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ABSTRACT
A significant portion of the population is at risk of being excluded from online learning environments. People with learning and/or physically disabilities may be prevented from participation due to problems in the design of the learning technology itself or with the pedagogy directing its use. This paper presents an overview of the results of Inclusion in an Electronic Classroom, a study conducted by the Adaptive Technology Resource Centre at the University of Toronto. The study examined six courseware environments as used by people with various disabilities. Results show that it is imperative for courseware manufacturers and instructors to take accessibility into consideration when designing online courses. Operating an accessible, inclusive electronic classroom ensures students with disabilities can participate with parity in global educational exchange.

Keywords
Accessibility, Courseware, Disabilities, Inclusion, Online learning

Introduction
People with physical or learning disabilities can be excluded from online learning opportunities when courseware environments are not designed according to the World Wide Web Consortium’s Website Accessibility Initiative guidelines (see Web Accessibility Initiative (WAI) http://www.w3.org/WAI). AccessAbility means providing an inclusive, accessible environment for learning that might otherwise be closed to people with physical and/ or learning disabilities. Inclusion in an Electronic Classroom is a study funded by the Office of Learning Technology and carried out by the Adaptive Technology Resource Centre at the University of Toronto (The study is a joint initiative of Adaptive Technology Resource Centre, The Resource Centre for Academic Technology, and the Special Needs Opportunity Windows Project of the University of Toronto). The study examined accessibility within various courseware environments in order to better assess both the technological and pedagogical issues associated with the general educational shift toward online learning networks (See http://snow.utoronto.ca/initiatives/access_study/inclusion.html for project details and appendices). This paper presents a summary of the results of the study along with recommendations for ensuring equitable access within online, courseware-enabled, networked learning. Mallard, TopClass, Virtual-U, Web Course in a Box, WebCT, and Courseinfo were examined for accessibility by participants with a variety of disabilities. The study data are placed within a framework that examines the technical and pedagogical implications for accessibility issues and online learning environments.

Inclusion in an Electronic Classroom
The Canadian government has recently implemented policy to ensure that legislation providing access to persons with disabilities is applied to digital media, following the WAI guidelines (see “Accessibility: Overview,” http://www.cio-dpi.gc.ca/cif-upe/1/1_e.asp). Recent legislation in the United States has also ensured that all online information is accessible to people who rely on adaptive and assistive technologies (Section 508, see http://www.section508.gov/index.html). It is necessary to encourage the design of accessible web materials from their first iteration using universal design principles (see, for example, the Centre for Applied Special Technology http://www.cast.org). “Improving accessibility begins with increased awareness of the potential barriers” (Harrison, 2000). As we increase our use of courseware to host online components of education, it is necessary to examine these environments and the materials hosted to test their accessibility and their functionality. Understanding the barriers faced by those using assistive or adaptive technologies is imperative if we are to improve accessibility.
The study focused on eight individuals from the following disability groups: Blind, Vision Impaired, Mobility Impaired, and Learning Disabled. The study encompassed both experienced and inexperienced users. The participants included:

- One person with quadriplegia who used infrared mouse technology to access a computer.
- One person with moderate vision loss who used screen enhancement technology to enlarge the computer screen.
- Two people with severe vision loss who used screen readers to aid their use of a computer.
- One person who had no residual vision, and who relied on a screen reader to access a computer.
- Two people with moderate reading disabilities who used text-to-speech technology to aid comprehension of large blocks of content.
- One person with a severe learning disability who chose not to use assistive technology to access a computer.

The adaptive technologies used were as follows:

- **Screen Reader:** JAWS 3.5
- **Screen Enhancement:** ZoomText Xtra
- **Text-to-Speech:** Read and Write 4.0
- **Onscreen Keyboard:** Wivik
- **Alternative Pointing Device:** Head Master Plus

Each participant was given a series of tasks to accomplish in each of the following courseware environments:

- **BlackBoard CourseInfo 4.0**
- **Virtual-U 2.5**
- **Mallard 2000b**
- **Web Course in a Box**
- **TopClass 3.1.2**
- **WebCT 2.1**

Specifics tasks required were dependent on the features offered in each environment. Two questionnaires were developed for the study: an intake questionnaire and an observation protocol. The intake questionnaire surveyed participants’ prior experience with online learning and accessibility issues, and was an adaptation of the Distance Education Survey (DES), developed by the Evnet Group (see [http://socserv2.mcmaster.ca/srnet/evnet.htm](http://socserv2.mcmaster.ca/srnet/evnet.htm)). The intake questionnaire surveyed the following:

- Learning Preferences
- Computer Access
- Computer Attitudes
- Employment and Education
- Disability Awareness
- Personal Information

The observation protocol was based on courseware features, and required the participants to access each feature. The relative accessibility was rated on a 5-point scale that an observer ranked according to the following:

1. **Was unable to access; Required the observer to intervene physically (inaccessible).**
2. **Was able to access with instruction, but with no physical help (instructional, how to).**
3. **Was able to access with a hint (e.g., “try tabbing”, “use the down arrow”).**
4. **Was able to access but asked for clarification/affirmation (e.g., “Am I in a text area?”).**
5. **Was able to access without any instruction or physical help from the observer (accessible).**

These analysis protocols were used to construct accessibility profiles of each courseware with respect to each participant’s particular disability.

**Interpreting the Results**

The study found that accessibility depends on: (1) the amount of prior experience with network/online technologies; (2) the availability of immediate assistance when problems arose; (3) the presence (or absence) of clear help files; and, the extent of familiarity with a given adaptive technology. This last point is important as some problems with the technology of access inhibited some interactions with course materials and within learning environment. In these cases, there may exist accessible alternatives or methods for correction, but functional problems with the adaptive technology, or with this technology’s interaction with the courseware or operating system, led to a negative experience in this study.

While all participants in the study received training in the use of both online technologies and the courseware environments, there were instances when novice users became confused because of inadequate instructions in the
courseware. In these cases, courseware developers had assumed a basic technological literacy. The data show that this assumption has the potential to exclude either novice users, or those who have a learning disability and need detailed, step-by-step instructions of what is necessary to fulfill required functions. For example, courseware environments contain no instructions in sections that require students to upload data; it is assumed that students already know how to navigate these kinds of requirements. Help files are either nonexistent or not readily available, and were difficult to use for those using screen readers. The data show that it is imperative to provide comprehensive instructions for the use of the courseware environment, as some participants had difficulty using the courseware even when there were no technical issues hindering access. This pedagogical direction is an important underlying factor that can make or break the success of online learning.

Accessibility Issues by Disability Group

The qualitative data gleaned from the study details the limitations each participant faced as a result of disability. The extent to which and how these challenges were overcome reflects the larger purpose of this study: to examine the context in which courseware is used and its relative accessibility in non-school learning situations. The following are general summaries of accessibility issues by disability group.

Blind

Blind users have unique obstacles in navigating the information-rich web environments, which rely to a large extent on visual cues and navigational aids. Blind users of the Web construct mental maps of the pages they visit. This is often time-consuming and requires substantial mental effort. As a consequence, it is important that learning environments are clearly and logically laid out and include appropriate navigation aids for people using screen readers. For example, a link to a site map page that explains the relationships between frames and/or navigation structures is an easy way to ensure blind users can grasp the learning structure.

There are several inaccessible items in courseware that make use of Java-based technologies. Things like chats, whiteboards, and progress displays are inaccessible to users who do not have use of the mouse and are instead completely reliant on a keyboard. This also extends to “Browse” buttons (for file uploads) that are not properly programmed and poorly labeled form elements that have no keyboard equivalents, and thus are completely inaccessible for those using screen readers.

People who rely on screen readers have problems with the use of multiple frames and nested tables, given that screen readers generally read across a screen and cannot differentiate between regular text and text in columns. Similarly, frames that are either unlabelled or improperly labeled present complications for blind users who are trying to form a mental picture of how the information is being presented and the specific function of each frame (navigation, content, etc.). In addition, surprise popup windows can confuse screen readers, as it may not be clear why the window has opened, and how the contents of the window are relative to the rest of the site. Other specific problems for blind users can include difficulty with the interaction of the screen reader and the operating system of the computer, the courseware, or both. There are also problems for blind users with inconsistencies in layout and in language used to describe functions and features, resulting in confusion over how to accomplish tasks. While these may not render a function inaccessible, it will cause unnecessary complications in the completion of a given task.

Low Vision

People with low vision experience problems similar to those experienced by blind students. However, due to the fact that these users can fall back on residual vision, these complications can be less confusing in some instances. Again, problems with the adaptive technology can create accessibility difficulties, although users may more easily overcome these through experience with both the adaptive technologies and online learning environments. One low vision participant in this study experienced problems that were the result of (or were exacerbated by) limited experience with web navigation and courseware environments in general, inexperience with the adaptive technology, and general preconceptions of online learning activities. Challenges experienced by the other low vision participant were a result of problems inherent to the courseware itself, including the illogical display of steps required for task completion, and ambiguous terminology.
Learning Disabled

Problems encountered by learning disabled participants were largely a result of the technical and pedagogical structures used in the courseware environments. These include inconsistencies in layout and in the language used to explain task requirements, the absence of alternative information formats, and the absence of instructions for multi-step activities. Learning disabled participants in the study faced problems largely resulting from inexperience with online learning environments and difficulties related specifically to their respective disability. However, problems with absent or incomplete instructions coupled with assumptions of technological familiarity exacerbated these difficulties. These latter problems can and should be addressed by both courseware manufacturers (which should make adequate and complete instructions available on demand) and by course developers and instructors, who should create an inclusive environment for learning. This environment should make provisions for people who need these instructions as well as the redundant display of key information.

Mobility Impaired

The study participant who was mobility impaired (quadriplegic) experienced no difficulties in accessing each courseware function, largely a result of this participant’s familiarity with both adaptive technology and online instructional environments. The only problems experienced by this participant were specific functions that were not operational.

Study Limitations

While the findings of the study are clear, it is pertinent to note limitations. One of these was the small number of participants used. The results may be influenced by order effects due to limitations in the subject pool. The study used the most up-to-date technology, which resulted in using online learning environments not designed for accessibility. However, this underscores the importance of considering accessibility guidelines in the development stage of a technology. Technology interactions presented a problem, in that in some instances there were adverse interactions between the assistive and adaptive technologies used and the operating system and/or courseware being tested.

General Accessibility Issues: Recommendations for Inclusive Design

The major technical obstacles to accessibility are complexities in page layouts, inconsistencies in item labeling, a lack of instructions for task completion and the absence of consistent and clear functions related to items within the courseware. Courseware developers should ensure that their environments conform to the current WAI guidelines in order to ensure full accessibility of information. In addition, redundant information display should be provided to aid those who are learning disabled. Finally, problems with courseware and adaptive or assistive technology should be addressed and tested or at least acknowledged in order to lessen the deleterious effects of any incompatibilities that arise.

Separating the media used to access educational material from the content puts the emphasis on the content, which should be flexible enough to fit a variety of presentation media (text, audio, etc.). New mark-up languages (XML, XSL, CSS, DOM, XUL, Java) “separate content and structure from presentation” and “separate function from input [and output] method” (Treviranus, 2000). This separation allows people who need alternative or redundant output devices to access media that otherwise may be inaccessible to them. Future courseware applications should strive to include these modalities.

Internet experience (or lack thereof) and experience with assistive technology can vastly affect the success or failure of any online learning experience. Course instructors using any courseware or considering using online learning networks should be aware of accessibility standards and how the environment being used might fail to meet these. Instructors should ensure that information is appropriately displayed (insofar as this relates to the ability of the instructor to manipulate the courseware display of information) and that any learning disabilities that may require special consideration (with respect to information display, redundancy, etc.) are taken into consideration in the design phase of the online course creation.

Some technical shortcomings can be overcome although this can be costly, time consuming, and frustrating for all concerned. Given these considerations, it is important that sound, inclusive pedagogical practices direct the
development of technology, rather than reacting to its successive innovations. Built-in accessibility in the tools that facilitate online learning should be a priority. For an examination of courseware accessibility in relation to WAI guidelines and the course creation process, see Harrison (2001).

At issue here is the role of timely information, adequate support and training for people just learning digital literacy skills. The concept of digital literacy includes not only the skill to use information technologies (broadly defined as any technology that mediates the use of information), but also the requisite skills to decode, contextualize, and critically evaluate this information (Beynon & Mackay, 1992; Dusick, 1998; Fanning, 2000; Kellner, 2000; Langford, 1998; Rose & Meyer, 1996). An important addition to this aspect of literacy has been the concept of universal design, or accessibility, with respect to physically and/or learning disabled persons. With 20% of the population—54 million people in the US alone (Waddell, 1999)—suffering from some sort of physical or learning disability, and with this percentage increasing as the population ages, it is essential that accessibility guidelines are considered from the first iteration of online learning development.

Enabling Learning Through Technology

Accessibility is factored into building architecture from the ground up. So too should WWW and Internet architecture account for accessibility initiatives from the outset, to ensure equitable access to online resources. When developers consider technical and pedagogical accessibility, people with physical and/or learning disabilities are encouraged to become producers of information, not just passive consumers. An accessible, inclusive electronic classroom will ensure students with disabilities can participate with parity in global educational exchange (Fichten et al., 1999). What is clear from the study is that the development of the incidental skills that accrue through the use of technologically mediated learning environments results in a more engaging learning experience. Ensuring accessibility in online course designs will ensure that the wider population benefits from these programs: “For people without disabilities, technology makes things convenient; for people with disabilities, it makes things possible” (Treviranus, 2000). Following the WAI guidelines for developing and designing accessible online media can help to prevent digital divides from growing disproportionately.

Technology is enabling to those with disabilities (via accessible technology). It also enables different conceptions of teaching and learning: it mobilizes or is mobilized to construct digital pedagogies. Information and communication technologies can allow access to educational opportunities for a wider audience, especially with asynchronous online delivery of curricular materials (see Rose & Meyer, 2000). Rather than simply using online media to deliver course materials and perhaps to facilitate communication between students and instructors, these media have the potential to radically alter the pedagogy that underlies distance education. “Accessibility is the challenge that will finally push the Web to become the ubiquitous tool for interactive knowledge sharing it was meant to be. Creating an environment which is welcoming to billions of users with widely varying motivations, capabilities and needs is not a fringe goal but the critical goal” (Treviranus, 2000). Using online learning technology leads to an enhanced understanding of the ground of these media themselves; that is, a recognition of how these media operate with and in the larger context of a learning culture. Technical considerations notwithstanding, the most important element of ensuring and designing accessible media is a sound pedagogy driving the technology itself.

References


