Digital inclusion for visually impaired students through assistive technologies in academic libraries

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Introduction

A visual disability could mean partial sight, low vision, color blindness or total blindness. People living with visual disabilities struggle with two major challenges: difficulty in accessing (retrieving and reading) materials in print and navigation. Golledge (1993) notes that people living with visual disabilities have difficulty in performing daily routines such as locating streets, reading store names, reading product information and other information in print format. There are restrictions in their mobility because of cognitive limitations and fear of falling (Worth, 2013; Wong, 2018). Students with visual disability face difficulty in getting to classrooms and other places within and outside the campus. In general, people living with disabilities, especially those who are visually incapacitated, suffer exclusion from active participation in society. This is conflicting to the themes of the UN global development agenda, sustainable development goal (SDG) four, which states that governments and policymakers across the globe should create an enabling environment (physical and virtual) for people living with disabilities to enable them have unfettered access to school buildings and other educational and recreational facilities, including libraries, dining areas, toilets and playgrounds.

With assistive technologies (ATs), those with disabilities are able to participate in society; communicate effectively; have access to, and exchange information without restriction; and not experience digital and social inclusion (Lloyd *et al.*, 2016; Ragnedda, 2017). Regrettably, most libraries do not give adequate attention to provision of ATs to the visually impaired students. They experience difficulties in having access to information, face lack books in accessible formats and face marginalization or total exclusion from policies on library services and access to library websites (Zaid, 2017; Kaunda and Chizwina, 2019).

The emergence of new technologies has been widespread, and libraries should not be left out (Oyelude, 2017). These technologies are referred to as assistive or adaptive technologies. By definition, AT is any device, equipment or product, whether acquired commercially, modified or customized, to increase, maintain or also to improve the functional capabilities of any individual with a disability (Munin and Yu, 2017, p. 446). ATs can be divided into two categories, namely, low-tech and high-tech, with the low-tech category being less expensive. They can also be classified according to their functionalities into academic and learning technologies, daily living, listening for computer access and instruction and mobility aids. AT can be computer hardware or software or electronic device.

With the aid of ATs, visually impaired students are able to gain autonomy, improved quality of life and are able to participate in society (Riemer-Reiss and Wacker, 2000). AT also serves as an avenue for compensation for inherent constraints experienced by people living with visual disabilities and help them to tackle obstacles in the digital environment, thereby giving them equal opportunities as their sighted counterparts (Koulikourdi, 2008). The Convention on the Rights of Persons with Disabilities (CRPD) mandated that people living with disabilities be provided with ATs. This mandate is well supported by the World Health Organization (WHO) in partnership with UN agencies, donor agencies, professional organizations, academia and industry through the Global Cooperation on Assistive Technology (GATE). Next, we explore the state-of-the-art ATs developed for visually impaired people and those that should be included in academic libraries as a way of proffering solutions to the challenges faced by visually impaired students in accessing information in achieving their academic goals. With developments in artificial intelligence, people living with visual impairment can now live more independently.

High-tech assistive technologies

To help people living with visual impairment overcome the problem of navigation, the following ATs have been developed:

Vizorro is a small wearable laser navigation device that measures the distance to any obstacle at which user points it. It enables blind people "sense" the distance to different obstacles using the principle of sensory extension. It can be moved in different directions, and it helps the user "scan" the environment for obstacles. More information can be found at: www.indiegogo.com/projects/vizorro-laser-navigation-for-the-blind–3#/

Sunu – ultrasonic wearable (mobility and independence), Sunu Band is the first smart-bracelet that uses an object tracker to enhance mobility and independence for the visually impaired individuals. It is capable of sensing environment and delivering feedback on the wrist to indicate proximity with its ultrasonic technology. With the help of the Sunu Band, visually impaired individuals can navigate easily with precision and feel what is around them without physical contact. It is suitable for individuals who are totally blind, have low vision or are partially sighted. See www.indiegogo.com/projects/sunu-ultrasonic-wearable-to-heighten-perception#/

WeWALK Smart Cane (innovative smart cane for full participation in the society) was designed by a visually impaired person known as Kursat Ceylan, who was blind since birth. This smart cane helps visually impaired people move independently and gain full participation

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in society through smartphone integration via Bluetooth, advanced obstacle detection, navigation through Google maps, Alexa enablement, open platform for endless practical skills and 20-h battery life. More information can be found at: https://wewalk.io/en/product/wewalk-smart-cane/

Parsee Smart Glasses (reading and navigation) is a pair of 3D high-tech smart glasses that help visually impaired and totally blind people perceive and explore their world as sighted people. It consists of a 3D frame, rechargeable battery, Internet Protocol (IP) camera and earphone. It uses text, face shape and color recognition to provide audio information to the user through an earphone. With these glasses, visually impaired people can read anything in print. The condition for its use is that there must be access to a mobile network and a smartphone. The overall benefit of this AT is that it provides full mobility and can be used without restrictions, enabling visually impaired individuals to recognize text, face, shapes, items and colors. See more at www.indiegogo.com/projects/parsee-world-s-first-free-glasses-for-blind-people

BLITAB (Tablet for the Blind) (Reading) is the world's first tactile tablet for blind and visually impaired people. With innovative stimulating technology, it creates tactile text and graphics in real-time. Visually impaired students can control the tablet with voice-over to listen to an e-book. With the use of a side button, the top half of the device turns into a Braille reader. It enables visually impaired students download documents and web pages and read them in Braille. More information on AT for people living with visual disability is provided by the National library Service (NLS) for the Blind and Print Disabled Library of Congress and can be found at: www.loc.gov/nls/resources/blindness-and-vision-impairment/devicesaids/assistivetechnology-products-information-access/ (Figure 1).

Job Application With Speech (JAWS) is the most common screen reader for visually impaired people. It works well with Windows and gives access to software applications and the internet by reading the content.

Kurzwei software scans material in print and reads it aloud to the user. It is available in two versions, namely, 1000 and 3000 Scan, and reading software scans printed material and reads it aloud to user by converting print into speech. It can also covert text into Mp3 files and DAISY books.

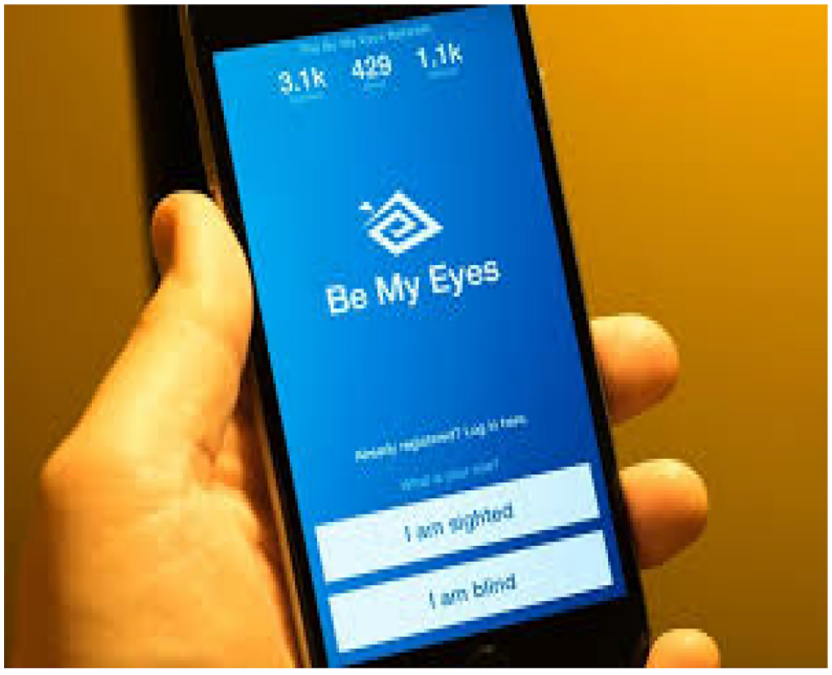
Figure 1. *BLITAB*

DAISY (Digital Accessible Information SYstem) books are digital audio books that allow easy navigation through texts by page and chapter. Using EasyProducer software, text can be turned into DAISY, and with the help of a DAISY player (e.g. Victor Reader, Plextalk, EasyReader), visually impaired students can listen to DAISY books in audio formats.

Supernova is both screen reader and screen magnification software that allows for up to 60 times magnification and diverse screen magnification styles.

ClaroRead is software that helps people living with visual impairment to read, write, study and sit for exams. The ClaroRead Plus and Pro versions have features that help visually impaired students to read any print material that

Figure 2. *Be My Eyes*



is scanned. It is useful in creating "audiobooks" from journal articles or book chapters.

ZoomText software is a text and graphic magnifier software that enlarges text and graphics on the computer screen from 2 to 16 times its actual size.

Dragon Naturally Speaking is speech recognition software which allows use of the voice instead of typing by turning speech into text. It allows students living with visual disability perform tasks such as document preparation using the Microsoft Office software such as Microsoft Word, Excel, etc.; control the PC; and use email. It has a dictionary and a spell checker.

MyReader auto reader is the first portable auto reader just like a CCTV/video magnifier, but it can be carried easily around by the user. When a book is placed underneath the camera, it captures and enlarges the text size on a display screen. It can capture up to ten pages at a time and has a selection of different color combinations for contrast.

Audio Notetaker for Windows and Mac allows one to capture full recordings of classes and meetings and to work with that audio for students to record lectures and organize their lecture notes into different sections according to the module or the lecturer. An example of an Audio Notetaker is Sonocent.

Smartphones allow visually impaired students to access free and fee-based apps such as Be My Eyes and ColorSay. Be My Eyes is a new app that allows blind people to "borrow" the eyes of a volunteer by connecting the phone camera of a blind person to the phone of a sighted volunteer to perform short tasks such as reading product information in a store. ColorSay enables people living with visual impairment identify colors by pointing their camera at something. More information about apps for visually impaired students can be found at AbilityNet www.abilitynet.org.uk/news-blogs/top-ten-apps-visually-impaired-students (Figure 2).

Ensuring digital inclusion for the visually impaired in academic libraries through assistive technologies

Academic libraries can leverage ATs as information access mechanisms on the one hand, and as a platform for ensuring digital inclusion for students living with visual impairments on the other hand. In a contemporary academic

Table I.
Top universities in the world and types of ATs used as information access mechanism for the visually impaired students

Institution	Types of ATs provided	Innovation
Massachusetts Institute of Technology (MIT), USA	Kurzweil 1000 and 3000 Scan and Read software, JAWS, ZoomText software; TeleSensory Vantage 14" CCD, Low Vision Video Magnifier (5x to 45x) and alternative keyboards (Microsoft Natural Keyboard Pro and Goldtouch Keyboard). More information can be obtained at: https://libguides.mit.edu/c.php?g=176047&p=1160449 and http://studentlife.mit.edu/atic/assistive-technology/software#Reading%20Software	
Harvard University, USA	SensusAccess, Kurzweil 1000, Kurzweil 3000, JAWS, ZoomText, Optelec ClearView and CCTV. See https://accessibility.harvard.edu/assistive-tech-lending	University Disability Resources (UDR) manages the Assistive Technology lending Library and Lab (ATLLL) through giving loans or licenses or for in-lab use
University of Oxford Bodleian library, UK	JAWS, Supernova (screen reader/magnifier), Kurzweil 1000 and 3000, Dragon Naturally Speaking, DAISY Books and My Reader Auto Reader See www.bodleian.ox.ac.uk/using/disability https://www.bodleian.ox.ac.uk/using/disability/resources/assistive_technology	There is a disability support librarian
University of Cambridge, the Cambridge University Library, UK	Dolphin Supernova software, Dragon scanners, adjustable keyboard, a trackball mouse, headphones, microphone and CCTV scanner. More information can be found at www.lib.cam.ac.uk/using-library/readers-disabilities/assistive-technologies	These facilities have been made possible by a generous donation from the Abbey Charitable Trust. There is a disability support librarian with the contact: disability@lib.cam.ac.uk
UCL, UK	JAWS, ZoomText, Dragon, Read and Write Gold Apps: Be My Eyes, ColorSay and NVDA See www.ucl.ac.uk/isd/services/accessibility-disability-it/disabilities/visual-impairments	The ATs are provided at the Digital Accessibility Hub to assist disabled students study independently. The opening hour is from 9.00 a.m. to 8.00 p.m. Monday to Sunday
The University of Chicago, USA	Computer, scanner, MAGic, Openbook, JAWS software and Kurzweil 3000 See www.lib.uchicago.edu/research/help/infofor/accessibility/ for more information	The institution provides a mission statement on support for people living with disability on the university's website
Cornell University, USA	JAWS screen-reading software, text magnification LCD screen, assistive laptops which include Dragon NaturallySpeaking software See www.library.cornell.edu/services/disability	

Source: Researcher composed data

library environment, ATs such as screen magnifiers, screen readers, optical character recognition software, text-to-speech software, voice recognition software, translation, scanners with specialized keyboards and closed-circuit television (CCTV) are necessities. The most commonly used screen reader software is the JAWS. JAWS, with its propensity for speech and Braille output, enables people living with visual impairment navigate the internet, write a document, read an e-mail and make presentations. Zoom text Xtra remains the most popular text magnifier or screen enlargement software. Other screen readers/enlargement software are Window-Eyes, non visual desktop access and Cobra and Dolphin. Among the text-to-speech software are ClaroRead and Read and Write Gold. Optical character recognition software include ABBYY, OmniPage, SARACE, OpenBook and Kurzweil. There are specialized keyboards such as braille keyboards and large print keyboards. Out of fourteen of the top world universities, only seven provide information on their website on various ATs used as information access mechanism for visually impaired students or those with other forms of disability. Findings are presented in Table I.

Conclusion

ATs are beneficial to people living with visual disabilities. Library directors should give adequate attention to budget for, and appropriate space for the the use of these technologies in the library. It is also imperative that a librarian be designated to meet the needs of students with visual and other limiting disabilities. Access to ATs in the library is a fundamental human right.

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