Library Philosophy and Practice (e-journal)   Libraries at University of Nebraska-Lincoln

Assistive Technologies used in Canadian University Libraries for the Visually Impaired

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Title

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Abstract

Information has always been a catalyst for societal improvements. Libraries play a crucial role in ensuring equitable access to information resources. Enhanced accessibility helps in establishing an atmosphere that supports and promotes inclusive education. Information and resource access is quite a challenge for visually impaired people. The needs of people with varying levels of visual impairment differ in their range and magnitude. The use of assistive technologies greatly aids in closing this gap. Resource and accessibility provisions should be modified to meet the needs of visually impaired users, who need specialized equipment to access traditional and modern technology-based information resources. University libraries worldwide have used many assistive technologies to make it easier for patrons who are blind to access information resources. This research is a preliminary examination of the Dalhousie University Library's (2021) website for the assistive technology tool used to support visually impaired patrons and students. The research examines the assistive technologies used by Canadian university libraries similar to Dalhousie Libraries and offers potential implementation recommendations for Dalhousie Libraries to increase their arsenal of assistive technologies to support and promote access to visually impaired users.

1. Introduction

Assistive technology (AT) "is an umbrella term covering any item, piece of equipment, software program, or product system that is used to increase, maintain, or improve the functional capabilities of persons with disabilities" (World Health Organization [WHO], 2018). AT enables equitable and inclusive access to resources for people with disabilities and makes them capable of performing tasks they were formerly unable to accomplish. Disability is a physical or mental condition limiting a person's movements, senses, or activities, including vascular, motor, visual, auditory, and neurological. Visual disability is one of the top disabilities amongst adults and children (Centers for Disease Control and Prevention, 2020). According to the WHO, (2018) an estimate of 253 million people live   with   vision impairment, 36 million are blind,   and 217 million have moderate to severe vision impairment. Assistive technologies have significant roles in improving the quality of life of individuals with disabilities by providing better access to information, knowledge, education, healthcare, and employment. (UNESCO, 2006).

Information has always been a driving force for positive changes in society. As critical players in information and management, libraries have a significant role in improving accessibility and equitable access to information resources, creating a safe environment ensuring inclusive education, and enhancing communication and academic skills. By realizing the significance of accessibility, academic libraries worldwide implemented various technologies and tools to enhance accessibility services. Dalhousie University and many academic libraries across Canada have adopted various assistive technologies to help visually impaired patrons. This essay explores and analyzes the assistive technologies used in academic libraries in Canada for the visually impaired and provides suggestions for implementing better tools at Dalhousie University Library.

2. The rationale of the study

People with visual impairment face many challenges in accessing information. The needs of people with varying levels of visual impairment differ in their range and magnitude. Visually impaired users require specialized equipment to access information resources, and traditional sources should be made adaptable to fit their requirements. Assistive technologies help bridge this gap to a great extent. University libraries have adopted various assistive technologies to help visually impaired patrons access information services. However, a preliminary analysis of the Dalhousie University Library's (2021) website shows that only one assistive technology tool (Dragon Naturally speaking software) is listed for the visually impaired. The university accessibility website lists some assistive technologies available for free and purchase. *(Dalhousie University A*ccessibility Centre*, 2021)*. However, the full range of this genre of technologies is not being listed/utilized by the university library. In what follows, this study explores assistive technologies adopted by similar academic libraries in Canada and provides possible implementation suggestions to Dalhousie libraries in expanding their armory of assistive technologies for visually impaired students.

3. Objectives

The primary objective is to explore assistive technologies for the visually impaired used in academic libraries and review the available technologies and tools in the industry. This study also intends to look at the best practices regarding assistive technologies used in academic libraries

in Canada and provide appropriate assistive technology suggestions to the DAL libraries for implementation considerations.

4. Methodology

The study adopted a combination of literature review, looking at the websites of assistive technology manufacturing companies to identify appropriate technologies for visually impaired students and scanning the websites of Canadian universities to identify the use of assistive technology tools.

5. Background of the study

About 15% of the world's population, one billion people, experience some form of disability, and at least 2.2 billion people have a near or distance vision impairment (The World Bank, 2021). There are various levels of visual impairment, and the total loss of vision is blindness, an inclusive term in visual impairment. The World Health Organisation has adopted the International Classification of Diseases 11 (WHO. ICD 11, 2018), classifying vision impairment into two groups, distance vision impairment and near vision impairment. According to this definition, a person is visually impaired if the presenting VA (Visual Acuity) in the better eye is worse than 3/60 (WHO. *ICD-11, 2018*). Many countries have binding laws to provide equal opportunities to disabled people. The member countries that signed WHO Conventions on the Rights of Persons with Disabilities (CRPD) are bound to promote, protect, and ensure full and equal human rights. The Americans with Disabilities Act of 1990, ADA Amended Act of 2008, the Equality Act 2010 (UK Parliament), and the Canadian Charter of Rights and Freedoms, enacted in 1982, all ensure equal opportunity and accommodate the needs of people with disabilities (*Convention on the Rights of Persons with Disabilities (CRPD) | United Nations*, 2020).

Governments and institutions are bound to provide accessibility services for the disabled to ensure the right to equality. Canada has always been a pioneering nation with laws providing inclusion and accessibility for the disabled (CNIB, 2021). Accessibility refers to designing products, devices, services, or environments for people with disabilities (Henry et al., 2014). Assistive technologies enable equitable and inclusive access to resources to people with disabilities. Assistive Technology Industries Association defines assistive technology "as any item, piece of equipment, software program, or product system that is used to increase, maintain, or

improve the functional capabilities of persons with disabilities" (2015). Assistive Technologies (ATs) offer independence by enabling people with disabilities to perform tasks they were formerly unable to accomplish. The main intention of Assistive technologies in an academic environment is to sustain or enhance students' learning experience and independent functioning, thus helping them accomplish better and achieve academically. According to the 2017 Canadian Survey on Disability, more than 6 million Canadians aged 15 and over (22% of the population) identify as having a disability, and more than 8 out of 10 Canadians with disabilities use aids and assistive devices. Due to the growing awareness of AT, many companies are engaged in producing innovative equipment and software to focus on the requirements of the disabled.

University libraries worldwide adopt various technologies to empower students with disabilities to ensure inclusion and thus ensure accessibility. Library organizations such as the Canadian Library Association, the International Federation of Library Associations and Institutions (IFLA), the American Library Association, etc., extend various support services by providing guidelines on assistive technologies. Professional organizations such as RESNA (Rehabilitation Engineering and Assistive Technology Society of North America: https://www.resna.org), **ATiA** (Assistive Technology Industries Association: https://www.atia.org), **RNIB** (Royal National Institute for the blind: https://www.rnib.org.uk), **AHEAD** (Association of Higher Education and Disability: https://www.ahead.org/home), **CNIB** (a Canadian non-profit organization that advocates to empower people impacted by blindness: https://www.cnib.ca/) etc., have been providing commendable services in promoting and popularizing assistive technology devices. ABLEDATA, funded by the National Institute on Disability and Rehabilitation Research, Department of Education, USA, is an excellent database providing information of over seventeen thousand rehabilitation products from two thousand plus manufacturers in the US and Canada (Clemmons, 1991).

6. History of Assistive technologies for the visually impaired

Modern assistive devices for the visually impaired do not have a long history. Braille was invented by Louis Braille in 1824, allowing blind people to read. Other assistive technology devices' timelines are listed below.

On July 18, 1892, Frank Hall invented the first brailler machine. On January 30, 1928, The American Foundation for the Blind began distributing radios to enable blind individuals to gain access to information. On October 5, 1935, talking books were invented, often known as phonographs by Thomas Alva Edison. The first voice synthesizer was conceived on July 1, 1936, and both text-to-speech and speech-to-text technologies arose from this early creation, known as the Voder. David Abraham created the Perkins Brallie prototype on August 7, 1941. His design was groundbreaking since it was light, quiet, and less likely to break. The first Perkins braille machine was manufactured on April 11, 1951. Even though a prototype had been accessible for a few years, these machines could not be manufactured during World War II due to manufacturing materials for the war effort. Many persons with vision impairments were able to access printed content when Ray Kurzweil produced the first "talking" reading machines in 1975. The Speech Synthesizer TSI, a speech+ portable calculator, designed for individuals with visual disabilities, was released on July 19, 1976. Ray Kurzweil, the creator of the reading software that bears his name, made significant advances in Omni-font optical character recognition (OCR) and flatbed scanner technology on October 21, 1976. He connected such technologies to a text-to-speech synthesizer to make a reading machine. On July 18, 1977, Paul Schwejda and Judy McDonald designed the Adaptive Firmware Card (AFC), which allowed persons with impairments to use a computer with only one switch and an alternative keyboard. Drs. Jim and Janet Baker launched Dragon Systems on February 6, 1982, employing early voice synthesizing technology that was refined by other engineering consortiums, notably the Defense Advanced Research Projects Agency (DARPA). They also used the "Speak and Spell" toy from Texas Instruments. Kurtzweil Educational Systems introduced text-to-speech functionality on April 11, 1996, allowing anyone with a visual impairment. On February 5, 2008, 57 years after the first Perkins Brailler was created, the next generation Perkins Brailler was introduced, reconfigured for the twenty-first century. Perkins Smart Brailler-Computer Interface debuted on September 1, 2012. This gadget includes a USB port, text-to-speech functionality, and a standard braille interface. (Timeline of Assistive Technology in History, 2021.)

7. Literature review

There have been several studies in Assistive technologies in university libraries of various countries. Some studies emphasized the accessibility aspect, while others assessed from an inclusion perspective.

Many universities in Asian and African continents do not have adequate assistive technologies. A study by S. Dodamani & A. Dodamani (2019) of 185 universities in India reported that only 23 percent of universities have provisions for Assistive Technologies for students with visual impairment. Another study at the University of Khartoum by Abdelrahman (2016) revealed that the services and facilities available are inadequate. Osadebe et al. (2019) reported that Nigerian federal university students were not satisfactory on assistive technology provisions in their universities. Their study recommended that university libraries regularly conduct user-satisfaction studies to ensure that their services meet clients' expectations.

Another study from the United Arab Emirates by Al Harrasi & Taha (2019) revealed that the visually impaired students were not happy with library services to adequately answer their needs for accessing digital content and using online services.

Some studies evaluate academic librarians' skill sets in providing assistive technology services. A survey conducted in the University libraries of Zimbabwe established the need to scale up AT training of academic librarians. (Munyoro et al., 2021)

A Qualitative Study about Blind User Experiences in US Academic Libraries done by Mulliken (2017) revealed that a more significant number of participants reported contacting librarians for helping with assistive technology use.

A recent study by Alabi & Mutula (2020) on assistive technologies in academic libraries in the UK and the USA for visually impaired students found that most university libraries use Job Access With Speech (JAWS) software. The study highlighted that one university library provided its mission statement on its website that supports disabled students.

A survey of assistive technology use for the visually impaired in academic libraries was conducted by Tripathi & Shukla (2014). They highlighted the need for governmental intervention to enact friendly laws to avoid discrimination towards the visually impaired.

8. Commonly used Assistive Technology tools for the visually impaired

There are different categories of assistive technologies based on the functionalities they offer. Reading aid and writing aids are the two broad categories.

8.1. Reading aids

There are different tools available for low-vision people and the completely blind.

Screen magnifiers

Screen magnifiers are one of the widely used technology for the visually impaired. Many computer operating systems such as Windows, Mac, and mobile operating systems such as Android and iOS have in-built screen magnifying software. These tools help magnify the text and images on the screen to multifold. Users can focus on the area where they want to read.

Hand-held Magnifiers

These tools are helpful for low vision students to magnify texts and objects. Several models with different ranges of magnifying powers are available in the market.

Video Magnifier

Video magnifiers are available in various formats in a hand-held device, part of a computer system or projector, stand-alone device, etc. Video magnifiers are capable of greater magnification compared to normal magnifiers.

Screen readers

These are software that converts text to speech. There are various options available in controlling the speed and accent of the voice.

Speech recognition software

This software convert speech into text. It is beneficial for visually impaired students to convert their voices to text on the screen. Mac and Windows operating systems and smartphones have inbuilt speech recognition software.

Refreshable Braille displays or Braille terminals

Braille terminals comprise a rubber strip with pins. By raising and lowering the pins, users can read Braille strips.

Audio Books

Audiobooks can be accessed using dedicated computer software, devices, or mainstream tools like MP3 players and are usually recorded using a human voice. There are many options and features like searching and navigating an audio file.

Writing tools

Adaptive Paper

Adaptive papers are beneficial for low-vision students. These papers are with darkened lines, raised lines, or color and can considerably improve writing.

Slate and Stylus

Like paper and pencil, the slate and stylus can be used by the blind. Though they are not practical for longer writing tasks, the slate and stylus is simple tool that enables students to instantly and effectively complete simple tasks like creating labels or writing notes to themselves.

Hand-held Digital Recorder

 A hand-held digital recorder helps create self notes, record lectures, and dictate assignments.

Word Processor with speech recognition

Speech recognition software is available in specialized word processors, which enables students to dictate, and the software converts it into text.

Braille writers

Similar to a manual typewriter, a braille writer enables the blind to type using a braille key-set. Electronic typewriters have built-in screens and speakers for getting immediate visual and audio feedback.

Braille Notetaker

A braille notetaker uses a braille keyboard and a refreshable braille display. Word processors and other programs such as speech output, email access, GPS navigation, and wi-fi connectivity are associated with this software, enabling users to work in multiple applications using a braille keyboard.

Braille Embosser

This impact printer allows users to print out their completed work in braille format.

Braille Translators

A braille translator converts a text file into a braille file, takes a document, and converts it into a braille file which can be sent to a braille printer or display.

Optical Character Recognition Systems (OCR)

Using OCR systems, text can be scanned and converted to speech for the blind or visually impaired or saved to a computer file. This is helpful for the blind to hear the text content through voice. InftyReader is an example of an OCR software that recognizes scientific documents, including mathematical formulae. With InftyReader results can be displayed in LaTeX, MathML, XHTML, HRTeX, and IML format (*InftyProject Software*, 2021).

Tactile graphic tools

These software tools can convert pictures, graphs, maps, etc., into tactile graphics, enabling the blind to feel the object by touching the raised lines and surfaces.

Scientific Calculator with Speech

Speech recognition calculators enable the blind to perform mathematical and scientific calculations. The results are available both in display and speech format.

Geometric Set in Braille

Braille compatible geometric set is helpful for visually impaired students in performing operations that require geometric tools.

9. Assistive technology used in university libraries in Canada

This study examined the websites of Dalhousie University and the top 10 universities in Canada (based on QS ranking: https://www.topuniversities.com/university-rankings/world-university-rankings/2022). The following assistive technology devices for visually impaired students were identified. The list below contains only the devices listed on the respective Library's website.

University	Assistive Technologies available
University of Toronto	• ZoomText Fusion (ZoomText + JAWS) • Kurzweil 3000. • CCTV electronic magnifier
McGill University	• The Library has an Accessibility Working Group (LAWG) to monitor and review accessibility services

	• McGill University website adheres to web accessibility standards
University of British Columbia	• Dragon Naturally Speaking • Read Write • Kurzweil 3000 • Inspiration
Université de Montréal	• Accessible website • Other AT technologies are not listed on the website
University of Alberta	• ZoomText • Kurzweil 3000 • JAWS 18
McMaster	• JAWS 18: • Kurzweil 3000 • ZoomText • Dragon Dictate • C-Pen Reader Pen • CCTV - Closed Circuit TV Magnifier
University of Waterloo	• Merlin HD OCR video magnifier • Pebble HD hand-held magnifiers
University of Ottwa	• Jaws 18 • Kurzweil 1000 & 3000 • ZoomText • Dragon Naturally Speaking. • CCTV video magnifier • Accessible content E-portal
University of Calgary	• Kurzweil 1000 & 3000 • TextHelp Read & Write • ZoomText • Inspiration • Dragon Naturally speaking
Western University	• Document magnifier • Access lab with various software
Dalhousie University	• Adaptive workstation with Dragon Naturally Speaking software

**Short descriptions of the software mentioned above

- Zoom Text – Screen Magnification

- Kurzweil 100/3000- Text to speech software

- Dragon Naturally Speaking – Speech recognition software

- Dragon Dictate – Speech recognition software

- Jaws 18- A screen reader for Windows

10. Web accessibility of Canadian University library websites

Accessibility Guidelines Working Group (AGWG) of Worldwide Web Consortium (W3C) published Web Content Accessibility Guidelines (WCAG) to make web content more accessible to people with disabilities. WCAG 2.0 and WCAG 2.1 standards list the guidelines and testable success criteria. There are various tools for web accessibility testing. WAVE (2020) is an evaluation tool by (*WebAIM: Web Accessibility In Mind*, 2020) that helps identify many accessibility and Web Content Accessibility Guideline (WCAG) errors and helps evaluate the web content. The study analyzed the library websites of Dalhousie Universities and other top 10 Canadian Universities(based on QS ranking: https://www.topuniversities.com/university-rankings/world-university-rankings/2022).

University	Errors	Contrast Errors	Alerts
University of Toronto	7	8	28
McGill University	20	7	21
University of British Columbia	0	9	56
McMaster University	0	42	1
Western Univrsity	1	9	11
Université de Montréal	4	16	13
University of Alberta	4	0	5
University of Waterloo	11	0	1
University of Calgary	14	35	15
University of Ottawa	53	6	3
Dalhousie University	17	22	61

The analysis reveals that WCGA 2.0 compliance is not met in some Canadian university libraries' websites, including Dalhousie University. The British Columbia and MacMaster University library websites do not have WCGA errors. Dalhousie University is in the 9th position compared to the top 10 universities with 17 errors, 22 contrast errors, and 61 alerts.

11. Assistive Technologies at Dalhousie University library

In line with the Nova Scotia Human Rights Act, the Dalhousie University Student accessibility center ensures that disabled students have equitable, inclusive access to the university's academic programs, facilities, activities, and services. The Centre is responsible for administering the university-wide Student Accommodation Policy working across all programs and faculties. As part of the inclusive policy, Accessibility Center facilitates various assistive technology through their lending library. Apple Pencil, C-pen, Dragon Naturally speaking (Dictation Software), Livescribe Smart Pen (recording device), text to speech software are some of the tools listed on the DAL accessibility center website (Dalhousie University Accessibility Centre, 2021). However, the Dal University library website has listed only one tool for the visually impaired: Dragon Naturally Speaking software (Dalhousie University Library, 2021). In 2018, a 23-year-old engineering student at Dalhousie University with a degenerative eye condition had filed a complaint with the Nova Scotia Human Rights Commission, alleging that the university failed to provide him with the required accommodations to enable him to succeed in his studies. According to doctors and CNIB, Dalhousie University should provide facilities to help him catch up with his learning. They recommended professors' lecture notes and textbooks in digital format and copies of fellow students' class notes to be provided to the student as per 19th September 2018 CBC News (2018). This incident highlights the need for Dalhousie university to review its accessibility and inclusion policies.

Suggestions for Dalhousie University

The study recommends making the DAL library website WCAG 2.0 compliant (*Web Content Accessibility Guidelines (WCAG) 2.0*, 2008) easily accessible for visually disabled people. After analyzing the assistive technologies used by other academic libraries, professional organizations, and trade websites, the study suggests the following assistive technologies for the visually impaired for DAL libraries that are not currently available. The descriptions of these AT tools are mentioned in section 8 of this document.

- Screen magnifiers
- Hand-held Magnifiers
- Video Magnifier

- Screen readers
- Speech recognition software
- Refreshable Braille displays or Braille terminals
- Audio Books
- Writing tools
- Hand-held Digital Recorder
- Word Processor with speech recognition software
- Braille writers
- Braille Notetaker
- Barille Embosser
- Braille Translator
- Optical Character Recognition Systems (OCR) with text to speech converter

12. Conclusion

Summary of Key points

- Canadian University library websites list the assistive technology facilities in the respective websites. Dalhousie University provides only one tool (Dragon naturally speaking software) details on their website, and it is not clear whether the Library has more assistive technology tools for helping its users.

- Some University library websites are not WGCA compliant. Dalhousie University Library website has 17 errors, 22 contrast errors, and 61 alerts.

- Screen magnifiers, Handheld Magnifiers, Video magnifiers, Screen readers, Speech recognition software, Audio Books, Video Magnification/CCTV are the tools that are common in most libraries.

General conclusion

Compared to other Canadian University libraries, there are fewer options in Dalhousie university libraries for assistive technologies for the visually impaired. The university should make further efforts to create an accessible environment with assistive technologies to meet the visually challenged students' information needs. Concerted efforts need to be taken to introduce and maintain these facilities for the visually impaired user community. The provision for inclusion should not be restricted or confined to a few books of braille stacked in the libraries. Instead,

provision should provide for assistive technology devices using which each book in the Library could be accessible for the blind or the vision impaired students. Advanced IT applications have enabled university libraries to provide innovative library services to their patrons.

From a broader perspective, some governmental-level control for all books being published globally to be made available in formats that are usable for the visually impaired and be freely distributed to academic libraries

Further, research needs to be undertaken to determine visually challenged students' information-seeking behavior, study their requirements, use available assistive technology devices for accessibility for their academic pursuits, and assess their satisfaction level.

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