AN ACCESSIBLE AND USABLE E-BOOK AS EDUCATIONAL TOOL: HOW TO GET IT?

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Abstract: Accessible electronic publications, such as electronic books, journals, and training tools, can be useful for disabled students and workers, particularly in an educational context. E-books are an important educational tool for supporting the real integration of disabled students into classroom activities or distance learning. This paper discusses the main features of an e-book which is appropriate for visually impaired readers. Developing useful educational e-books for blind and visually impaired students often requires the adaptation of e-texts for sighted readers and therefore a number of different factors needs to be considered. In this paper particular consideration is given to the development of e-books which are suitable for blind and visually impaired people.

Keywords: accessibility, usability, e-book, e-text, e-learning, information access

1. Introduction

The "Individuals with Disabilities Education Act" (IDEA) - a special education law published by the USA in 1975 - was revised first in 1997 and then in 2004 (http://idea.ed.gov/). The focus of special education moved from the necessity of providing ad-hoc services to disabled students to the possibility of educating more students in mainstream classrooms. Thus, schools are now required to place disabled students in inclusive classrooms, when appropriate, in order to provide them with the social skills and academic tools as the other students. In the same way, distance learning is an increasingly popular way for institutions of higher learning to deliver educational services to students. It is popular among disabled students as well (Edmonds, 2004). Thus, electronic material, such as e-books or e-texts, is increasingly used as a learning tool.

E-books offer many advantages to both disabled and non-disabled users. If appropriately designed, they allow readers to easily locate specific chapters or sections, to place bookmarks for future reference, to quickly access glossary definitions or indexed terms, as well as providing adjustable fonts for easier reading and recorded or synthetic speech to aid in comprehension. In addition to providing these important features, a digital publication ensures that every student, new employee or worker undergoing training is using the same material, and obtains it on the first day of school or work.

Moreover, learning processes are increasingly using electronic media and information available on the Web. In (Chen et al., 2005) the authors discussed an approach for automatically generating an e-textbook on the Web for a user specified topic hierarchy. Their approach consists of generating an e-book on the Web starting with a topic indicated by the user. Users can then browse through the

descriptive pages like a book. Hence, e-books are increasingly providing new ways to learn and obtain information.

In this paper we will first introduce the issue and explain the basic motivations leading to the research in this field. Then, we will discuss the new and fundamental role of the e-text as a learning tool in distance or in-school education, especially for visually impaired people. We will also describe the accessibility and usability issues that should be considered in developing e-texts for visually impaired readers. Finally, we will briefly introduce a semi-automatic tool, which is being developed to support the conversion of e-books to an accessible format.

2. Motivation and goals

In several countries, specific accessibility laws have been passed, which require publishers to provide an electronic accessible version of school textbooks. Nevertheless, disabled students in mainstream classrooms do not always have access to the same learning tools as their classmates. For example, students with visual impairments rely on alternative-format books (such as large print or Braille). The time-consuming process of turning books or other materials into Braille, audiotape, or large-print editions means that visually impaired students often start the school year without their textbooks. Thus, while the other students receive complete printed books, blind children receive their books chapter by chapter with the risk that the material does not arrive in time to follow the learning schedule. Moreover, visual learning tools are often totally unsuitable for blind students. As a consequence, students must rely on teachers or classmates, who have to try to describe visual content as well as they can. This situation can restrict the educational opportunities of blind students.

When reading or studying a book, readers need to develop an understanding of the contents (textual and graphical), reflect on it on the basis of their own experiences and knowledge, and then represent it mentally in their own terms. When authors are preparing a literature study or book review, they also need help in exploring the themes and threads of the book and identifying cross references quickly. These scenarios could be applied to many kinds of books, including novels, textbooks, scientific books, conference proceedings, digital journals. The resulting demands on the reader are serious, particularly when the book is long and complex and/or the reader has a vision impairment.

Our project - named "S.T.E.L.A.E" (Scienza e Tecnologia per Libri Accessibili Elettronici/Science and Technology for Accessible e-books) - focuses on these important issues. Overall, this project aims at addressing the accessibility and usability issues in electronic publishing. Specifically, it is looking for solutions to the main barriers to the creation of cultural/scientific e-books that are accessible and usable by disabled users. The project is also working on recommendations for the creation of accessible e-texts and the conversion of inaccessible e-books to an accessible format.

Other studies on this topic include the work of Sun et al. (2004), who designed e-Book browsers that aid users in perceiving and understanding the important conceptual structures of a book, and hence improve their comprehension of the book content. Marshal et al. (2001) conducted a preliminary study of a new generation of e-books. For example, they redesigned an e-book in the area of law. They developed an evolving e-book prototype which allowed them to examine the interconnected issues of usability and utility, and to redesign an existing e-book user interface to suit the needs of law students. The authors considered facilities, such as text navigation, reading, annotation, following links and writing practices, in a heterogeneous information environment (law).

A number of authors have proposed ad-hoc solutions for visually impaired people. Adjouadi et al. (2006) introduced a new automatic book reader for blind people. Their objective is the design of a fully integrated system that is relatively fast, but inexpensive and effective with a high reading accuracy. Conversely, we prefer to design and develop an accessible and usable e-book, which can be read with traditional tools (e.g. adobe reader, internet browser). We believe that more general solutions and design for all approaches have the greatest benefits.

The format of some e-books (e.g. narrative ones) is relatively simple and easy to modify for accessibility. However, in the case of scientific books, the e-text can contain complicated explanations, graphs, tables, and formulae and it is more difficult to create an accessible and usable version, since a complex net of alternative explanations and complementary descriptions of these

graphs, tables and formulae is required. Publishers could develop e-text for blind readers by taking into account their requirements from the start of the development process. Unfortunately this rarely happens, as the development process is generally graphical and accessibility and usability rules are rarely considered. For example, publishers usually provide documents in PDF (portable document format) version. Such e-texts are often not accessible and their content is inappropriate (figures are not provided with useful alternative descriptions and tables are difficult to comprehend and to read in a sequential way). Consequently, the electronic document needs to be modified to make it accesible to readers using assistive technologies. A semi-automatic tool for carrying out the conversion could be very useful.

3. E-text as an Educational Tool
3.1 The e-book as a class or educational distance tool

In recent years, there has been an increase in the numbers of educational e-books being produced, both by academics trying to keep pace with the advanced requirements of the virtual university and by publishers trying to meet the increasing demand for educational resources that can be accessed anywhere and at any time and that include multimedia information, hypertext links and powerful search and annotation mechanisms. Distance learning is an increasingly popular way for institutions of higher learning to deliver educational services to students. However, distance education is also increasingly inaccessible to disabled people. The design of many of the distance learning courses offered by institutions of higher learning presents barriers to the full participation of students and instructors with some types of impairments (Burgstahler, 2002).

An electronic book is the digital media equivalent of a conventional printed book. It can either be read on a personal computer or on dedicated hardware or software. An e-book is also a specialised type of e-text in terms of learning information and educational content. Hence an e-book can be used both in the classroom and in distance education. Electronic material is an indispensable tool for people with vision impairments. Digital documents and resources enable disabled people to be more autonomous in their work or studies. Readers who have difficulty reading conventional books can benefit from the ability to adjust text size and change the font. Text-to-speech software can be used to automatically convert e-books to spoken books. Disabled instructors can also benefit from accessible online distance education and electronic material. Since e-books and e-texts are important tools for providing educational material and contents, the terms "e-text" and "e-book" can be used as synonyms.

3.2 Reading an electronic text: the problems

Developing a useful educational e-book requires consideration of many different factors, such as the reading patterns of users, accessibility to different types of users and different computer platforms, copyright and legal issues and the development of new business models. Accessibility is the main feature that makes an e-book readable by everyone. Consideration of usability is also very important since e-books are interactive systems and their design should therefore consider the needs of their readers.

A visually impaired person generally interacts with the operating system and its applications through assistive technology, a screen reader in the case of a blind user and a magnifier for a low vision user. As in the case of a Web page (Leporini et al., 2004) the main problems encountered by a visually impaired person when interacting via these assistive technologies can be summarised as follows:
- Lack of context – When navigating with a screen reader (or a magnifier) the user is only able to access small portions of a text at any one time and may lose the overall context of the current content shown on the screen.
- Information overload – Often several unchanging portions of the content (such as menu, index and any repeated information) may overload the system, as the user has to read through all the items nearly every time the text is read, thus slowing down content exploration.
- Excessive sequencing in reading the information - The commands for navigation and reading may force the user to access the content sequentially. For instance, long tables can make reading frustrating.

Due to these problems, reading a document can be somewhat laborious. Even if a document is available in a format considered accessible, such as TXT, PDF or HTML, the reader can still find it

difficult to read it efficiently. When reading an electronic text users should have the same options as when reading a paper document, including being able to obtain an overview of the contents (e.g. sections) and reading each component (e.g. figures) easily. Further details can be found in (Leporini, 2006). Therefore a specific structure, additional navigation features, and appropriate text descriptions should be added to an e-book.

4. How to obtain an Accessible and Usable e-text
4.1 Overview

The main purpose of our project is building a digital library which is accessible to visually impaired people. To this end, we focused on three main issues: (1) How to obtain accessible and usable electronic documents (e-texts and e-books); (2) How to develop accessible online mini-courses; (3) How to organise online materials and services.

Producing accessible and usable e-books, e-texts, services and online courses requires the consideration of a number of criteria and principles during the design and development phases. Indeed a developer should consider accessibility and usability from the very start of product design. This require the application of specific rules and principles. Accessibility and usability criteria to improve Web navigation for blind and low vision people have been identified by Leporini et al. (2004). Based on those criteria, we have developed the following three sets of guidelines:

- Library Web sites: the main intention of these guidelines is to recommend what services should be available on library Web sites (e.g. searching for e-books, downloading the catalogue, current news). They also cover how to deliver e-books and audio material (e.g., audio-books) and specific usability criteria, as well as standard accessibility guidelines to improve library navigation for users who interact through screen readers or magnifiers.
- Online mini-courses: this set of guidelines provides recommendations for the development of an online course, including suggestions for presenting the material and structuring the Web interface.
- e-books: this set of guidelines discusses how to organise and structure content in order to produce an accessible and usable electronic document (e-book).

4.2 Guidelines for e-books

The S.T.E.L.A.E. Project is investigating the structure and development of books with particular features (e.g. scientific books with a complex structure and e-texts) to make them easier to read. For instance, the inclusion of appropriate features, such as heading styles, at the document preparation stage, enables the reader to obtain an overview of the content. The set of guidelines proposed for e-texts addresses the accessibility and usability features required to simplify the user's interaction with the document, as well as to structure its content (textual and graphical). Thus the guidelines are intended to be applied to the final version of a document (i.e. the document provided to the user). With this aim in mind, ten guidelines were proposed for accessible and usable e-books, which take into account three main aspects: structure, non-textual objects, and navigation.

I. Structure. This group of guidelines aims to make it easier to comprehend the structure of the whole document. This should make it easier for the user to identify its main components, including chapters, sections and sub-sections. To make an e-book easy to access and read efficiently its content should be well-structured (marked) by using specific tags. This enables assistive technologies to recognise and easily identify the document's main structural elements, such as titles, paragraphs and notes.

II. Non-textual objects. Figures, images, graphs, tables, etc. in an e-book should be properly represented and clearly described. This is particularly important when figures and graphs are an important component of the content. For instance, a maths function or graph should be adequately described in order to present its main contribution. Tables should be appropriately structured and provided with additional information. A lack of appropriate descriptions for graphs and figures could cause visually impaired readers serious problems and make it very difficult to understand the content of the e-book. In the case of an educational e-book or e-text, this can seriously interfere with the learning process. It is therefore very important that the content is provided to the user in an appropriate and accessible format. The guidelines proposed by the S.T.E.L.A.E. project provide an important first step. However they just

provide an indication of how complex non-textual objects such as graphs, images and figures can be made fully accessible and usable. Further investigation of these complex objects will be required to obtain the most effective solutions.

III. Navigation. Appropriate navigation facilities should be provided to enable users to navigate the e-text efficiently. The specific facilities required will depend on the format of the e-book, such as X/HTML, PDF, TXT. For example, adding an interactive index (with links) to the start of the document facilitates finding and moving forward to a particular section. In the case of X/HTML and PDF documents, each item in the index can be a link, whereas for text documents, the index comprises a list of non-linkable items.

4.3 How to produce an accessible e-book

The electronic format provided by publishers may not provide adequate support for disabled students. In fact, an electronic book can only be made fully accessible and usable if specific rules and steps are followed. The procedure for obtaining accessible and usable e-texts may differ depending on whether they are produced from the original file or by manipulation of another (non-original) file version.

4.3.1 Creating an e-text from the beginning: When generating a new document, rules for ensuring accessibility and usability should be followed from the start. Publishers should follow accessibility guidelines when preparing the electronic format of books. In this section the main steps to follow when creating an accesisble PDF document are presented as an example. When preparing an electronic document the author should pay attention to the following:

- Use of a format that allows styles to be assigned to each part of the content. For instance, "heading1", "heading2" styles can be applied to section and sub-section titles. Styles can be used in MSWord; or <h1>, <h2>, etc., can be applied in X/HTML format.
- Applying the guidelines while editing the content. This means that descriptions have to assigned to each figure, graph and image element. In addition tables should be well-structured.
- Conversion of the document to PDF format. When the original document is ready and complies with all the guidelines, a final version PDF can be produced. This requires the use of specific software, such as Acrobat Professional to generate the PDF format. Only conversion tools which produce accessible PDF should be used. In particular, printing to a PDF file should not be used, as the result is not accessible. The use of an unsuitable conversion tool will not insert appropriate tags and result in an untagged PDF format. This is a problem, as it is the tags which determine the reading order of the document.

4.3.2 A semi-automatic conversion tool: In the previous section we discussed the production of accessible and usable text from the early preparation stages. Publishers unfortunately rarely consider accessibility issues when preparing the electronic version of a book. Therefore, they generally do not apply guidelines during the development process. Usually publishers take into account graphical aspects by using graphical software to design a book (e.g., Indesign, XPress, etc.).

In support of the project's main aim of investigating how to facilitate the development of accessible versions of existing electronic books, a prototype of a semi-automatic support tool is being developed. It uses the fact that the design tools allow content to be saved in PDF format and provides assistance in converting an inaccessible PDF document to different accessible formats (X/HTML, PDF, TXT, etc.). Modifying an existing inaccessible PDF to another version suitable for people with different disabilities requires considerable effort by an operator. For this reason a semi-automatic support could significantly help people in carrying out such transformation activities. The main features of the proposed prototype can be summarised as follows:

- One format input, several output formats. The tool inputs a PDF document and produces several different output formats. In addition to accessible PDF and X/HTML files, the DAISY (Digital Accessible Information System) format is supported.
- Semi-automatic support for transformation activities. The tool performs as many actions as possible automatically, but several activities have to be carried out manually. For instance, descriptions of figures and graphs have to be added manually. Other activities can be carried out by the tool and then the result can be revised by the operator. For example, the tool tries to rebuild the structure by recognising the titles of sections and sub-sections. Using this structure a table of contents is added to the document and heading styles are assigned.

When such activities are carried out automatically, the operators have to check and correct any incorrect titles. The same is true for tables. The tool attempts to rebuild a table from the original version; the operator has to check and probably modify it to ensure the structure is correct.

- Interactive modality to facilitate adapting non-textual objects. As a book can be composed of many pages, the tool offers operators a set of functionalities that assist in carrying out several repetitive activities more quickly. For example, when the operator is adding descriptions to figures and graphs, the tool helps by showing only the pages which contain images.

Thus, the tool aims to facilitate carrying out the process of transforming a PDF file to an accessible format. The prototype is composed of various parts, which transform the initial and intermediate files sequentially. At the end of the process the prototype outputs several different formats in order to provide the most appropriate format for the particular end-user. The DAISY (Digital Accessible Information SYstem) format is provided as well, because it is used by many digital libraries (Brzoza et al., 2006). This format contains mixed textual and audio content.

5. Conclusions and future work

The main factors and steps to follow to obtain an accessible and usable electronic text have been discussed. As electronic material has an important role in supporting the real integration of visually impaired students into mainstream classes, e-texts and/or e-books are useful educational tools in both classroom and distance education. Therefore, the provision of accessible and usable e-books is becoming increasingly important. The main accessibility features of e-texts considered in the S.T.E.L.A.E. project were summarised by analysing the main difficulties encountered by a blind reader and the possible solutions. Publishers and writers should apply specific rules in order to ensure an accessible electronic format. Unfortunately this is not usually considered during the preparation of books. Consequently, it is necessary to modify existing electronic documents to make them accessible and usable by visually impaired people. The transformation process requires considerable effort. A semi-automatic prototype conversion tool was presented to support the conversion of existing inaccessible electronic documents to an accessible version. The tool is still being developed and offers a series of support functions to assist operators in converting documents. The tool still requires further development and improvement. The final prototype, which will have a number of additional features, will be tested with a group of potential operators.

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