into *four* broad areas, grouped in Table 1 and described below (Bocconi et al. 2006).

Table 1. Relation between accessibility Law requirements (Law 4/2004), types of disabilities and accessibility testing areas.

	Area 1	Area 2				Area 3		Area 4			
Law 4/ 2004 / Disability Type	**Req. 1** Keyboard Access	**Req. 2** Facilitated Access	**Req. 3** Compatibility with AT	**Req. 4** Graphic symbol	**Req. 5** Text legibility	**Req. 6** Audio signals	**Req. 7** Non-unique channel	**Req. 8** Display properties	**Req. 9** Flashing elements	**Req. 10** Active Focus	**Req. 11** Supporting documents
Motor Disability	✔	✔		✔						✔	✔
Hearing Disability		✔		✔		✔	✔				✔
Visual Disability (Blindness)	✔	✔	✔	✔	✔		✔	✔		✔	✔
Visual Disability (Low vision)	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔
Learning disabilities					✔			✔			✔
Cognitive disabilities				✔		✔		✔	✔	✔	✔

Area 1. Keyboard access is one of the most important aspects of accessibility. The legal requirement (cf. *Law Requirement No. 1*) demands that there should always be keyboard access to a program's controls and features. This is meant to allow people with special needs who use alternative input devices (e.g. head mouse, tracker ball, etc.) to use the software application. For example, users with neuromuscular impairments may find it impossible to move or hold a standard pointing device with sufficient accuracy to activate desired features. The same difficulties may also apply to a person with a visual disability (e.g. partially sighted) who relies on assistive technologies, such as screen magnifier tools, 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. To grant access to those users, it is therefore of prime importance to verify whether main controls (e.g. menus, toolbars, working spaces, etc.) of a software application have standard keyboard access.

Area 2. As concerns ***compatibility with assistive technology***, users with impairments often use assistive technologies to gain independent access to information. Applications should thus be able to adequately detect input from and return output to assistive technologies; this allows users to perceive the application objects and act on them. As an example, labeling all graphic objects that are available in the software environment allows people with visual impairments using assistive technologies (e.g. screen reader) to perceive the information conveyed. To guarantee consistency and avoid generating confusion, it is also crucial that text labels associated to objects are coherent and consistent throughout the whole application (e.g. using the label “cut” vs. “delete” for the same object). In addition, for the users of assistive technologies to perceive these objects and properly act on them, it is also essential that even interface iconic elements (buttons, checkboxes, menus) have text labels stating their identity, operation and current state (active or not). For example, when a checkbox is present, a text label should be associated to it providing information readable by the assistive technology about whether the checkbox is presently checked or unchecked. Finally, as assistive technologies may not recognize information in the form of textual schemes or graphics, applications should also provide these elements (including text content, text input caret location and text attributes) through standard operation system functions. All these elements are addressed during the practical testing process described above (particularly in relation to *Law Requirements No. 2, 3, 5*).

Area 3. Non-unique method to convey information and allow communication: this refers to the problem of how people with disabilities get information. In order to ensure that all the information presented are adequately perceived by all users, multiple communication codes and channels should be used to convey it (c.f. *Law Requirements No. 4, 6, 7, 11*).

Users with visual disabilities, for instance, can only rely on auditory outputs to get the information conveyed by texts and by graphics; conversely, users with hearing impairments need transcription or visual representation of any audio material available the applications.

In the above-mentioned cases, avoiding the uniqueness of the adopted information channel (e.g. only audio or visual) provides both users with the possibility to access information. In relation to this, audio information also needs to be considered. In particular, visual or textual equivalents should be made available for any audio signals that 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).

Area 4. With respect to the ***legibility of on-screen information*** *(c.f. Law requirements No. 8, 9, 10),* for many users with visual (i.e. the partially sighted) and learning disabilities it is crucial that information displayed on the screen are presented in a clear manner. In relation to this, a software application should thus allow users to personalize display settings such as colour coding, background, contrast, screen and text colours, and font size and type. For those users who activate their preferred settings (e.g. text size, colour background) in the operating system, it is also crucial that those settings are maintained even when the software application is running.

Using flashing and blinking in texts and objects elements can cause problems in susceptible individuals and reduce legibility for users with visual impairments, particularly when the flashing frequency is within a certain range. Hence, it is important that software applications allow the user to deactivate these options.

In order to guarantee that users with physical impairments, or who are partially sighted or blind, can easily move and navigate around the screen, it is crucial that the current on-screen focus point is clearly identifiable at any given time. This implies to express the position of the program’s focus point using codes that can be recognized by any assistive technologies. As an example, users of alternative pointing devices must be able to use them to access the information and to move objects around the screen; individuals who use a screen enlargement program must be able to magnify the focus area to perceive focus point details; users of screen readers and reading assistant technologies must receive operational information so that they can navigate the software environment.

5. DOCUMENTING THE ACCESSIBILITY OF EDUCATIONAL SOFTWARE

As it emerges from what outlined above, one of the key issues to be considered is the accessibility of the educational software products, but how should this kind of information be structured and presented so to effectively help teachers and educators to make an appropriate and suitable choice?

In the following, ideas and observations about what elements should be documented in relation to educational software as AT for learning are proposed coming from the experience carried out in the framework of ESSEDIQUADRO, Italy's leading online catalogue of educational software (http://sd2.itd.cnr.it) which will also meet the ETNA portal.

ESSEDIQUADRO (SD2) is an online service providing comprehensive information on over 4000 educational software products from both Italy and abroad. Since 1999, ITD-CNR has been running SD2 under the auspices of the Italian Ministry of Education, University and Research (ITD-CNR, 2011).

At the heart of SD2 is a searchable catalogue listing educational software for all school levels and disciplines, with particular attention to special education needs. The system also offers support and guidance for integrating software and multimedia into the teaching / learning process: subject area software surveys, classroom reports, and more. Each software product is described in a sheet that comprises a number of pages with different contents: general information about the product (author, cost, availability etc.), educational information (subject area, topic, target users, educational strategy, pre-requisites etc.), summary of contents. The product system requirements are also listed and a few screenshots are available so that user may get an idea of the software interface (images).

In the framework of the Ministerial program on "New Technologies and Disability" an "Accessibility" sheet has been added to the description of each educational product in order to provide users with the possibility of being aware of software accessibility features. The actual "Accessibility" page of Essediquadro implements the conceptual approach and tools described above.

The sheet includes four main sections:

1. *Suppliers/author's self-declaration*
2. *Evaluation of compliance with legal requirements*
3. *Evaluation of the level of accessibility with respect to the different types of disability*
4. *Results of field-testing.*

Figure 4 shows the accessibility page of the SD2 system, where the black arrows underline the four different fields listed above, which of course can be further exploited to access the full documentation.

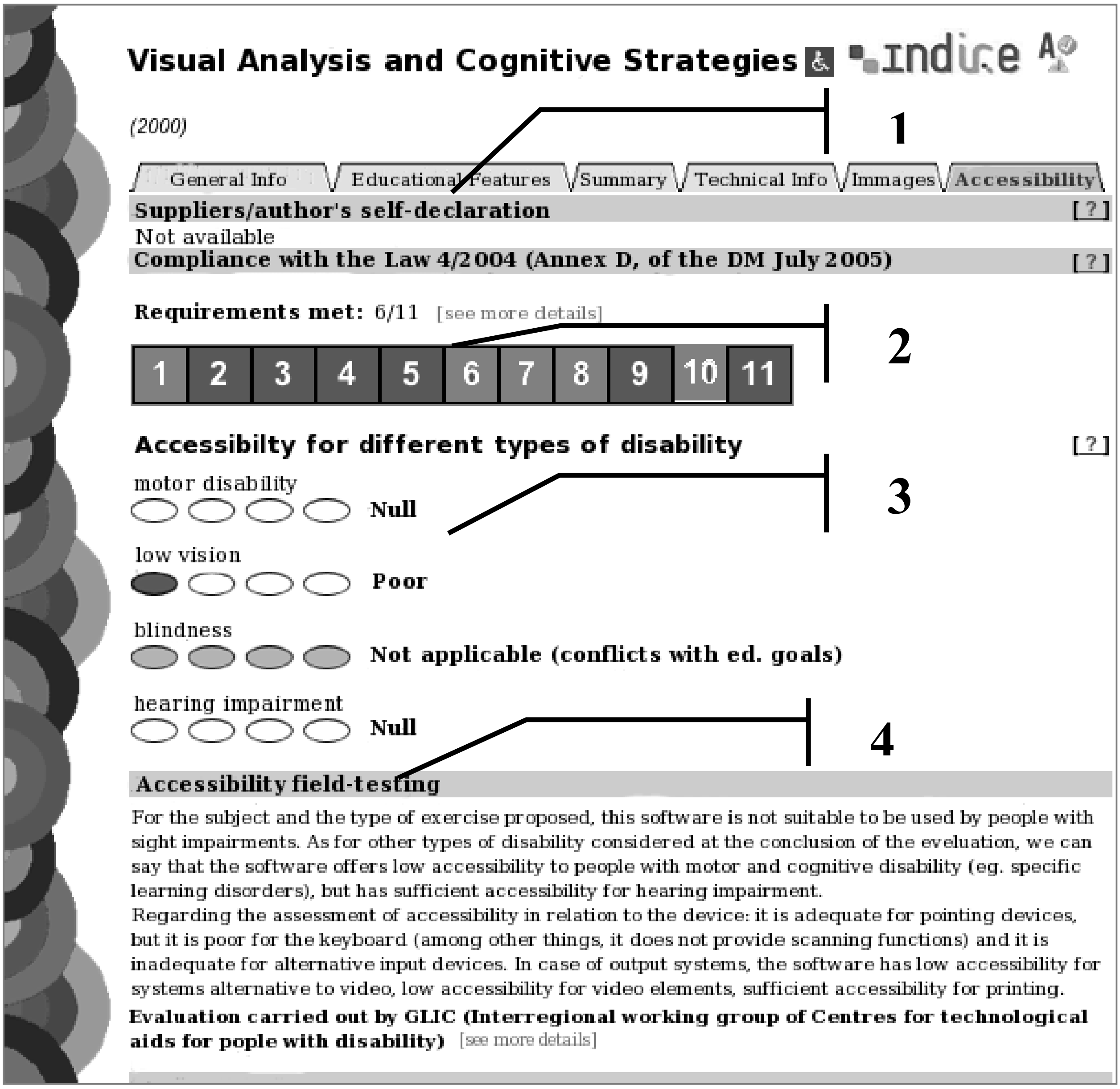


Figure 4. The standard "accessibility page" of the SD2 edu-software documentation system.

1. Self-declaration provided by suppliers and authors. In this specific section, Essediquadro recalls directly what the authors/ publishers officially say about the accessibility of their products. According to the Riga Ministerial Declaration on Inclusion (European Commission, 2006), in fact, software authors and/or suppliers are entrusted to clearly state whether or not (and to what extent) each software product responds to the accessibility standards. Unfortunately, nowadays only very few multimedia educational developers provide such documentation.

2. Evaluation of compliance with legal requirements.This section outlines the main results of the research efforts conducted at ITD for the design and application of an ICT-based grid (developed for this purpose by ITD- CNR) aimed at evaluating the accessibility of educational software (Bocconi et al., 2006). The grid is shaped along the Italian law in force: Law no. 4/2004 (also known as "The Stanca Act") which was followed by the Ministerial Decree (DM) 8 July 2005. Eleven requirements for both commercial/non-commercial "on the shelf" software are indicated in the DM, following the main requirements outlined in Section 508 of the Rehabilitation Act of the US Federal Government (USA Access Board, 2011).

Under this section, Essediquadro presents the data resulting from testing the compliance of each educational software product with the eleven accessibility requirements of the Italian Law (Figure 4). This analysis is carried out by expert evaluators using methodologies and tools designed and implemented, in the framework of the research project by ITD-CNR (namely the above mentioned specific evaluation grid). It is worth remembering that while the methodology adopted in Italy to carry out this type of evaluation (compliance with the national law in force) can easily be transferred to other national contexts the actual contents of the evaluation (fields of the grid) may vary according the differences of the national laws in force and related requirements.

As shown above in Figure 4 the results of the evaluation process are expressed in terms of numbers of requirements actually met (out of the eleven indicated in the DM): for instance, the result of 6/11 represented in the figure means that the product respects only 6 requirements of the regulation in force.

For a better understanding, details of which specific requirements are/are not met are also provided as shown in Figure 5.

Details of compliance with the Law No 4/2004

Evaluation carried out on Windows operating systems (XP) and/or Linux (So.Di.Linux DVD) and assistive technology Jaws (vs.7.1) Evaluation completed on 27.7.2009	**Law Compliance**	**Disability** Motor Dis.	Hearing Dis.	Low vision Dis.	Blindness
Law Requirement No 1 [see more details] *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.*	✗	●		●	● **CO**
Law Requirement No 2 [see more details] *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.*	✓	●	●	●	●
Law Requirement No 3 [see more details] *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.*	✓			●	●

[More Requirements]

Figure 5. Details of compliance with the law in force.

3. Accessibility for different kinds of disability. Assessing and documenting the compliance of each product with the regulation in force is, of course, important but it is not enough to give an effective answer to all SD2 potential users. Typically educators ask for an answer to the question: “Is this product accessible for deaf (or blind, or dyslexic, etc.) students?” To answer this question, the methodology set up in Essediquadro draws on the correspondence between the law's requirements and each specific type of disability: if a product is not fully compliant with all of the eleven accessibility requirements, further information is supplied about the specific target for whom that product is not accessible (and, conversely, the eventual full or partial accessibility for other categories of disabled students is underlined). As an example, the product considered in Figure 7 appears to be fully accessible (compliant to all the DM requisites = all green circles) by motor and hearing disabled students while results scarcely accessible by sight impaired and partially by low vision students.

Figure 6. Sheet showing the level of accessibility with respect to the different types of disability.

To be more precise, Essediquadro also highlights whether there is a potential conflict between the educational goals of the application and a specific type of disability: this happens when using a product can be considered nonsense for a specific category of disabled students (i.e. most products aiming at teaching/supporting/practicing colour recognition skills are per se useless for blind students and investigating their accessibility for this category of disabled students can only be a waste of time).

Within the Essediquadro Accessibility page, the grey-coloured circles (Figure 8) alert users that the evaluation of such a product's accessibility features is not meaningful for that type of disability because of the mentioned conflict between legal requirements and the intended educational goals (Bocconi et al., 2007).

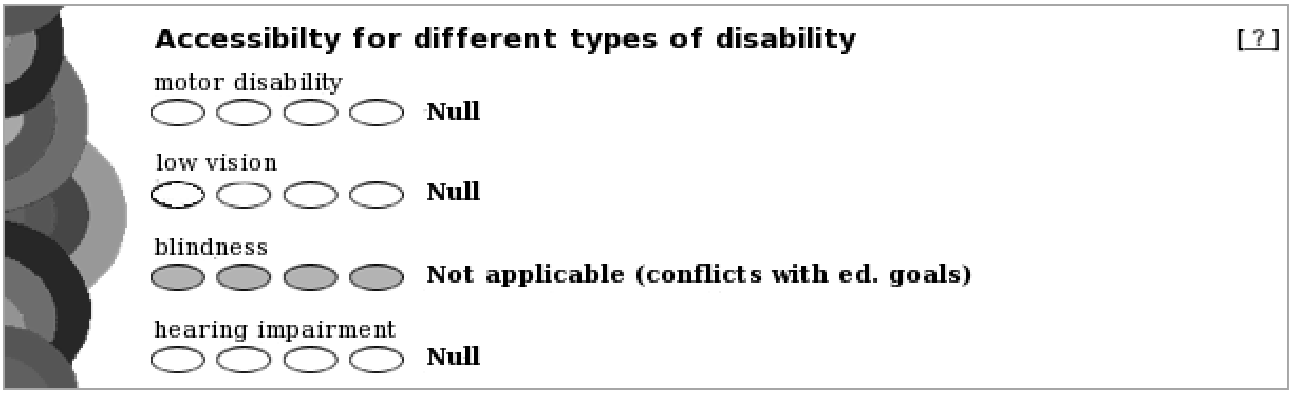


Figure 7. Sheet showing the level of accessibility by type of disability.

As an example, one of the basic accessibility requirements foreseen by the Italian law entails the labeling of all software audio elements. However, educational products aimed at teaching foreign languages that present unlabeled dialogues should not be rejected out of hand as they serve a precise and very specific, educational objective (listening comprehension) and, furthermore, can be used by all disabled students other than the hearing impaired. Listening comprehension exercises are, of course, fundamentally based on audio presentations but they also require that such audio presentations are not backed with written labels, which may change the activity focus. Summarizing: Essediquadro, in case of lack of perfect compliance of a product with all the accessibility requirements indicates 'for whom' (type of disability) each product is not fully accessible and also indicates if there is a conflict between legal requirements and software educational goals and/or between legal requirements and educational activities cannot be performed by (are nonsense for) different types of disabled students.

4. Field testing outcomes. Thanks to the support of the Italian network of clinical centres specialised in the field of technological aids (GLIC- Gruppo di Lavoro Interregionale) the data on accessibility provided in Essediquadro also include information about the actual usability of software products and about their compatibility with the main assistive devices. In order to perform the evaluations, GLIC researchers constantly monitor the performances of some end-users while using specific educational software applications (often in conjunction with assistive devices); during the working sessions, they constantly take notes about software compatibility with specific assistive devices, record the obstacles encountered and the possible solutions, if any.

6. DOCUMENTING SIGNIFICANT EXPERIENCES OF USE OF EDUCATIONAL SOFTWARE SUPPORTING INCLUSIVE PRACTICES

A good and exhaustive documentation of inclusive practices enacted by means of educational software offer further ground for reflecting on the learning processes involving students with disabilities; it can also be a key for the successful deployment of educational software to support the learning of disabled students (Seale, 2006). The added value of such documented activities lies in the possibility to gain a deeper understanding of educational activities and multiple field experiences (i.e. informing about what has already been done in this field and how). This often entails to adopt innovative educational approach, as well as to take into account new aspects of the educational resources; the documentation of such experiences should then be clearly and exhaustively proposed.

In the following, an experience of usage of a software environment with students with disabilities is described (Source: http://sodilinux.itd.cnr.it/zoomlinux/scheda.php?stile=cl&id=5232).

<table>
<tr><th colspan="2">Ksudoku</th></tr>
<tr><td colspan="2">Description</td></tr>
<tr><td>Subject area: Logic and Mathematics

School Level: Lower and Upper Secondary</td><td>Pedagogical Strategy: game-based learning

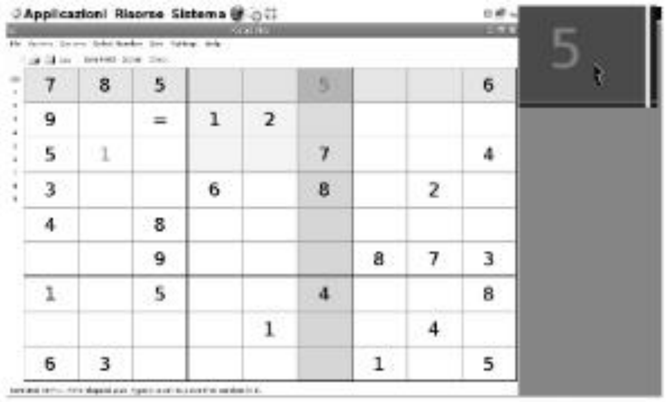
Language: English</td></tr>
<tr><td colspan="2">Summary</td></tr>
<tr><td colspan="2">This software fully features the traditional Sudoku game. The user can choose to play using either the 3D-version (consisting of a cube) or the classical 2-dimensional version (rows and columns): the level of difficulty is very different, not so much from the theoretical perspective (compared to the strategy of solution), but rather from a visual-spatial point of view. In fact, the 3D version is not easy to navigate and it also requires the user to perform more complex operations with the mouse in order to "move" the cube that contains the numbers on all its sides. The user can choose between four difficulty levels, including: to work in base 9 (each "square, each row and each column contains 9 boxes), or 16 or even 25, as well as to define some characteristics in the initial configuration. Using the "GiveHint" option, the software can also provide suggestions, i.e. placing a number on the chessboard in a random position, regardless of the position that the user was analyzing. However, greater educational value is provided by the following three working options. Firstly, the "show tracker" allows to focus on the box taken into consideration, colouring in a different way the row, the column, the section and the box itself; however, this mode, aimed to attract user's attention, can make the viewing more difficult if the mouse is moved quickly on the screen. Secondly, each time the user enters a number, the "Guided mode" indicates if the number is wrong (i.e. coloring it in red) or correct (i.e. coloring it in gray). Numbers in black are only those visualised at the starting of the game. Thirdly, the option "Only-mouse superscript mode" allows to type several numbers in the box at the top of the window, so as to encourage the formulation of hypotheses. Numbers can be entered both by the keyboard and the mouse (the mouse allows also to choose the numbers displayed on the left side of the box or included in a menu list).</td></tr>
<tr><td colspan="2">Experience of usage with students with low vision</td></tr>
<tr><td colspan="2">This software includes many features (e.g. keyboard access, display customization) that address the diverse needs of vision, thus giving the user a wide chance to play smoothly.
The educational activity, intended to promote logical reasoning, is mostly based on visual observation and memory skills needed to decide where to place the numbers and mentally anticipate how the game scenario changes after each entry.</td></tr>
</table>

Hence, although the overall accessibility requirements of this software are limited (only 8 out of 11 legal requirements are met; cfr. *Accessibility Focus* below), this software can become accessible to students with low vision by changing the window size, which modifies the grid size and the characters themselves thus making the use of the magnifier less necessary. For those students who have difficulty in colour perception, it has proved effective to not use the suggestions in red; for students who have poor contrast sensitivity, it was useful to avoid the use of bars of different colours that usually serve as guides to the insertion point (and which are, however, optional). In order to facilitate access to those students who find it hard to focus on details in crowded screens, it was possible to reduce the number of squares and set up proper dimensions (see screen shot 1). The use of the magnification was not essential but it can be especially convenient for viewing the initial menu choice, to increase the perception of contrast (especially when used with inverted colors) and to see the smaller numbers; the user can place the magnifier in the corner of the boxes as a reminder or to try alternative solutions (see screen shot 2).

Therefore, in order to use ksudoku software with students with low vision, it is important both to properly set up display parameters based on user specific needs and to instruct the user to enter / edit the numbers using the preferred input system.

Software screen shots

Screen shot 1: Visualization of normal screen with reduced the number of squares



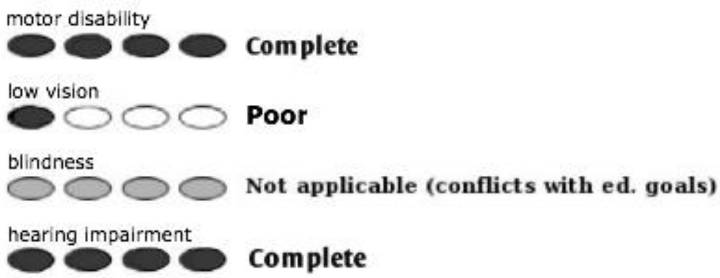
Screen shot 2: visualization using the magnifier (sized as a small box and negative color).

Accessibility focus

Compliance with the Law n. 4/2004 (Annex D, of the DM July 2005)

Requirements met: 8/11 [Met requirements:1, 2, 4, 6, 8, 9, 10, 11; not compliant: 3, 5, 7.)

Accessibility for different types of disabilities



CONCLUSIONS

In this paper we have briefly discussed around the concepts of educational software and assistive technologies with the final aim of defining whether educational software products should be included in assistive technologies databases or not. We have argued that in order to be regarded and classified as assistive technologies, educational software at least 1) should meet the basic accessibility requirements or rather 2) should have been employed in well documented field experiments involving students with disabilities (so to allow reusing the adopted working methodology).

We have then provided some examples of how can accessibility-related issues be treated in databases dedicated to educational software and of how experiences of use of educational software can be described so to instantiate its usability (and possibly effectiveness) with disabled students.

This approach is meant to sustain teachers' and educators' choice of the most appropriate educational material for students with disabilities and, in a larger perspective, it was also targeted to sustain a wider spreading of the culture of universal access to knowledge and education (Meyer, et al., 2006).

In today's society knowledge is felt as one of the most important assets (Sharma et al., 2010). Contributing to building a knowledge culture is crucial to support development and innovation processes in a variety of contexts (Bakry & Alfantookh, 2010), but it also implies acknowledging the idea of cultural "pluralism", thus also advocating for the recognition of the specific, individual rights of all people (Bakry & Al-Ghamdi, 2011).

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