7

Designing E-Learning Collaborative Tools for Blind People

Maria Claudia Buzzi[1], Marina Buzzi[1], Barbara Leporini[2] and Giulio Mori[1]
[1]*IIT – CNR, Pisa*
[2]*ISTI – CNR, Pisa*
Italy

1. Introduction

The basic principle of e-learning is to achieve personal learning goals by acquiring skills and knowledge through computers or other network-enabled systems. The use of computers and the Internet have changed classic methods of teaching and learning, introducing the concept of distance learning as a great opportunity for studying unfettered by constraints of time and space. Although information and communication systems are helpful for implementing both the learning and teaching processes, e-learning is not merely a trivial way to transfer knowledge using electronic devices (computers, smart phones, mp3 players, etc.) while relying on the network and Web user interfaces. According to the recent concept of third-generation distance learning, the active participation of students in the formative process is an important factor in the personal learning phase (Beard & Wilson, 2002; Kolb, 1984). E-learning is a great opportunity to move from old traditional systems towards more effective and efficient methods for acquiring and transferring knowledge beyond the traditional classroom environments, adapting to the modern life and new technologies.

In addition, acquisition of new skills and knowledge is not only affected by an individual's mental schemes or beliefs, but also by their interaction, cooperation and collaboration with others (Merrill, 1991). Communication and social collaboration are crucial for generating the best learning environment. In the learner-centred model, students assume the most important role while teachers investigate and experiment more interesting and interactive ways of teaching. Another important aspect is personalization of rhythms of studying, according to student abilities.

Unfortunately, learning tools and collaborative tools in general are not always designed to be effectively used by blind users, who generally interact via an assistive technology, a screen reader, using a vocal synthesizer and only the keyboard. For instance, collaborative editing of documents could be very difficult or not usable at all for blind users if: 1) they are unaware of other users' changes; 2) the formatting toolbars and other interactive elements like menus are difficult or impossible to access; 3) the list of documents is not quickly available (Mori et al., 2011).

In this chapter we will analyze e-learning collaborative and alternative tools in the learning environment, following the new paradigm for personalized acquisition of knowledge, in order to suggest basic guidelines for making effective and improving the interaction for blind people. We will present the possibilities and advantages of e-learning, focusing on its challenging opportunities for the blind. We will describe how blind people interact with interfaces using a screen reader with a voice synthesizer (as output modality) in combination with a keyboard (as input device). In addition, we will propose suggestions for improving the design of more effective tools to facilitate collaboration and blind users' interaction and personalization. Finally, we will supply two examples of the new paradigm of learning: 1) the design of more accessible interfaces of a Web editing collaborative tool, interacting with a screen reader and 2) a Web system to personalize learning by blind students using an mp3 player.

Generally, active participation and collaborative interaction can improve the learning experience, so the full support of screen reader users in e-learning collaborative user interfaces (UIs) could also improve interaction and learning for blind people.

2. Related works

E-learning has become a hot research topic in recent years. Usability of e-learning systems and objects is a primary focus of research in this field. E-learning users can vary significantly regarding differences in learning strategies, know-how, experience, motivation to learn, user age and ability. If appropriately designed and implemented, e-learning systems are more effective and useful than classroom learning (Debevc & Bele, 2008). However, interactive learning is still difficult for persons with disabilities who use assistive technologies. Various studies focus on the usability of e-learning systems and some also include a general discussion on accessibility, but to our knowledge only a few focus on totally blind persons (especially considering collaborative tools). In (Ardito et al., 2005) the authors outlined a methodology for the rigorous evaluation of e-learning applications, but accessibility for disabled students is not analyzed. Sloan et al. proposed a holistic approach to treating accessibility. They believe that the goal of universal accessibility on the Web is inappropriate, and that instead it is necessary to explore multiple routes to equivalent experience (Sloan et al., 2006). Furthermore, Zaharias critically examined the usability of e-learning applications and proposed the student's intrinsic motivation to learn as a new usability measure (Zacharias, 2006). Developing a usability evaluation method based on a questionnaire, he carried out two large empirical studies showing the reliability of this approach. As Kelly et al. argued, rather than demanding that an individual learning resource be universally accessible, it is the learning outcome that needs to can be accessible (Kelly et al., 2005). Based on user profiles, metadata and dynamic connection to resources, the user's experience can be customized to match his/her abilities. Then an appropriate design is crucial for improving the accessibility and usability of e-learning Systems (Kelly et al., 2005).

All disabilities should be considered when designing e-learning applications. Leporini and Buzzi have discussed accessibility issues for e-learning systems (such as Learning Management Systems environments) and they have proposed empirical principles for designers developing e-learning applications in order to simplify interaction for a blind student or teacher (Leporini & Buzzi, 2007). E-learning environments should be friendly and easy to use. Furthermore, the educational material should be suitable for the abilities and skills of any user, so the same information should be provided through multiple channels, i.e. visual, auditory, tactile. De Marsico et al. defined methodological guidelines involving users with disabilities as well as pedagogical experts in the development process, believing that input from different know-how could enrich the quality of e-learning applications and provide a more satisfying learning experience (De Marsico et al., 2006). They also include two examples of building and providing Learning Objects accessible respectively to visually- and hearing-impaired students. Rodriguez et al. described a project for improving the e-learning experience for the visually impaired, based on ethno-methodology and taking into account psychosocial issues, the user context and experience (Rodriguez et al., 2006). Next they created different Learning Object formats suitable for the blind, including DAISY (Digital Accessible Information System).

Within the framework of a project aimed at providing an accessible e-learning platform for disabled and adult learners, Santos et al. (Santos et al., 2007) illustrated a methodology for developing standard-based accessible courses using two-step evaluations. However, for the totally blind more specific UI features are necessary than those in this study, such as providing a page overview, full control of interface elements and easy and rapid navigation via keyboard.

Cooperative environments and tools are particularly interesting and useful in the educational field, where knowledge is assembled cooperatively. Some studies focus on the accessibility and usability of e-learning systems for blind people but to our knowledge only a few specifically involve a study concerning collaborative environments and tools.

Khan et al. (Khan et al., 2010) performed a usability study in the educational environment ThinkFree, a collaborative writing system, with four novice and four experienced users. Specifically, authors compared ThinkFree to Google Docs by means of a user test with Think Aloud protocol, a post-test questionnaire to collect user feedback and interviews to validate the gathered results. Although ThinkFree proved effective for the proposed tasks, efficiency and availability of resources were more limited than in Google Docs.

Schoeberlein et al. (Schoeberlein & Yuanqiong, 2009), revising recent literature on groupware accessibility and existing solutions, have highlighted the need for future research. Authors observed that most articles address the needs of a specific category of disabled persons. In particular, visually-impaired people with reduced or no visual perception experience objective difficulties when interacting with a complex layout via screen reader, and they are frequently studied.

Recently Kobayashi developed a client application (Voice Browser for Groupware systems VoBG) for enabling visually impaired persons inexperienced in computer technology to interact with a groupware system that is very popular in Japan (Garoon 2). The VoBG browser intercepts Web pages generated by the groupware server, parses their HTML code and simplifies on-fly their content and structure in a more understandable format for target users (Kobayashi, 2008).

Thiessen gave an example of using WAI-ARIA to design and implement a chat, highlighting some limitations of live regions (Thiessen & Chen, 2007). However, this problem is common with emerging standards, since browsers and assistive technologies need to conform to the new specifications, and this takes some time before reaching stable implementations.

Different studies exploring singular aspects of educational and collaborative environments should be integrated towards a new concept of learning adaptable to all the categories of students, including people with special needs.

3. Background: A new paradigm of learning

Analyzing the rising trend of information and communication technologies, the emergence of new devices with new interfaces and web 2.0 technologies has changed our way of living, the way of communicating, operating and delivering knowledge. As a consequence, a new paradigm occurs in transferring the knowledge from teachers to students, and vice versa. Before trying to analyze this new learning paradigm, it is necessary to understand the different impact of studying activities on the efficiency of learning.

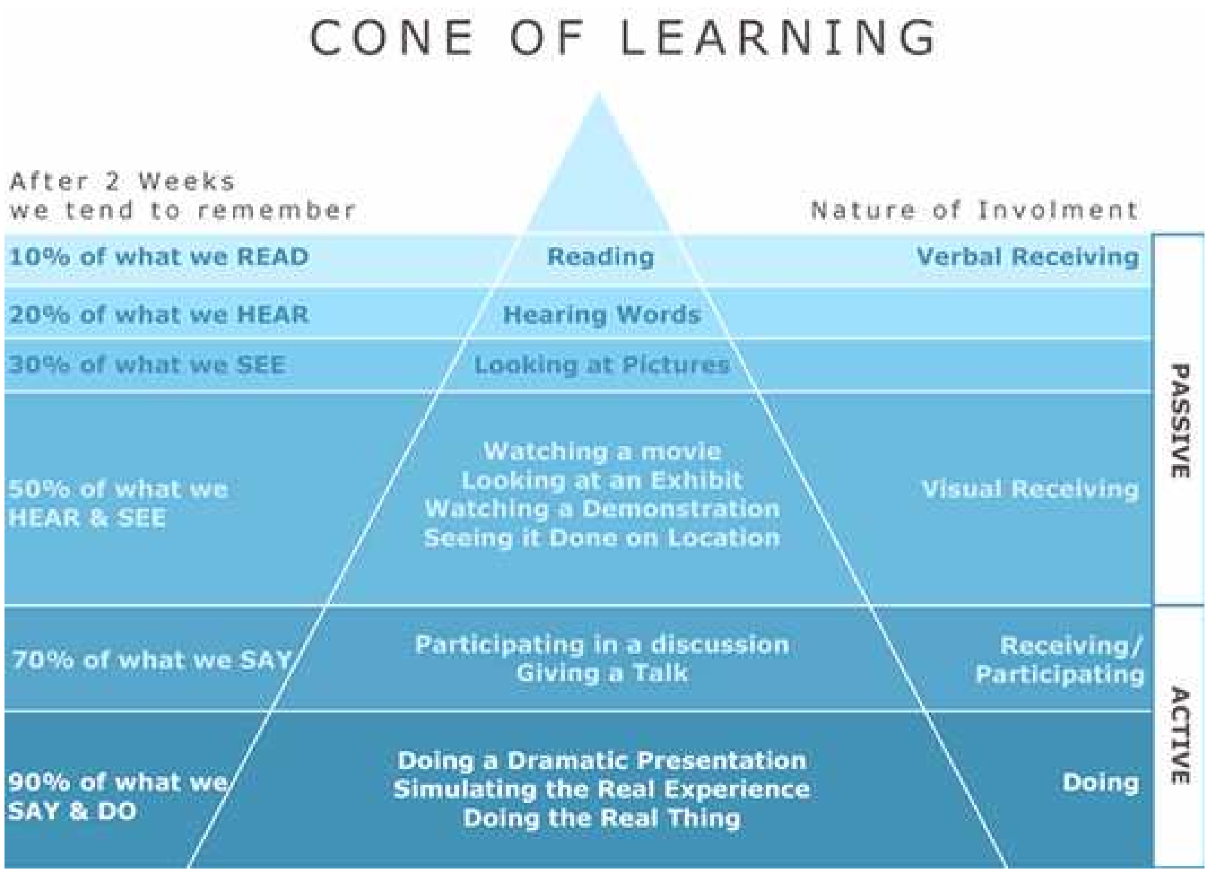


Fig. 1. Cone of learning (Dale 1969).

3.1 Cone of learning

Edgard Dale, an educationalist at Ohio State University (Dale, 1969), conducted his research on the impact of audio and visual material, to investigate the learning effects of direct experience vs. pure abstraction or simple academic theory. Dale got interesting results from his experiences with students. He tried different methods on different student groups, and he tested their knowledge after two weeks. Groups of students that learned from just reading remembered only 10% of the information, while the group that learned from watching and hearing a demonstration remembered 50% of content, and the group that actually practiced a real experience, remembered the 90%. Dale's research emphasized a *"Cone of learning"*, distinguishing the learning methods in passive and active categories. Graphical results of the Cone of Learning are shown in Fig. 1.

Nevertheless the validity of the Cone of Learning depends on the subject's personal abilities. This is especially critical for persons with disabilities, especially subjects with learning disturbances or pathologies. Furthermore there is the tendency of individuals to have a certain resistance to change, not easy to overcome. In the following section we will present the main reasons.

3.2 Need for new educational learning methods

Social and cultural changes are not always simple, especially when they involve many actors and consistent shifts in their habits and their way of thinking. The aim to improve learning efficiency at different levels of the Cone of Learning can have great impact on teachers who have to prepare learning material in an alternative multimedia style (instead of mainly textual), with considerable effort. This effort and consequent tasks increase still more for teachers with some sort of physical disability who address the same problems as students with special needs. Other general and cultural obstacles for applying the Cone of Learning are (Potts & LaMarsh 2004; Birenbaum et al. 2006): 1) despite the fact that world knowledge increases exponentially so fast, and quick adaptation is necessary, most academic institutions continue to rely on older educational methods; 2) Higher education is not yet using technology to its best advantage and rapid industry development is infrequently in correlation with the education programs; 3) there is a gap between the knowledge that is taught in the university or in the educational institutes and that required to students in the actual jobs. In the same paper, Birenbaum, states that in various European countries current assessments focus on *"teaching for assessment and not teaching for learning"*; this practices is limited in scope and fails too many learners because they ignore individual learner differences.

An interesting journal (Bisoux, 2007) interviewed five experts in online education, showing how they stress many common points about the incomplete diffusion of e-learning:

1. not understanding the advantages that online technology affords
2. little interest in discovering how students really use technology and how online pedagogical structures operate
3. lack of training to use that technology to best advantage
4. difficulty understanding that the Web is not yet a simple one-way channel of delivery but an immersive environment where users-learners create and share information
5. collaborative interactive e-learning environments help students *"learn to be"*, not just watch and listen. At present, the situation has changed little.

According to the difficulty applying the Cone of Learning, there is a need to change traditional teaching methods, adapting to the new rapidly changing situation and exploiting Dale's different levels of learning delivery. Past teaching methods implied hierarchical transfer of knowledge from teachers or professors to the students, who passively accepted the given information. Students often repeat or mechanically reproduce information with the only goal of passing the exam or being promoted at the end of the year. This way of teaching is mere mechanical transmission of information, often reflecting the teacher's interests and area of expertise, and not considering the real interests of the students. Modern educational methods should offer students the possibility choosing topics of interest so they can further explore what they really like (in addition to the basic institutional program). Considering the huge amount of available data on the Web and media in this "epoch of information", new generations of students are multitasking and able to acquire information about their interests faster than in the past. Google-like multimedia information systems delivery contrast with traditional educational passive methods. Students want to be active participants in the learning process, reproducing knowledge based on experience. Introducing this kind of interactive learning, students will be able to understand better and remember much longer (Tomasegovic et al. 2011).

Introducing a more interactive way of learning can change the vertical hierarchy between teachers and students to a horizontal one, improving teacher-student interaction and relations. Active interaction is a concept that is strictly integrated with the idea of personalization. Active interaction improves the "feeling" of the students of being the primary participant in the learning process, while personalization gives them the opportunity to learn "anytime, anywhere" following self-based rhythms of study to fulfil their needs. Students feel more involved in the learning process and teachers can improve their educational skills, designing new learning methods to help students developing their talents and capabilities. Traditional educational methods valued individual effort, while the new learning paradigm focuses on emphasizing interaction between students with the objective of also favouring the communication and socialization skills, which are very important in the learning but also in the working environment. Students are often involved in group or working teams, because cooperation and collaboration are fundamental to a learning experience based on concrete experience.

4. Collaboration

Human-Computer Interaction (HCI) is a research field aiming at improving interaction of users with applications and electronic devices. Its aim is to do so by developing new user interfaces (UIs) that make interaction more natural and devices easy-to-use for any individual. A key concept for HCI is usability: according to the ISO definition, an interface should allow the user to achieve a target goal (effectiveness) in the best (efficient) and fully satisfying way (ISO 9241-11, 1998). The evolution of the working style of human beings, and improved technology regarding communication and interaction mechanisms have profoundly changed the classic concept of HCI towards a new HCHI (Human-Computer-Human Interaction), in order to work in collaboration with other people. These changes have introduced the Computer-Supported Cooperative Work (CSCW) discipline. The user interacts not only with the system (a typical area of HCI) but also with other users throughout the system, performing cooperative tasks (typical area of CSCW). The term **groupware** is especially used for this technology (usually with use of computers) to facilitate a task shared among many persons. In order to get high quality groupware applications, special features regarding CSCW should be taken into account: collaboration, coordination, communication, information sharing and cooperation (Poltrock & Grudin, 1994, 1999, 2005). While **cooperation** is used for small groups of users who share key objectives and cooperate among themselves, **collaboration** is used for big groups (such as big organizations) that collaborate together even when they have different goals (possibly even coming into conflict). The main difference is that the term "cooperation" is used for people working closely together (Grudin, 1994). **Coordination** is fundamental in any organization working in a unifying way to increase quality and reduce costs (Poltrock & Grudin, 1999). **Communication** brings people into contact through frequent, unplanned, high-quality and real-time interaction (Greenberg, 1989). Data, information, documents in general are shared (**information sharing**), elaborated, modified in a virtual software environment to ease interaction and improve knowledge between collaborators (Poltrock & Grudin, 1999).

Although active cooperation between students is fundamental and facilitates the training process during practice, sometimes individual learning is preferable, especially regarding theoretical aspects (Prince et al., 2005; Stahl, 2005). Calibration and combination between an individual's learning phase (following personal rhythms) and the active collaboration phase with other participants, is an important aspect discussed in academic and research literature (Kayes, et al., 2005). Sometimes an approach to teaching and learning combines traditional face-to-face classroom methods with more modern computer-supported activities (*blended learning*), because this strategy creates a more integrated approach for both instructors and learners.

Active interaction with other students (following a common goal), listening to different points of view or suggestions from a teacher (to clarify obscure concepts and other issues in the studying phase) is a kind of collaboration that provides concrete benefits for the personal learning process.

However, collaboration can also be influenced by different ways of content delivery. For example, the off-line or on-line modes of learning produce a completely different user experience. In fact, Computer Based Training (CBT) consists of only self-paced learning activities, usually delivered by CD-ROM, while Web Based Training (WBT) is delivered via Internet using a web browser, allowing more interaction with the external world. Sometimes a "live" collaborative experience is also preferable: for example visiting an exhibition can be more effective than obtaining cultural information from a Web site or multimedia CD (Ghiani et al., 2009).

Between collaborative features, **awareness** is fundamental (especially using collaborative computer-supported tools) since it represents a user's perception of the other users in the system. A participating user interacting with other users on an interface should know who is performing (or performed) an action, when, where and specifically what. Collaboration in e-learning environments allows easier acting in time and space, really affecting the way people interact. Combination of other additional special features of time and space (typical of a groupware application), produces four categories of collaborative tools (time-space matrix):

1. same time/same places (in which decision rooms, single display groupware, shared table/wall display, etc. are typical e-learning tools);
2. same time/different places (using video conferencing, instant messaging, chats, shared screen, etc.);
3. different times/different places (using email, bulletin boards, group calendar, wikis, etc.);
4. different times/same places (using team rooms, shift work groupware, project management, etc.).

Collaborative environments should keep in mind many learning styles and interaction needs of different kinds of people, including people with special needs, so the design of accessible and usable interfaces is crucial.

5. Importance of accessible and usable interfaces

Knowledge and information can be properly expressed heterogeneously using text, audio, videos, etc. (depending on the educational content), so interfaces of e-learning tools can present many multimedia elements (enriched user-interfaces) involving multi-sensorial channels (visual, auditory and kinaesthetic) (Fleming, 2001; Hawk & Shah, 2007; Kayes et al., 2005; Stahl, 2005). Unfortunately, visual and multimedia interaction can be a problem for users with visual disabilities.

E-learning environments should be usable by anyone. For this reason, it is important to also verify the accessibility and usability of e-learning collaborative tools for people with special needs. Accessibility and usability should always be considered during the design of a user interface allowing universal access to anyone. Accessibility permits users to reach on-line application content, while usability provides simple, efficient and satisfying navigation and interaction.

Guidelines for designing usable and accessible Web interfaces have been proposThe W3C Web Content Accessibility Guidelines (WCAG, 2008) are general principles for making Web content more accessible and usable for people with disabilities. The WCAG (2.0) are organized into four principles: clear perception of content information (content perceivable), complete interaction with an interface in its functions (interface elements operable), comprehension of meaning (content understandable), and maximizing the interface's compatibility with new assistive technologies and devices (content robustness).

6. Blind user interaction

Facing many kind of disabilities can require different and individual strategies. In the research literature, of all the various sensorial disabilities (low vision, motor, auditory) blindness presents the most difficulties when completing a task (Craven & Brophy, 2003; Ivory et al., 2004; Petrie et al., 2004). For this reason, we focus our attention only on blind users, who have no sight at all, without other kind of disabilities (motor, auditory, etc.).

There is a tendency to assume that people who become blind manage better with blindness than people who were born blind, because they have more references and memories. However, this tendency can depend on individual learning and life experiences (Chambel et al., 2009).

Blind people interact with a user interface using an assistive technology, the screen reader with a voice synthesizer or a Braille display. The latter is expensive and slow, so it is rarely used. A screen reader is a software that describes aurally (if a voice synthesizer is used) and sequentially the content of a user interface; blind users mostly navigate via keyboard since it is considered faster than a vocal input. This kind of interaction and perception can be difficult and frustrating for blind people because:

a. content serialization produces an overload of vocal information in sequence
b. a blind user has no overall perception of the whole interface
c. the screen reader announces information mixing content and structure (related to description of interactive elements)
d. the screen reader can announce information in the wrong order, depending on the HTML code (for instance a table's content is generally organized in columns but it is read by rows).

All these problems cannot be completely resolved by the W3C Web Content Accessibility Guidelines alone because they are general principles for making Web content more accessible and usable for all people with disabilities. To fill this gap, the WAI group is working on the Accessible Rich Internet Applications specification (WAI-ARIA) that specifically aims to make dynamic web content and applications (developed with Ajax, (X)HTML, JavaScript) more accessible to blind people.

6.1 Accessible Rich Internet Applications (WAI-ARIA) suite

Usually, certain functionalities used in websites are unavailable to some users with disabilities, especially people who rely on screen readers and people who cannot use a mouse. Typical difficulties of blind interaction using a screen reader with a vocal synthesizer can be resolved by using the WAI-ARIA suite (WAI-ARIA, 2011), which favours effective interaction with the Rich Internet Application; among other things, WAI-ARIA permits drag & drop via keyboard, the definition of standard roles for graphical widgets of the user interfaces and also allows developers to define the main regions of a user interface to allow a blind person to move quickly to the desired area instead of being forced to interact with the UI sequentially. The challenge is considerable regarding one of the most notorious problem for Web developers and users: different behaviours of different browsers. In addition, it is necessary to also consider different supports of browsers for different versions of screen readers. For our tests, we used a common commercially available screen reader, JAWS for Windows (JAWS, 2011), in versions 10, 11 and 12.

Although considering all these aspects is not an easy task, we can suggest some basic characteristics for collaborative learning tool interfaces and applications, focusing on facilitating interaction and learning experience for blind users.

7. Appropriate learning tools

Designing appropriate learning tools for any kind of users is not a trivial task. In general a good embedded e-learning tool or platform should take into consideration the following aspects:

a. **personalization** (considering a student's knowledge level, objectives, time and pace)
b. **learning by doing** (through practical activities, simulations, virtual laboratory, etc.)
c. **active participation and collaboration with other students** in the Virtual Learning Environment (sharing resources with other students, teachers, tutors or mentors).

We believe that for blind users, extra aspects should also be addressed at three levels:

1. **Making accessible and usable interfaces for blind students**: this feature will also facilitate and simplify the interaction of other users;
2. **Increasing the accessibility of awareness information on other collaborators**: every user (especially the blind) want to know who is collaborating, what, when and where she/he is doing something, and desire to be updated on her/his and others' status;
3. **Providing educational content in different sensorial channels**: interaction and integration between blind students and students without disabilities will develop perception of less exploited internal sensorial representations in everyone.

In addition, considerations on the use of different sensory channels are indispensable for understanding their effects on learning and delivering educational content.

7.1 Importance of enriching sensory learning experience

Most common and important communication media in our society are based on sight (television, graphical advertisements, 3D movies, illustrated magazines, Web, etc.). Many studies confirm visual sensorial channels as the most used by humans and the fastest way to acquire information. Obviously, this way of communicating is unavailable to blind users. The exclusion of printed educational material (books, magazines, journals, etc.) is a major challenge for blind students using digital content in the educational environments when there is reference to visual material (photos, diagrams, videos, etc.) in the didactic content. Nevertheless, a person's predominant internal sensorial perception (visual, auditory and kinaesthetic) has an impact on her/his interaction with the external environment and on the way new information is elaborated. An important study by UCLA Professor of Psychology Albert Meharabian (Meharabian, 1971), expert in communication, asserts that especially in the beginning of communicating new concepts, the impact of verbal communication (words) accounts for 7%, non-verbal communication (tone of voice, intonation, speed, etc.) accounts for 38%, and paraverbal (body language) accounts for 55% of overall communication. Independently of the precision of these percentages, it is clear that this predominant visual gap for the blind should be compensated for in a different way. A solution to this aspect could be the exploitation of senses other than vision (hearing, touch, sense of smell and taste), using them in a single modality or in a proper input/output combination (otherwise, a bad combination can decrease attention during learning). Perceptibly, the senses of smell and taste do not appear important for learning activities (excepting in particular contexts in which particular sensors are used), but hearing and touch can be exploited in a more sophisticated manner in many applications. For example the quality of voices and their characteristics (tone, speed, etc.), targeted use of sounds, use of non-invasive haptic devices, use of appropriate tactile effects or use of sensors for recognizing human gestures, etc., are all elements that can enrich the learning experience of multi-sensorial educational material.

Sight is the predominant sensorial channel and can quickly deliver more information than touch and listening (Ghiani et al., 2011; Chittaro, 2010). However, in terms of acquiring information, touch requires more time than listening to be familiarized during decoding of the information; so touch is usually used in combination with audio and graphics. When designing applications for the blind, audio is preferred for delivering crucial information, while touch is used to integrate particular feedback effects or to emphasize repetitive notifications (being less annoying than using the auditory channel).

However, design of an interface for a specific sensorial channel can also have effects on learning. For example graphical or vocal interfaces have substantial differences. Although audio has many advantages (see section 8.2), interaction with a vocal interface presents different and limiting characteristics compared to a graphical one. Using a metaphor, sight can transfer more information "in parallel", while listening is "sequential" (Pitt & Edwards, 2003). A graphical interface can present an overview of the content, while audio interaction has to face volatile human memory. Ability to memorize during interaction with a vocal interface is limited to few seconds, so a user can be easily distracted or disoriented about her/his status, often requiring feedback from the system. Thus designing learning applications using alternative sensorial channels other than sight has particular requirements.

Blind students also present different styles of learning, even if they have a tendency to be more audible and sometimes kinaesthetic in regard to touch. Thus, different approaches of learning should be adapted to the individuals. Designing learning application for students with special needs can benefit other students as well, but sometimes it is necessary to consider particular situations. For example, a too-meticulous description of a diagram can become boring for a sighted person, beyond a certain level of detail, while it can be essential for a blind person. (Chambel et al., 2009). It is important to be aware that proper collaborative learning tools should offer different choices of suitable educational material, fulfilling the needs of different kinds of students interacting together or studying alone.

Although personalization of learning "anytime, anywhere" is an important aspect of the new learning paradigm, sometimes it is also necessary to consider the effects on interaction when a student (blind or without disabilities) moves, instead of sitting at a desk (Chittaro, 2010):

- **Perceptual**: conditions of the environment can change (illumination, noise, temperature, vibration, motion, etc.). For example, exploitation of the auditory channel can be difficult in a noisy environment.
- **Motor**: mobile conditions can impair the ability to fine-control voluntary movements. For example, vibrotactile devices can be less effective during acceleration or deceleration in a vehicle.
- **Social**: sometimes certain kind of interaction are restricted by the social rules. For example the use of gestures near strangers can be embarrassing, or using sound at a conference not well-tolerated.
- **Cognitive**: mobility can limit one's attention to the device or to the application content. For example, paying attention to the announcement changes in the airport or listening to an audio device while properly responding to other people can be source of distraction. Also, interaction with an audio device in the street even for a sighted user can be a risk for her/his safety.

It is clear that the proper combination of multi-sensorial channels in a proper manner together with knowledge acquisition by real experience are important factors for more efficient learning: Dale's Cone of Learning confirms this, as shown in Fig. 1 (Section 3.1).

8. Examples of learning tools

In this section we present two examples of possible learning tools. The first example is a preliminary prototype related to the design and development of more accessible interfaces of a Web collaborative editing tool (Google Documents) that improves the interaction of blind users operating with the JAWS screen reader (Mori et al., 2011); the second example is not properly a collaborative tool (in the strict meaning of term), but could be used by teachers and students to facilitate delivery of educational material, i.e., provided with the tool of the previous example. We designed and developed an experimental accessible Web system transforming digital documents to audio podcasts loadable on an mp3 player. In this example, we want to emphasize three important concepts of the new learning paradigm: a) the importance of using different sensorial channel for blinds and sighted users (for example, belonging to and cooperating together in the same class); b) the importance of personalized learning ("anytime, anywhere") beyond the classroom limits; c) the importance of using tools that can facilitate teachers and students. This second example shows a Web tool transforming digital documents (for example edited with Google Documents), in audio podcasts that can be loaded on a personal mp3 player (Mori et al., 2010). Audio podcasts exploit the auditory sensorial channel of the students, in order to facilitate personalization of studying following self-based rhythms. The concept of learning "anytime, anywhere" beyond the class limits is a key concept for all students, and also helps teachers improve their way of teaching. The tool of the second example could be useful for any student and specifically is really useful for blind students in which the going-over phase is critical.

8.1 Design and development of accessible interfaces of Google Documents

Google Docs is a collaborative web-based word processor, spreadsheet, presentation, form, and data storage service offered by Google (Google Docs, 2007). Google Documents is the Google Docs application focused on collaborative editing and word processing. This application allows users to edit text documents at the same/different times and places. It is an online collaborative word processor.

In a preliminary study, we analyzed interaction with Google Docs via JAWS (version 10, 11 and 12) on both the Microsoft Internet Explorer (IE) and Mozilla Firefox browsers in order to understand the problems encountered by blind people when writing a document collaboratively, focusing on the login, document list and text editing Web pages. The design and implementation of a modified version of these Google Docs interfaces aimed to incorporate accessibility criteria enhancing user experience while maintaining the same appealing "look & feel" (Mori et al., 2011).

The main accessibility problems detected by our inspection (in February 2011) via screen reader can be summarized as follows:

a. Many interactive elements cannot be detected by a screen reader nor be accessed via keyboard (since they are not standard (X)HTML elements and their labels are announced by the screen reader as simple text), making some tasks impossible to complete.
b. Blind users have difficulty orienting themselves during interaction, listening to the interface contents sequentially, with no possibility of quickly moving from one part of the interface to another or using main editing functions (such as creating or accessing a document) or the document list.
c. Lack of a summary attribute for table used as layout purposes for the list of documents in the Main page does not quickly provide useful information on its content, and this requires and extra effort for blind users who have to read all cells sequentially to understand the content of the table (see area 5 of Fig. 2).
d. The editor is not practically accessible. The main menu (file, edit, view, insert, format, etc.) and the style formatting toolbar (font type or size, etc.) are inaccessible because they cannot be reached via keyboard, while bold, italic or underlined functions can only be used through keyboard shortcuts (CTRL+b, CTRL+i, etc).
e. Some dialogue windows are not accessible at all and messages notifying the presence of other users are not announced by the screen reader, against the awareness principle (Fig. 3).

The modified pages of Google Docs have been created saving the original pages and ridding them of useless code (such as Javascript and functions responsible for dynamic behaviour of interface elements). Creating the modified pages starting from the original Google Documents pages was preferred instead of creating them from scratch, permitting a better maintenance of the same "look & feel". Fig. 2 shows the Main ("All items") page of the modified UI.

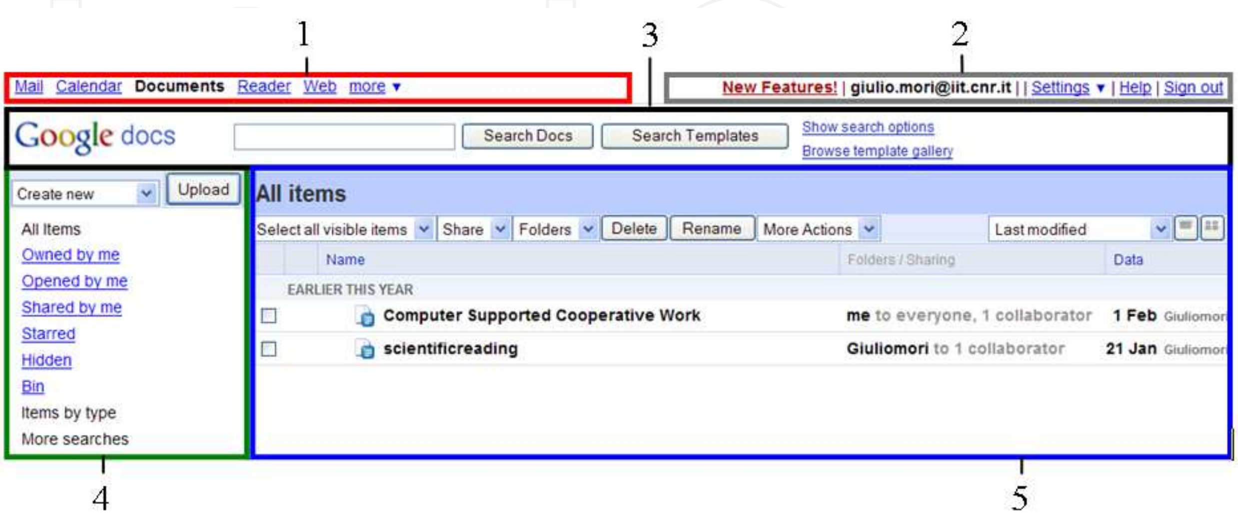


Fig. 2. Modified Google Docs "All items" page, divided into five areas.

Fig. 3. Graphical notification of another collaborator online.

Previously listed accessibility problems have been fixed as described below:

a. Interactive elements (buttons, links, pull down menus, etc.) in the modified interfaces have been substituted with standard (X)HTML widgets, producing more accessible effects, because they has become reachable via keyboard, allowing JAWS to announce them.

b. Each modified page has been divided into a number of areas to facilitate user navigation, permitting a blind user to jump quickly from one point to another and avoid listening to all the content sequentially. Areas are not visible to the users, but are marked by WAI-ARIA landmarks roles allowing a blind user to move quickly to a different area (by pressing a special shortcut that provides a list of areas navigable via arrow keys). Fig. 2 shows five areas of the Main page of Google Documents. Standard WAI-ARIA landmarks use prefixed labels to indentify the name of an area such as *banner*, *contentinfo*, *search*, *navigation* and *main*, which are not very significant for the user and for her/his orientation. WAI-ARIA also permits the use of regions with personalized labels; these labels are correctly announced by Version 12 of JAWS, but unfortunately at the time they were not properly supported by the previous versions (only the name "region" was announced). To solve this problem, we used a trick introducing hidden labels, which are like a sort of bookmark in the interface (Fig. 4).

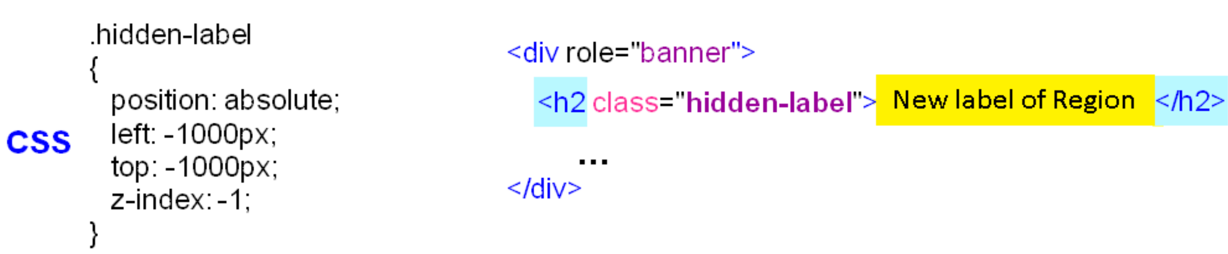


Fig. 4. Implementation of hidden labels.

Each area is a (X)HTML *div* element that contains a label; the *New label of Region* is an (X)HTML heading *h2*, that is not visible in the layout of the page because a CSS script moves it outside the screen. This solution allows a blind user (pressing the "h" key for retrieve headings) to jump from one heading to another. Finally, the blind user can move from one area to another by either: 1) activating landmarks by pressing a special key combination on the keyboard (showing a navigable list via arrow keys), or 2) pressing the "h" key to jump to the next hidden label (by adding the shift key, it is possible to reach the previous one).

c. The "summary" attribute has been added to the tag <*table*> to clarify its content. Usually the "t" JAWS key quickly permits to move to the next table, so a descriptive summary can facilitate navigation and understanding. However, in case the user wants to explore the content of the table, JAWS allows her/him to jump easily from one row to another.

d. The modified editor page is composed of a toolbar and a text area (Fig. 5) and it is now accessible and reachable via keyboard. The blind user can write in the text area and can quickly access to the toolbar buttons (*save*, *bold*, *italic*, *underlined*, *left*, *center*, *right*, *justified*) and to the pull down menus (*Paragraph*, *Font Family*, *Font Size)* by pressing the "h" key related to the hidden label inserted before the toolbar.

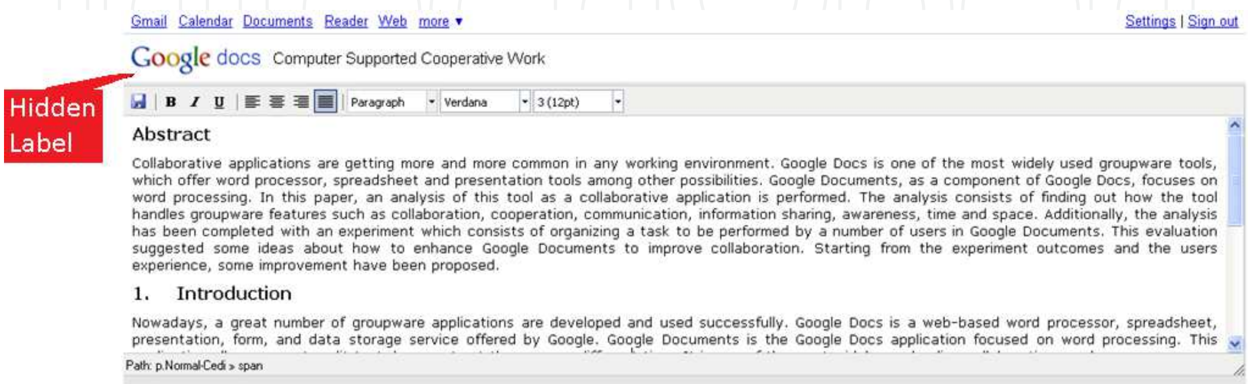


Fig. 5. Modified page of the editor.

Accessibility of the editor has improved because we used an existing accessible ready-to-use editor online, the TinyMCE editor (an Open Source Javascript-based HTML WYSIWYG editor) (TinyMCE, 2011) that works correctly with both Mozilla Firefox and Microsoft IE;

e. Real time and informative messages can be solved using server side Ajax code, since WAI-ARIA has been designed for dynamic content and advanced user interface controls that exploit this technology.

This experience has shown the importance of designing accessible and usable interfaces for cooperative or learning tools in general. Unfortunately, this experience has also shown various compatibility issues during interaction and different behaviors that occur using IE and Firefox browsers. Compatibility between browsers is a real actual hard challenge for designing and developing Web UIs.

8.2 A Web tool transforming digital documents to structured audio podcasts

This second example shows a Web tool transforming digital documents (for example, edited with Google Documents) to structured audio podcasts that can be loaded onto a personal mp3 player (Mori et al., 2010). Audio podcasts exploit the auditory sensorial channel of the students, with the objective to facilitate personalization of studying following self-based rhythms. A podcast is a digital file (audio or video) distributed on the Internet through Web Syndication. Audio podcasts are a great tool for learning and offer many advantages:

a. a student can listen to educational material while doing other things (running, driving, ironing, etc.)
b. extends classroom limits, because a student can listen to the recorded lesson files again, at any moment or location
c. students are less anxious because they can listen to the lesson even when they miss a class
d. a student can personalize her/his pace of studying

e. audio requires less resources than video to create and reproduce
f. teachers can improve their teaching methods by listening to audio podcasts of the lessons again.

When reading a book such as a novel, one is forced to be sequential in order to understand the plot; otherwise, in the case of educational books or documents (like manuals, paper, technical reports, transcription of lessons, etc.) continuous reading is not always the most appropriate for effective learning; usually this kind of educational material is structure-based in sections and paragraphs: this kind of structure facilitates exploration and internal searches, so that student can read only the parts of interest.

In a preliminary questionnaire (Leporini et al., 2009), blind and visually impaired users stated they preferred listening to a document in form of audio podcasts with a personal mp3 player, instead of reading it by a screen reader or a magnifier on a computer (this was a confirmation of the desire for a certain freedom in personalizing learning). Many studies have shown that short podcasts (max 10-15 min) are more effective for learning than a single long unit. Long podcasts may decrease attention, thus reducing comprehension (Cebeci & Tekdal, 2006; Ormond, 2008). When podcasting is used for educational purposes, well-structured short podcasts (following the structure of a document – i.e., converting each section into one podcast) facilitate exploration and internal searches. Educational audio podcasts can be produced by recording live events but this requires time, costs and resources; in alternative software text-to-speech converters (like Text2mp3, DSpeech, etc.) can break a document down into several mp3 files based on a time division (e.g., 5/10/15 minutes) or on a manual "break string" inserted by the user in the document, but time division cannot be as effective as a structured one.

From the previous considerations, we designed and developed an experimental web-based prototype that receives a document (.doc,.docx,.rtf,.txt) and provides a set of audio files reflecting the document's internal structure (one file for each document section). Fig. 6 shows the architecture of the system. An example of application is the following: a teacher (or a student) can upload a document (for instance, created with Google Documents) of the daily lesson (or personal notes) using the input interface of the system. The system tries to identify titles of sections, splits the document according to the sections detected and converts each section into an audio file using a Text-To-Speech module (TTS); the mp3 files (one per section) can be downloaded by students from an accessible Web page. Input and output Web interfaces are accessible based on WAI-ARIA and can also be accessed by blind students with a screen reader. Blind students are also provided with .talk files, used by the firmware Rockbox (Rockbox, 2001) that allows the blind to be guided vocally on an mp3 player during navigation of files and folders. Talk files are obtained transforming each title of sections in audio streaming.

The system emphasizes titles of sections aurally using a different gender of voice, while it uses the voice chosen at the beginning for the podcast content (Fig. 7).

The system also highlights bold phrases inside a paragraph of each section (to better deliver the author's emphasis) by inserting in the podcast an ascending sound at the beginning of each bold phrase and a descending sound at the end. The system also identifies tables inside the document, converting each one into a single separated podcast, since listening to a table (especially if very big) is frustrating for a blind person. When a blind student uses an mp3 player, she/he can easily skip from one mp3 file to another (using the buttons track forward/previous) to learn whether the content of each podcast is interesting (because each

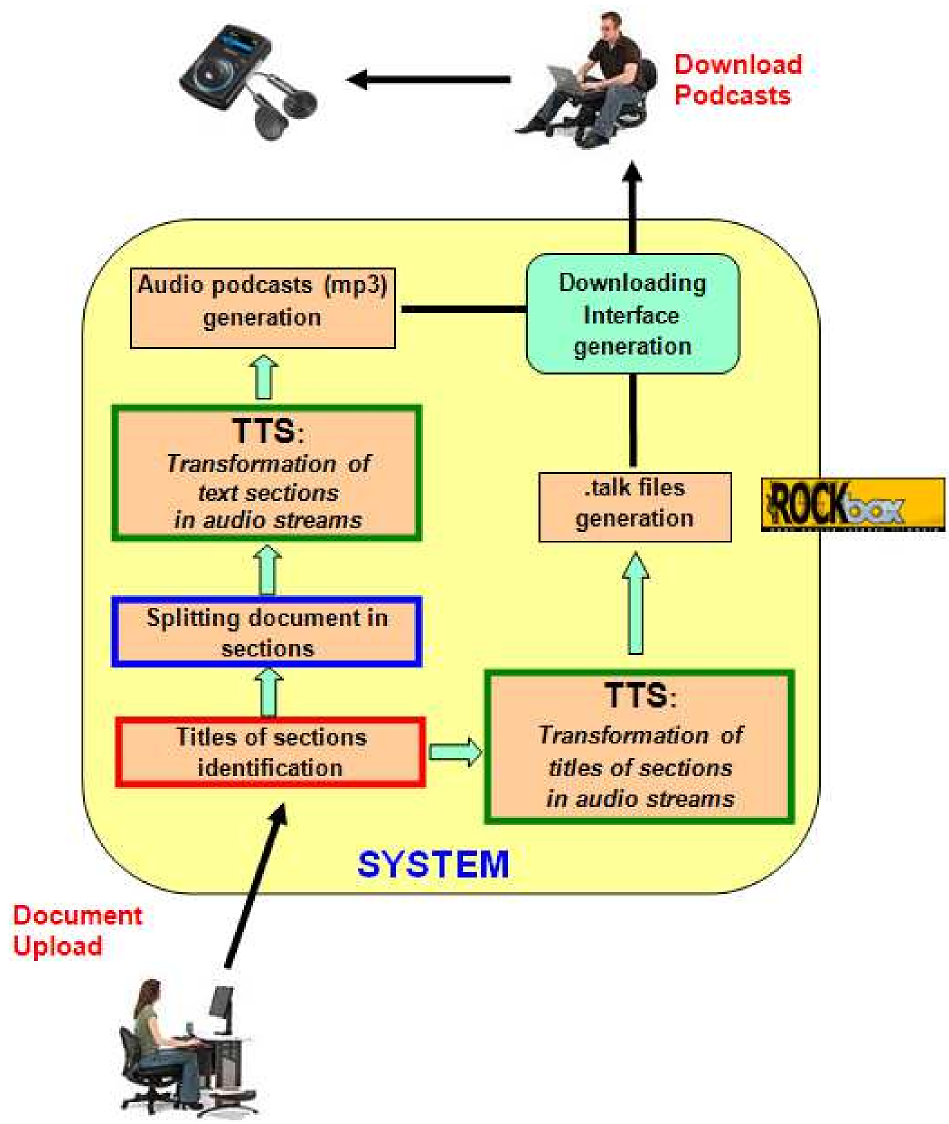


Fig. 6. Architecture of the web-based system for generating structured audio podcasts.

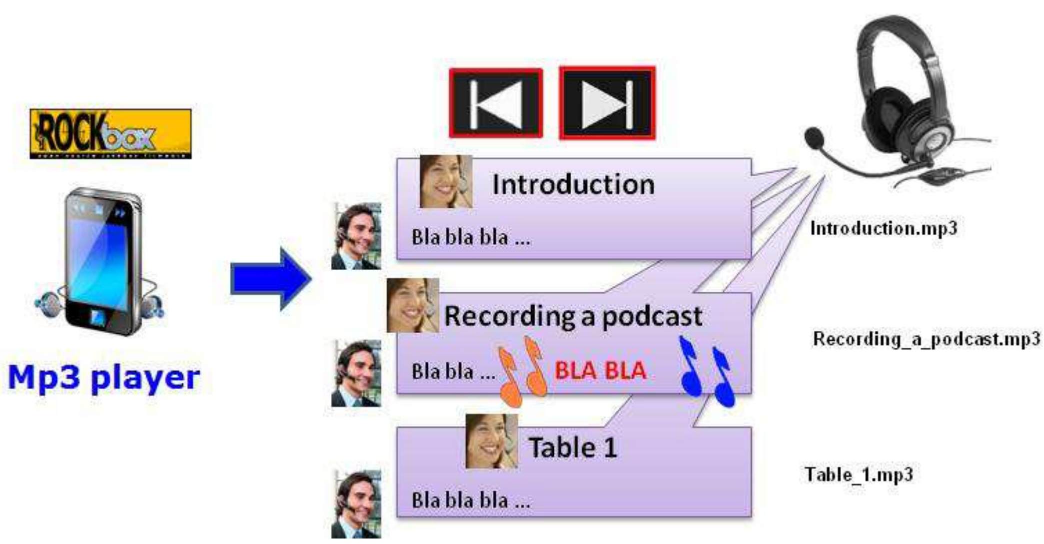


Fig. 7. Interaction of blind user on an mp3 player equipped with Rockbox firmware.

audio podcast contains the title in the first few seconds). This is especially helpful when listening to new audio educational material in order to understand content and search for the most important sections, or for the going-over phase, which is critical for blind students.
This experience has confirmed for us the importance of using alternative learning tools to personalize the pace of studying beyond classroom limits, facilitating education for any kind of student and teacher.

9. Conclusion

New learning paradigms are based on collaboration, experience, and personalized acquisition of knowledge according to student ability and skills. Collaboration is a key element of learning, so the availability of usable tools supporting and favouring student cooperation is a critical factor for achieving easy and rapid results. New technologies and the Internet offer a fertile ground for foraging this growth.
In this chapter we have discussed features of collaborative e-learning tools and suggested basic guidelines for enhancing their usability for blind people. We first have discussed the potential of e-learning, focusing on the great opportunities it offers for the blind. After describing the interaction mode of the blind people, we have proposed basic general suggestions for improving the design and personalization of collaborative tools. Two examples have been presented to clarify the concepts introduced: 1) the design of accessible interfaces of Google Docs, a popular collaborative Web editing tool, optimized for interacting via screen reader and 2) the design of a Web tool for converting digital documents to structured audio podcasts to support personalized learning, especially for the blind.
Active participation and collaborative interaction can improve the learning experience for anyone. Personalization is crucial for those with cognitive and learning disabilities, tailoring education to each student's ability.
However, new tools alone are not enough to deliver effective and usable customized learning units. The great challenge actively involves teachers who must know and creatively apply new technologies, systems, applications and tools to improve the learning process, making them also available on mini-computers, laptops and mobile devices (smart phone, mp3 players, play devices, etc.). When designing learning tools, teachers should also keep in mind student abilities, interests and capabilities in order to bring them to their full potential.
In conclusion, further research in this direction is needed. Future studies would investigate several topics: the accessibility, usability and adaptability of e-learning systems on mobile computing and handheld devices, the customization of user interfaces to personalize the learning experience, the delivery of educational units with different sensorial channels, and the design and creation of new collaborative learning objects and applications. Moreover, educational-centred topics such as pedagogical and teaching strategies, behaviour analysis and new assessment methodologies should also be addressed.

10. References

Ardito, C., Costabile, M., De Marsico, M., Lanzilotti, R., Levialdi, S., Roselli, T. & Rossano, V. (2005). An Approach to Usability Evaluation of e-Learning Applications. *Universal Access In the Information Society*, Vol. 4, No. 3, pp. 270-283, ISSN: 16155289

Beard, C. M., & Wilson, J. P. (2002). *The Power of experiential learning: a handbook for trainer and educators,* (first edition), Kogan Page, ISBN 0 7494 3467 8, London, UK

Birenbaum, M., Breuer, K., Cascallar, E., Dochy, F., Dori, Y., Ridgway, J., Wiesemes, R. & Nickmans, G. (2006). A learning integrated assessment system. *Educational Research Review*, Vol. 1, No. 1, 24 April 2006, pp. 61-67

Bisoux, T. (2007). The Evolution of E-learning, In: *BizEd*, January/February 2007, pp. 22-29, Available from: http://www.aacsb.edu/publications/archives/janfeb07/p22-29.pdf

Cebeci, Z., & Tekdal, M. (2006). Using Podcast as Audio Learning Objects. *Interd. Journal of Knowledge and Learning Objects*. Vol. 2, pp. 47-57

Chambel, T., Antunes, P., Duarte, C., Carriço, L. & Guimarães, N. (2009). Reflections on Teaching Human-Computer Interaction to Blind Students, *Proceedings of Creativity and HCI: From Experience to Design in Education, Vol. 289, pp.* 123-142

Chittaro, L. (2010). Distinctive aspects of mobile interaction and their implications for the design of multimodal interfaces, *Journal on Multimodal User Interfaces*, Vol. 3, No. 3, pp. 157-165

Craven, J. & Brophy, P. (2003). Non-visual access to the digital library: the use of digital library interfaces by blind and visually impaired people. In: *Technical report, Manchester: Centre for Research in Library and Information Management - CERLIM*, 08.03.2011, http://www.cerlim.ac.uk/pubs/index.php

Dale, E. (1969). *Audio visual methods in teaching* (third edition), Holt, Rinehart & Winston, New York

De Marsico, M, Kimani, S, Mirabella, V, Norman, K. L. & Catarci, T. (2006). A proposal toward the development of accessible e-Learning content by human involvement. *Journal Universal Access in the Information Society*. Vol. 5, No. 2, August 2006, pp. 150-169

Debevc, M. & Bele JL. (2008). Usability testing of e-learning content as used in two learning management systems, In: *European Journal of Open, Distance and E-Learning*, 08.03. 2011, Available from: http://www.eurodl.org/materials/contrib/2008/Debevc_Bele.htm

Fleming, N. D. (2001). *Teaching and learning styles: VARK strategies*, ISBN 0-473-07956-9, Christchurch, New Zealand

Ghiani, G., Leporini, B. & Paternò, F. (2009). Vibrotactile feedback to aid blind users of mobile guides, Journal of Visual Languages and Computing, Vol. 20, No. 5, October 2009, pp. 305-317

Google Docs, In: Google Documents, Available from: http://www.docs.google.com

Greenberg, S. (1989). The 1988 conference on computer-supported cooperative work: Trip report, *Canadian Artificial Intelligence ACM SIGCHI Bulletin*, Vol. 20, No. 5, pp. 49-55, July 1989

Grudin, J. (1994). CSCW: History and Focus. University of California, *IEEE Computer*, Vol. 27, No. 5, pp. 19-26

Hawk, T. F. & Shah A. J. (2007). Using Learning Style Instruments to Enhance Student Learning, *Decision Sciences Journal of Innovative Education*, Vol. 5, No. 1, January 2007, pp. 1-19

International Organization for Standardization (ISO) 9241-11. (1998). Ergonomic requirements for office work with visual display terminals (VDTs) - Part 11: Guidance on usability, In: UU Department Information Technology, Available from: http://www.it.uu.se/edu/course/homepage/acsd/vt09/ISO9241part11.pdf

Ivory, M. Y., Yu, S. & Gronemyer, K. (2004). Search result exploration: a preliminary study of blind and sighted users' decision making and performance. *Proceedings of Extended abstracts of CHI 2004*, pp. 453-1456, ISBN:1-58113-703-6, Vienna, Austria, April 24-29 2004

JAWS Screen Reader. (2011). In: Freedom Scientific, 08.03.2011, Available from: http://www.freedomscientific.com/products/fs/jaws-product-page.asp

Kayes, A., Kayes, D. C. & Kolb, D. A. (2005). Experiential Learning in Teams, *Simulation and Gaming*, Vol. 36, No. 3, pp. 330-354

Kelly, B., Phipps, L. & Howell, C. (2005). Implementing a holistic approach to e-Learning accessibility. *Proceedings of ALT-C 2005, International Conference of the Association for Learning Technology*, In: UKOLN, 08.03.2011, Available from: http://www.ukoln.ac.uk/web-focus/papers/alt-c-2005/accessibility-elearning-paper.doc

Khan, M. A., Israr, N. & Hassan, S. (2010). Usability Evaluation of Web Office Applications in Collaborative Writing. *Proceedings of ISMS, First International Conference on Intelligent Systems, Modelling and Simulation*, pp. 147-151, ISBN: 978-0-7695-3973-7, Liverpool, England, January 27 – 29, 2010

Kobayashi, M. (2008). Voice Browser for Groupware Systems: VoBG - A Simple Groupware Client for Visually Impaired Students. *Proceedings of ICCHP 2008, International Conference on Computers Helping People with Special Needs*, pp. 777-780, ISBN: 978-3-540-70539-0, Linz, Austria, July 9-11, 2008

Kolb, D. (1984). The Process of Experiential Learning, Chapter 2 in: *The experiential learning: Experience as the source of learning and development,* pp. (20-38), Prentice Hall, ISBN 0-13-295261-0, New Jersey, USA

Leporini, B. & Buzzi, M. (2007). Learning by e-Learning: Breaking Down Barriers and Creating Opportunities for the Visually-Impaired. *Proceedings of UAHCI'07, International Conference on Universal Access in Human-Computer Interaction: applications and services*, pp. 687-696, ISBN: 978-3-540-73282-2, Beijing, China, July 22-27, 2007

Leporini, B., Buzzi, M. C., Buzzi, M. & Mori, G. (2009). Automatically Structuring Text for Audio Learning, *Proceedings of UAHCI 2009 International Conference Universal Access in Human-Computer Interaction. Applications and Services, part III,* Volume 5616, pp. 73-82, ISBN: 978-3-642-02712-3, San Diego, CA, Inuted States, 19-24 July 2009

Mehrabian, A. (1971). *Silent Messages* (1st ed.), ISBN 0-534-00910-7, Wadsworth, California: Belmont

Merrill, M. D., (1991). Constructivism and Instructional Design. *Educational Technology*, Vol. 31, No. 5, May 1991, pp. 45-53, ISSN-0013-1962

Mori, G., Buzzi, M. C., Buzzi, M. & Leporini, B. (2010). Structured Audio Podcasts via Web Text-to-Speech System, *Proceedings of WWW 2010, international Conference on World Wide Web*, ISBN: 978-1-60558-799-8, Raleigh, North Caroline, United States, April 26-30 2010

Mori, G., Buzzi, M. C., Buzzi, M., Leporini, B., & Penichet, V. M. R. (2011). Making "Google Docs" User Interface More Accessible for Blind People, *Proceeding of ADNTIIC 2010, International Conference on Advances in New Technologies, Interactive Interfaces, and Communicability*, pp. 14-17, ISBN: 978-3-642-20809-6, Huerta Grande, Cordoba, Argentina, October 20 – 22, 2010

Ormond, P. R. (2008). Podcasting enhances learning. *Journal of Computing Science in Learning*, Vol. 24, No. 1, pp. 232-238

Petrie, H., Hamilton, F. & King, N. (2004). Tension, what tension?: Website accessibility and visual design. *Proceedings of the International Cross-disciplinary Workshop on Web Accessibility (W4A)*, No. 76, pp. 13 – 18

Pitt, I. & Edwards, A. (2003). Design of Speech-based Devices, Springer, ISBN 978-1-85233-436-9

Poltrock, S. & Grudin, J. (1994). Computer Supported Cooperative Work and Groupware, *Proceedings of CHI 1994 Conference Companion on Human Factors in Computing Systems*, pp. 355-356, Boston, Massachusetts, United States, April 24-28, 1994

Poltrock, S. & Grudin, J. (1999). CSCW, groupware and workflow: experiences, state of art, and future trends, *Proceedings of CHI 1999 Extended Abstracts on Human Factors in Computing Systems*, pp. 120-121, ISBN:1-58113-158-5, Pittsburgh, Pennsylvania, United States, May 15-20, 1999

Poltrock, S. & Grudin, J. (2005). Computer Supported Cooperative Work and Groupware (CSCW), *Proceedings of Interact 2005*, Rome, Italy, September 2005

Potts, R. & LaMarsh, J. (2004). *Master change, maximize success*, Chronicle Books, ISBN 0811841707, 9780811841702, San Francisco

Prince, K. J. A. H., Van Eijs, P. W. L. J. & Boshuizen, H. (2005). General competencies of problem-based learning (PBL) and non-PBL graduates, *Medical Education*, Vol. 39, No. 4, April 2005, pp. 394–401, Wiley Online Library, ISSN 0308-0110

Rockbox Open Source firmware, In: Rockbox, Available from: http://www.rockbox.org/

Rodriguez, E.P.G., Domingo, M.G., Ribera, J.P., Hill, M.A. & Jardi L.S. (2006). Usability for All: Towards Improving the E-Learning Experience for Visually Impaired Users. *Proceeding of ICCHP 2006, International Conference on Computers Helping People with Special Needs*, pp. 1313-1317, ISBN: 3-540-36020-4, Linz, Austria, July 9-11, 2006

Santos, O. C., Boticario, J. G, Fernández del Viso, A., Pérez de la Cámara, S., Sánchez, C. R., Gutiérrez y Restrepo E. (2007). Basic Skills Training to Disabled and Adult Learners Through an Accessible e-Learning Platform, *Proceedings of UAHCI'07, International Conference on Universal Access in Human-Computer Interaction: applications and services*, pp. 796-805, ISBN: 978-3-540-73282-2, Beijing, China, July 22-27, 2007

Schoeberlein, J. G. & Yuanqiong, W. (2009). Groupware Accessibility for Persons with Disabilities. *Proceedings of UAHCI '09, International Conference on Universal Access in Human-Computer Interaction*, pp. 404-413, ISBN: 978-3-642-02712-3, San Diego, CA, USA, July 19-24, 2009

Sloan, D., Heath, A., Hamilton, F., Kelly, B., Petrie, H. & Phipp, L. (2006). Contextual web accessibility - maximizing the benefit of accessibility guidelines. *Proceedings of W4A '06, International cross-disciplinary Workshop on Web Accessibility,* ISBN:1-59593-281-X, Edinburgh, Scotland, UK, May 22-23, 2006.

Stahl, G. (2005). Group cognition in computer-assisted collaborative learning, *Journal of Computer Assisted Learning*, Vol. 21, No. 2, Apr 2005, pp. 79–90 (2005), ISSN-0266-4909

Thiessen, P. & Chen, C. (2007). Ajax Live Regions: Chat as a Case Example. *Proceedings of W4A '07, International cross-disciplinary Conference on Web Accessibility (W4A)*, pp. 7-14, ISBN:1-59593-590-8, Banff, Canada, May 07–08, 2007

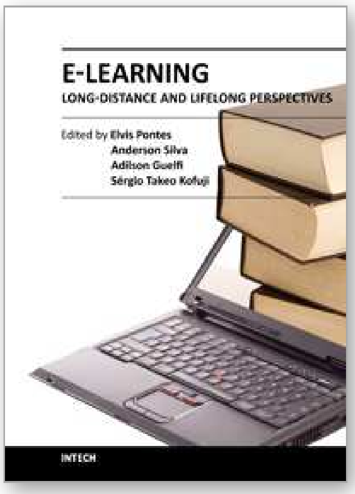
TinyMCE Editor. (2011). In: TinyMCE, 08.03.2011, Available from: http://tinymce.moxiecode.com/

Tomasegovic, T., Zitinski Elias, P. Y., Baracic, M., Mrvac N. (2011). E-learning and Evaluation in Modern Educational System, *US-China Education Review*, Vol. 8, No. 2, February 2011, pp. 198-203, ISSN 1548-6613

W3C. (5 Dec 2008). Web Content Accessibility Guidelines 2.0. In: W3C, 08.03.2011, Available from: http://www.w3.org/TR/WCAG20/ (5 Dec 2008);

W3C. Accessible Rich Internet Applications (WAI-ARIA) 1.0, In: *W3C Candidate Recommendation 18 January 2011*, 08.03.2011, Available from: http://www.w3.org/TR/wai-aria/

Zaharias, P. (2006). A usability evaluation method for e-learning: focus on motivation to learn. *Proceedings of CHI EA 2006 extended abstracts on Human Factors in Computing Systems*, ISBN:1-59593-298-4, Montreal, Québec, Canada, April 22-27, 2006



E-Learning - Long-Distance and Lifelong Perspectives

Edited by Dr. Elvis Pontes

ISBN 978-953-51-0250-2

Hard cover, 156 pages

Publisher InTech

Published online 14, March, 2012

Published in print edition March, 2012

E-learning enables students to pace their studies according to their needs, making learning accessible to (1) people who do not have enough free time for studying - they can program their lessons according to their available schedule; (2) those far from a school (geographical issues), or the ones unable to attend classes due to some physical or medical restriction. Therefore, cultural, geographical and physical obstructions can be removed, making it possible for students to select their path and time for the learning course. Students are then allowed to choose the main objectives they are suitable to fulfill. This book regards E-learning challenges, opening a way to understand and discuss questions related to long-distance and lifelong learning, E-learning for people with special needs and, lastly, presenting case study about the relationship between the quality of interaction and the quality of learning achieved in experiences of E-learning formation.