CONNECT A SCHOOL CONNECT A COMMUNITY

TOOLKIT MODULE

Using ICTs to promote education and job training for persons with disabilities

EXECUTIVE SUMMARY

Persons with disabilities in developing countries face particular difficulties in accessing the most basic forms of education. They face the lowest levels of educational access of any cohort of students. Of the 75 million children of primary school age worldwide who are out of school, for example, one-third are children with disabilities.[1]

Information and communication technologies (ICTs), and in particular assistive technologies (ATs), can provide persons with disabilities access to traditionally inaccessible educational content through electronic and online learning channels. Connected schools, with the right mix of ATs, can provide children and other persons with disabilities unprecedented access to education.

Connected, accessible schools can also be leveraged to create accessible community ICT centers, facilitating job-skills training and even providing employment opportunities for youth and adults with disabilities in the wider community.

1 What Are Accessible ICTs?

An *accessible* ICT product or service is one that can be used by all of its intended users, taking into account their differing capabilities. Accessible ICTs have the potential to provide persons with disabilities unprecedented levels of access to education, skills training and employment, as well as the opportunity to participate in the economic, cultural and social life of their community.

Two examples to illustrate how all these elements work together to make an accessible experience for a person with a disability are:

- **Making a call on a mobile phone:** A person with a hearing impairment wishes to make a call on a mobile phone. This person uses a piece of assistive technology (AT) called a hearing aid, which helps amplify sounds from the person's surroundings. An accessible experience is only possible in this instance if the hearing aid and the mobile phone are compatible with one another. If they are not, it is likely that the person will hear a loud whining noise, known as feedback, when the phone is placed near the hearing aid. Once the hearing aid and the phone are compatible, the person can then make and receive a phone call in the same way as would a person without a hearing impairment.

- **Browsing a website:** Consider a blind person who wishes to browse a website using a personal computer. The person uses a sophisticated piece of AT called a "screen reader," which is capable

[1] http://www.unesco.org/en/inclusive-education/children-with-disabilities/ See also, http://data.un.org/Data.aspx?q=disability&d=SOWC&f=inID%3a150

of converting text on the computer screen into synthesized speech. The person can also navigate around a website and input text into an online Web form by using this screen reader in conjunction with a standard keyboard. In this scenario, several things must happen for the person to have an accessible experience.

1. A localized version of the screen reader (i.e. adapted to local requirements in terms of language and culture) must be available.[2]

2. The person must have access to, and be trained in using, the screen reader.

3. The screen reader and the PC must be "interoperable" or compatible -- i.e., the screen-reading software must be able to control the browser and the operating systems on the computer.

4. The Web content on the website the person is browsing must also be designed to be accessible, based on international standards.

There are many policies, technologies and processes involved in bringing ATs to persons with disabilities.

1.1 The Benefits of Accessible ICTs in Connected Schools

A meta-study on research into use of accessible ICTs showed that they bring the following benefits to all stakeholders involved in education, including students, teachers, parents and care-givers: [3]

General benefits:

- Enable greater learner autonomy;
- Unlock hidden potential for those with communication difficulties;
- Enable students to demonstrate achievement in ways that might not be possible with traditional methods;
- Enable tasks to be tailored to suit individual skills and abilities.

Benefits for students:

- Computers can improve students' independent access to education;
- Students with special educational needs are able to accomplish tasks working at their own pace;
- Visually impaired students using the Internet can access information alongside their sighted peers;
- Students with profound and multiple learning difficulties can communicate more easily;
- Students using voice communication aids are able to gain confidence and social credibility at school and in their communities;

[2] http://portal.bibliotekivest.no/terminology.htm#L

[3] BECTA ICT Research (2003) *What the research says about ICT supporting special educational needs (SEN) and inclusion.* Available at http://research.becta.org.uk/upload-dir/downloads/page_documents/research/wtrs_motivation.pdf

- Increased ICT confidence amongst students motivates them to use the Internet at home for schoolwork and leisure interests.

Benefits for teachers and non-teaching staff:

- Reduced isolation for teachers working in special educational fields, enabling them to communicate electronically with colleagues;
- Support for reflection on professional practice via online communication;
- Improved skills for staff and a greater understanding of access technology used by students;
- Enhanced professional development and improved effectiveness in using ICTs with students, through collaboration with peers;
- Materials already in electronic form (for example, from the Internet) are more easily adapted into accessible resources such as large print or Braille materials.

Benefits for parents and care-givers:

- Use of voice communication aids encourages parents and care-givers to have higher expectations of children's sociability and potential level of participation.

With regard to accessible ICTs, employment and education, the obligations of government officials under the *UN Convention on the Rights of Persons with Disabilities* are:

- In general, accessible ICTs should facilitate the enjoyment of many other rights, including access to education and employment.
- Access to ICTs, including the Internet, are to be given the same priority as access to buildings and transportation.
- The universal design of mainstream products and ICTs that are accessible to persons with disabilities are to be promoted through research and the development of appropriate guidelines and standards.
- Research and development and promotion of new accessible ICTs, including assistive technologies, are to be undertaken with an emphasis on affordable solutions.
- Professionals and staff working with persons with disabilities should receive training on these rights and how they can be realized. This includes training as appropriate for teachers, educators, care workers and job trainers on how accessible ICTs can be used to provide access to education and job training.

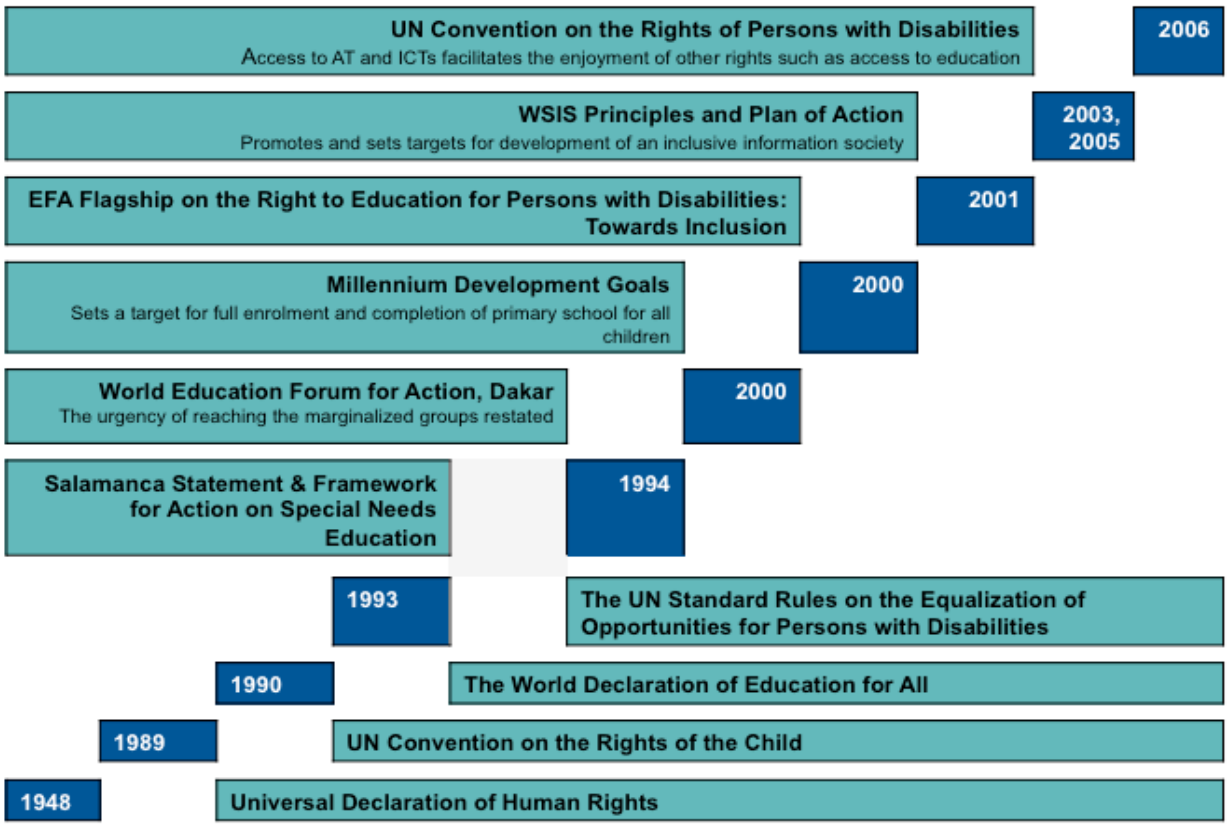
1.2 International Statutory Basis

The *UN Convention on the Rights of Persons with Disabilities* places significant obligations on all state officials responsible for equal access to education and employment opportunities.[4] The Convention

[4] Full text of the Un Convention on the Rights of Persons with Disabilities is available here: http://www.un.org/disabilities/default.asp?navid=13&pid=150

contains a number of innovative and progressive concepts on the enjoyment of human rights by persons with disabilities.[5] It also holds that the accessibility of ICTs is equally important as the accessibility of other domains, such as the built environment and transportation.

Figure 1.1 Overview of legal frameworks in support of the use of accessible ICTs in inclusive education



As seen in Figure 1.1, a series of relevant international documents led up to the 2006 Convention. The body of international policy and legislation on the rights of persons with disabilities is strongly in support of children with disabilities receiving their education in an inclusive, rather than segregated, school setting. National governments, therefore, have significant human rights and educational work to do in relation to the provision of education for children with disabilities. The major tendency in new policy approaches is towards inclusive education.[6] Whatever the policy environment, accessible ICTs can significantly empower children with disabilities to participate in lessons, to communicate, and to learn more effectively.[7]

2 *The Current Situation, Challenges and Opportunities*

[5] http://www.un.org/disabilities/default.asp?navid=23&pid=151#iq1

[6] IITE page 17

[7] BECTA ICT Research (2003) *What the research says about ICT supporting special educational needs (SEN) and inclusion.* Available at http://research.becta.org.uk/upload-dir/downloads/page_documents/research/wtrs_motivation.pdf

There are very few statistical studies that can point to the number of children with disabilities who receive education. Recent reports, such as the *Education for All Global Monitoring Report 2010*,[8] show modest improvements in some countries over some previous reports.[9] UNESCO has conducted significant research into the plight of children with disabilities in developing countries. It reports that exclusion from education "is particularly more serious among persons with disabilities, of whom approximately 97 per cent do not have the basic reading and writing skills."[10] Literacy rates are as low as 1 per cent for women with disabilities.[11] In its briefing paper, *Children out of School*, UNESCO states that most children with disabilities in developing countries are not attending school, and there is "no inclusion of those with physical, emotional or learning impairments within the education system."[12]

As a result of the low levels of school enrollment and attendance by children with disabilities, the literacy rate for adults with disabilities is just 3 per cent and, in some countries, as low as 1 per cent for women with disabilities.[13] Poverty and disability are closely linked. The World Bank estimates that 20 per cent of the poorest people are disabled. An estimated 30 per cent of the world's street children have a disability. The quality of life of persons with disabilities in developing countries is significantly lower than that of their peers. In most countries, persons with disabilities tend to be regarded as the most disadvantaged sector within their society. Women with disabilities experience exclusion due to both their gender and their disability.

The vast majority of persons with disabilities are cared for exclusively by their families. In developing countries, persons with disabilities are not expected to work, and many can only receive an income through begging. According to the International Labour Organization (ILO), some 470 million people with disabilities are of working age worldwide.[14] Yet, unemployment among the disabled is as high as 80 per cent in some countries.[15]

2.1 Reasons for Exclusion

The reasons that children with disabilities do not attend school in developing countries are complex. It is increasingly accepted that the so-called *medical model* of disability often serves to stigmatize persons with disabilities while inadequately dealing with wider issues of exclusion from a person's society,

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[8] http://www.unesco.org/en/efareport

[9] A 2004 report for the World Bank stated that "estimates of the percent of disabled children and youth who attend school in developing countries range from less than 1% (Salamanca Framework for Action) to 5% (Habibi 1999)". Peters, S, 2004. "Inclusive Education: An EFA Strategy for all children". Available at http://siteresources.worldbank.org/EDUCATION/Resources/278200-1099079877269/547664-1099079993288/InclusiveEdu_efa_strategy_for_children.pdf
One estimate from China suggests that "there are 8 million disabled children while special schools cater for approximately 130,000" Watkins, K (2000), *The OXFAM Education Report*. OXFAM. OXFORD cited in UNESCO *Children out of School*

[10] UNESCO 2008 "UNESCO 48th International Conference on Education" page 30, available at http://www.ibe.unesco.org/fileadmin/user_upload/Policy_Dialogue/48th_ICE/ICE_FINAL_REPORT_eng.pdf

[11] http://www.un.org/disabilities/default.asp?navid=37&pid=1514

[12] UNESCO "Children out of School", available at http://www.unesco.org/education/efa/global_co/policy_group/children_out_of_school.pdf

[13] UNESCO 2003 "Overcoming Exclusion through Inclusive Approaches in Education Conceptual Paper" page 30, available at http://unesdoc.unesco.org/images/0013/001347/134785e.pdf
UNESCO reports that in Uganda it is "not uncommon" for children with disability or suspected of carrying HIV/AIDS to be chased away from school. UNESCO "Children out of School", available at http://www.unesco.org/education/efa/global_co/policy_group/children_out_of_school.pdf

[13] http://www.ibe.unesco.org/National_Reports/ICE_2008/afghanistan_NR08.pdf

[14] http://www.ilo.org/wcmsp5/groups/public/---ed_emp/---ifp_skills/documents/publication/wcms_117143.pdf

[15] Of the some 70 million persons with disabilities in India, for example, only about 100,000 have succeeded in obtaining employment in industry. http://www.un.org/disabilities/default.asp?id=18

environment and culture. Under the *social model* of disability, conversely, the main barriers to access for children with disabilities can be summarized as follows:

- Attitudinal – Social or institutional attitudes that persons with disabilities cannot or should not be educated.

- Physical - Most schools are not designed to accommodate the needs of children with disabilities. Inaccessible entrances, toilet facilities, corridors and doorways for people with physical or sensory disabilities make physical access to school buildings difficult and often impossible. [16]

- Pedagogical - There is little or no training of teachers in meeting the educational and communication needs of children with disabilities.

- Infrastructural – No transportation (or inaccessible transportation) is provided to enable children with disabilities to travel to school.[17]

- Policy – While most countries have a policy framework to support inclusive national educational systems, many do not have strategies in place to address the barriers preventing children from attending school. Indeed, the grossly inadequate level of support for children with disabilities in general schools often drives parents and groups representing persons with disabilities to demand separate provision of educational services.[18]

2.2 Worldwide Distribution of Persons with Disabilities

In its 2007 report, *Measuring Disability Prevalence*, the World Bank estimated the number of persons with disabilities at between 10 and 12 per cent of the global population.[19] Using the United Nation's *World Population Prospects 2008*,[20] which indicates a global population of slightly more than 6.9 billion people in 2010, Table 2.1 shows the estimated global population of people with disabilities as just under 830 million people (691-829 million people) by the end of 2010. That number is expected to exceed 1 billion (915 million – 1.1 billion) before the midpoint of the 21st century. Statistics show that approximately one in five persons with disabilities are born with their disability, while most acquire it after age 16, mainly during their working lives.[21] Approximately 20 per cent of these are children with disabilities.

Table 2.1: Global population of persons with disabilities

[16] For example, in 2005, just 18 per cent of India's schools were accessible to children with disabilities, in terms of facilities such as ramps, appropriately designed classrooms and toilets, and transport. EFA Global Monitoring Report 2010 http://unesdoc.unesco.org/images/0018/001866/186606E.pdf

[17] One survey in Bangladesh found that parents of children with disabilities saw the absence of a specialized transport system from home to school in rural areas, and the lack of subsidized support for rickshaw transport, as major constraints. (Ackerman et al., 2005).cited in EFA Global Monitoring Report 2010

[18] (Lang and Murangira, 2009). Cited in EFA Global Monitoring Report 2010

[19] World Bank - Measuring Disability Prevalence, available at http://siteresources.worldbank.org/DISABILITY/Resources/Data/MontPrevalence.pdf

Disability figures in this module are based on the World Health Organisation's estimate that 10 per cents of the world's population have a disability.

[20] UN - World Population Prospects 2008, available at http://esa.un.org/unpp

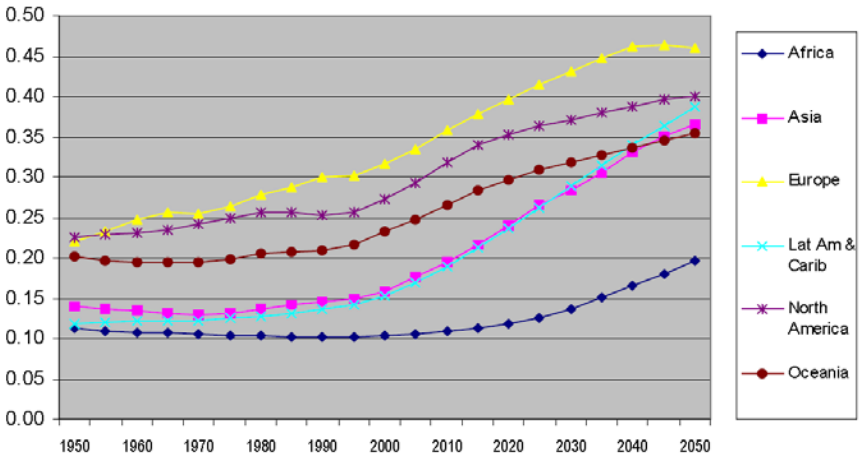
[21] Forum on Disability briefing for CSR practitioners, Disabled employees: Labour standards, an Employers", Available at www.csreurope.org/csrinfo/csrdisability/Disabledemployees

Year	2010	2020	2030	2040	2050
World Population (millions) **Medium variant**	6,909	7,675	8,309	8,801	9,150
Estimates of global population of persons with disabilities (imputed as 10-12%, in millions)	691-829	768-921	831-997	880-1,056	915-1,098
Estimate of global population of children with disabilities (imputed as 2-3%, in millions)	140-165	154-184	166-199	176-211	183-220

Sources: World Population Prospects 2008 cited in ITU/G3ict e-Accessibility Toolkit.

Another factor likely to influence the numbers of person with disabilities is the increase in percentages of older people in the world population and the associated prevalence of age-related disabilities. Figure 2.2 shows the share of persons 50 years and older by region.

Figure 2.2: Share of 50+ population by region



Source: World Population Prospects 2008

People are likely to develop new difficulties and impairments as they age – whether those impairments are sensory (vision and hearing), cognitive (thinking and communication) or motor (locomotion, reach and stretch, and dexterity). Likewise, people with existing mild difficulties and impairments may experience an increase in their severity. In any population in which the age profile is getting older, the total number of people with difficulties and impairments will increase.[22]

3 Assistive Technologies by Disability Type

Fortunately, there are multiple forms of assistive technologies (ATs) that can be employed to assist persons with disabilities of all ages. Categories of ATs include stand-alone devices that aid mobility (e.g. wheelchairs) and communication (e.g. hearing aids). They also include hardware and software that

[22] Anne-Rivers Forcke, IBM, in ITU/G3ict "e-Accessibility Policy Toolkit for Persons with Disabilities"

enable access to a computer (e.g. an adaptive keyboard or screen reader). This section deals primarily with ATs that relate directly to a person's ability to access a computer and participate effectively in an inclusive learning environment. Other concerns, such as accessibility of the building or computer workstations are also addressed.

3.1 Educational Needs of Children with Disabilities

The special educational requirements of children with disabilities caused by a functional limitation are often called *special educational needs* (SENs), and they are both diverse and varied. UNESCO groups the roles that ICTs can play into three main categories:

- Compensation uses – Technical assistance that enables active participation in traditional educational activities, such as reading or writing.
- Didactic uses – The general process of using ICTs to transform approaches to education. Many ICTs can be used as didactical tools to enable a more inclusive learning environment.
- Communication uses – Technologies that can enable communication – often referred to as *alternative and augmentative communication devices and strategies*.[23]

The following sections discuss the main categories of physical, sensory and cognitive disabilities and refer to best practices for ensuring that accessible ICTs enable learning in an inclusive school environment.

3.2 Persons with Physical Disabilities and Motor Impairments

Physical disabilities and motor impairments may result from traumatic injuries, such as spinal cord damage, or the loss of limbs due to diseases and congenital conditions such as Cerebral Palsy, arthritis or Parkinson's disease. A range of issues should be considered to enable access for persons with physical disabilities and motor impairments to a computer in a learning environment. These include (but are not limited to) the correct type of assistive technology, as well as the accessibility of the workstation and the building.

For some people, using a standard keyboard and mouse is possible, but due to tremor or low fine motor skills, default settings on the computer need to be adjusted to avoid continual errors. For other individuals, an alternative pointing or input device, such as a roller ball or switch, may be required. Users who are unable to access a keyboard using their hands or arms but have good head, neck and upper torso control may be able to type on the keyboard using a mouth-stick or head/chin pointer.

3.2.1 Mouse Alternatives and Replacements

Trackballs, joysticks and various forms of tablets are frequently easier to control than a mouse. The mouse pointer may also be controlled using head movements, which are tracked using infrared or ultrasound technology. Buttons on many alternative pointing devices can be programmed to perform a double click or to lock down the mouse button for a drag. Mouse buttons can be replaced with switches (e.g., puff-sip switches, foot pedal switches, etc.) or with software that performs the mouse click, double

[23] UNESCO IITE ICTs in Education for People with Special Needs. http://www.iite.ru/pics/publications/files/3214644.pdf

click, and drag by dwelling on a target for a predetermined time and then moving the mouse cursor in one of four directions.

The mouse pointer can be controlled using keys on the numeric keypad, or keys on an on-screen keyboard. Mouse emulators exist for single-switch users and users of voice recognition systems. These emulators employ a variety of strategies to quickly zero-in on the target.

3.2.2 Keyboard Modifications and Alternatives

Free software or operating-system modifications allow changes to be made to keyboard responses by slowing response time, eliminating or slowing key repeat rates and holding keys used in multiple key depressions when selected sequentially. Standard keyboards are also available with on-board memory for text or command macros. Mainstream alternatives include keyboards that are smaller, more ergonomically shaped, provide more efficient keyboard layouts (e.g., DVORAK or QWERTY) and have built-in trackballs or other mouse alternatives.

Specialized keyboards have been developed to accommodate a variety of individual needs. Miniaturized keyboards accommodate persons with limited range of movement or strength. These may have mouse emulation as a built-in feature. Enlarged keyboards are more suited to persons with poor motor control but adequate range of movement. Programmable keyboards allow for customization of the keyboard layout (key content, key size), with individualized overlays depicting the key contents for the user. Keys may also be programmed with mouse emulation functions. Numerous on-screen keyboard software programs allow the user to select keystrokes (e.g., letters, words, commands, phrases) using a mouse or mouse emulation.

Switch input devices can be used by persons who are unable to use a keyboard or mouse but who have good control of some other muscle groups. Switches can be used to emulate keyboard and mouse functions. Single, dual or three-switch input of Morse code, for example, can be translated by a hardware and/or software interface into keyboard and mouse inputs to the computer.

3.2.3 Voice Recognition

Voice recognition of commands or text input is available with some operating systems. Continuous speech voice recognition software that provides text input, mouse control and software application control, including optional levels of vocabulary and macros for various professions or specialty groups, is also available. Although voice models in the system allow the recognition of words without explicit training, each user has their own voice model file, which should be adjusted to allow optimal recognition. Proper maintenance of the voice model requires vigilance to errors made by the user and the system and proper correction of the errors. Most voice dictation systems have very large dictionaries, but the user must add proper names and specialized vocabulary. Several dictation systems rely on mouse controls to navigate the desktop and dictation functions.

3.2.4 Augmentative and Alternative Communication

Many people with a severe physical disability may also have speech impairments. Augmentative and alternative communication (AAC) is a way of communicating, not only for those with speech impairment

but also for those with difficulty in comprehending spoken or written language.[24] AAC strategies vary from the use of symbols or gestures to the use of AAC devices such as (a) text-to-speech generating (Fig 3.1) devices and (b) speech generating (Fig 3.2) devices. While AAC strategies and devices are not an integral part of enabling computer access, they are essential in enabling two-way communication in an inclusive education, job-skill training or work environment with teachers, trainers, fellow students and work colleagues.

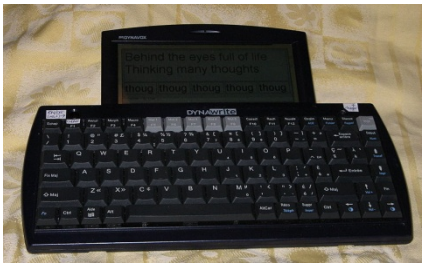


Fig 3.1 Keyboard text-to-speech generating device[25]

Fig 3.2 Speech generating device

3.2.5 Accessible Buildings and Workstations

In addition to providing the correct AT, it is important that the design of the building not present a barrier. To ensure that a school, training center or community center is accessible to persons with disabilities, builders should refer to appropriate building accessibility guidelines and national or regional building regulations. However, the following checklist provides some of the main areas to consider:

- External environment – e.g. parking spaces, entrance doors;
- Horizontal circulation – e.g. internal door design and width, corridors, signage and way-finding;
- Vertical circulation – e.g. internal stairs, elevators and ramps;
- Facilities – e.g. accessible toilets;
- Emergency egress – e.g. auditory and visual alarm systems, evacuation policies, evacuation chairs; and
- Accessible entrances – level entry or a mixture of steps and ramps.[26]

The path to the computer workstation must be free from obstacles such as steps, bins or furniture that would obstruct the progress of users who are either walking or using a mobility aid such as a wheelchair. This includes the path into any room or area containing the computer workstation. The user should be able to operate the computer from a clear, flat area with at least a 1.5 meter radius directly in front of the computer workstation to enable a wheelchair to turn (Fig 3.3). Ensure that users of all heights can reach all operable parts. The comfortable range is between 1200 and 900 millimeters (mm). The maximum

[24] http://en.wikipedia.org/wiki/Augmentative_and_alternative_communication
International Society for Augmentative and Alternative Communications (ISAAC) http://www.isaac-online.org/en/publications/index.html

[25] http://en.wikipedia.org/wiki/File:Dynawrite.jpg

[26] National Disability Authority, "Building for Everyone - Inclusion, Access and Use" http://www.nda.ie/cntmgmtnew.nsf/0/EBD4FB92816E8BB480256C830060F761?OpenDocument

acceptable reach height for wheelchair users is 1400mm (See Figure.3.4). There should be adequate lighting. The United Nations has a useful set of anthropometrical data covering ranges of height and reach when standing or sitting in a wheelchair, plus required path and turning space dimensions for wheelchairs.[27]

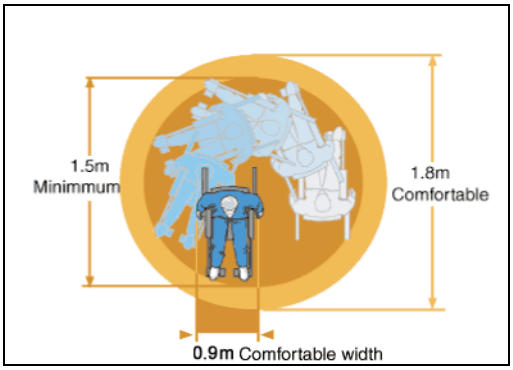


Figure 3.3 Wheelchair clearance and turning circle[28]

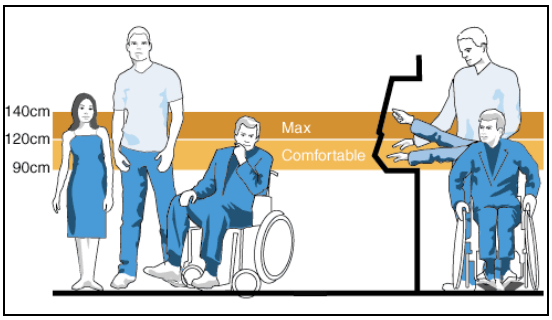


Figure 3.4 Common reach zones [29]

3.3 Assisting the Blind or Vision-Impaired

There are an estimated 180 million people worldwide who have a visual impairment. Of these, 45 million persons are blind and 135 million have partial sight.[30] Legal blindness is defined in many countries as a condition in which the best corrected visual acuity is 20/200, or less, or the person's visual field is 20

[27] http://www.un.org/esa/socdev/enable/designm/AD5-02.htm

[28] Irish National IT Accessibility Guidelines, Public Access Terminals. National Disability Authority. http://universaldesign.ie/useandapply/ict/itaccessibilityguidelines/publicaccessterminals/guidelines/priority-1/1-14

[29] Irish National IT Accessibility Guidelines, Public Access Terminals. National Disability Authority. http://universaldesign.ie/useandapply/ict/itaccessibilityguidelines/publicaccessterminals/guidelines/priority-1/1-1

[30] Lighthouse International, available at http://www.lighthouse.org/research/statistics-on-vision-impairment/ World Health Organization, November 2004, "Fact sheet 282: Magnitude and causes of visual impairment, available at http://www.who.int/mediacentre/factsheets/fs282/en/ " World Health Organization, November 2004

degrees or less.[31] Vision impairments include color blindness, and vision disorders include cataracts, trachoma, glaucoma and macular degeneration.[32]

Blind persons and persons with vision impairment can use a variety of assistive technologies to access computers and electronic content.

- Enhancements to the visual display of the computer - Adjustments can be made to the visual display using built-in system controls or free software. These adjustments provide higher contrast and can enlarge icons, display fonts and mouse cursors.

- Screen magnification - Screen magnification may be possible within the operating system of the computer. A large number of screen magnification programs are also available.

- Alternatives to the visual display - These include screen readers, which speak the text displayed on the screen, and refreshable Braille displays, which translate the text to Braille. Examples of screen readers include the following: JAWS, NVDA, Windows Eyes, Homepage Reader and ORCA.

- Optical character recognition (OCR) – Document scanners, in conjunction with OCR software, can translate printed text to electronic text that can be magnified or read aloud using the AT mentioned above.

- Note-takers, or accessible Personal Digital Assistants (PDAs) -- These are specialized and portable combined hardware and software solutions that typically incorporate a refreshable Braille display and screen-reading functionality. Examples include Braille 'n Speak, Type 'n Speak, Braille Lite Millennium (or 2000), Type Lite, BrailleNote (and VoiceNote), PAC Mate and BrailleSense. [33] These devices cost in the region of USD 6,000 or more.

- Braillers -- *Brailler* is the name generally given to a low-tech mechanical device, similar to a typewriter, with the capability for direct output of embossed Braille onto paper.

Students with vision impairments or print disabilities[34] (i.e. cannot perceive written text) may require information to be made accessible in a variety of formats and ways:

- Braille - A tactile system using patterns of raised dots representing letters and numbers. Braille is produced using a special printer, called an embosser, but can also be produced using accessible PDAs (above) or by attaching refreshable Braille output devices to a standard computer.[35]

- Large print – Printed text in which font sizes are typically increased to 16 points or larger, benefiting persons with mild vision impairment

- Electronic formats including:

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[31] The WebAim Guide to Web Accessibility (2005) Available from the WebAIM project at http://www.webaim.org/products/training/

[32] For a further list of vision disorders see http://www.lighthouse.org/about-low-vision-blindness/vision-disorders/

[33] For a comparison of Notetakers versus laptop computers for the blind, please see http://nfb.org/legacy/bm/bm03/bm0304/bm030407.htm

For further information on Notetakes and Accessible PDAs please see http://www.myflorida.com/dbs/assistive-technology/notetakers.php

[34] Print disabled: A person who cannot effectively read print because of a visual, physical, perceptual, developmental, cognitive, or learning disability. http://www.daisy.org/glossary/12#term325

[35] http://www.freedomscientific.com/news/pressroom/2010/Braille-Prices-Support-Braille-Literacy.asp

- *Word-processed documents* - Such as those produced by MS Word and OpenOffice Writer

- *Talking books* – Either narrated by a human or converted automatically into synthesized speech (a *Digital Talking Book*). Free online service and downloadable services are available to convert text files into synthesized speech audio files in formats such as MP3.

- *Accessible HTML*[36] *or PDF*[37]

- *DAISY (Digital Accessible Information System) Digital Talking Book (DTB)* – a DAISY DTB can include audio (human or synthesized) speech, which can be navigated, and a synchronized text version of the book.[38] Depending on its configuration, a DAISY DTD can be listened to on a computer or standalone audio player, rendered using a refreshable Braille display, read on screen or listened to with synchronized text displayed on screen.

- *ePub* – an open standard for eBooks used on some popular eBook players.

3.4 Assisting the Deaf and Hearing-Impaired

The World Health Organization (WHO) defines *deafness* as complete loss of the ability to hear from one or both ears. The WHO defines *hearing impairment* as a complete or partial loss of the ability to hear from one or both ears. Some 250 million people in the world are estimated as having a disabling hearing impairment.[39] The barriers encountered by children with a hearing impairment in inclusive schools relate primarily to communication.

The predominant AT used by people with a hearing impairment is a hearing aid. Hearing aids amplify sound from the surrounding environment, but they may also be used to amplify signals produced by a T-loop system.[40] A T-loop picks up audio from a microphone and transmits a signal within the area of a wire loop directly to a compatible hearing aid.

Issues encountered by deaf people when using a computer to access electronic content relate primarily to audio. Captioning is the rendering of speech and other audible information in the written language of the audio. Captions can be *closed*, meaning that they are encoded and can be toggled on or off if the user's browser or media player can decode them. Or, they are *open* -- they are presented at the same time as the visual content. Captions are more sophisticated than subtitles, which are well suited for hearing people who do not understand the language of the content. Captions may provide meta-information about who is speaking or the tone of the voice, and they can denote other sounds that occur on the sound-track of the content.

World Wide Web authors are becoming aware of the need to develop caption and file formats that accommodate a captioning track. Caption-authoring packages are available to add multimedia, overlay

[36] http://www.w3.org/TR/WCAG20/

[37] http://www.adobe.com/accessibility/

[38] http://www.daisy.org/dtbooks

[39] http://www.who.int/pbd/deafness/facts/en/

[40] A T-loop is a wire fixed around a designated listening area connected to a power source, an amplifier and a microphone. The microphone picks up sound from the sound source (which may be a television, a bank official or an actor in a theatre) and carries the sound to the amplifier which, in turn, sends the sound signal in the form of a current around the loop. A hearing aid user whose hearing aid has the 'T' facility, picks up the signal by moving a switch to the 'T' position. *http://*www.deafhear.ie/documents/pdf/04SG1207.pdf

captioning to computer-based video.[41] The online video-sharing website YouTube has introduced an automatic captioning service.[42]

Text transcripts or captions for learning resources or training materials enable access to these materials by literate students with hearing impairments. Text captions also aid comprehension by students whose first language is that not that of the course material. Many deaf people[43] use sign language, which they may consider to be their first language. Sign language may also be used in audio/visual materials, with a sign language interpreter appearing in the bottom right corner of the screen to provide a sign language interpretation of the speech in the audio track.

3.5 Cognitive Impairments

The "Disabled World" project proposes two main classifications of cognitive disabilities – namely, functional or clinical disability.[44] Clinical categories of cognitive disabilities include autism and Down Syndrome. Less-severe cognitive conditions include the sub-category of so-called learning disabilities, such as dyslexia (reading) and dyscalculia (mathematics). The functional disability perspective ignores the medical and behavioral causes of cognitive disabilities and focuses instead on the abilities and challenges the person with a cognitive disability faces. Functional cognitive disabilities may involve difficulties or deficits involving:

- Problem-solving,
- Attention,
- Memory,
- Math comprehension,
- Visual comprehension,
- Reading,
- Linguistic (speech), and
- Verbal comprehension.

The following list shows the benefits that access to ICTs can bring to people within the wide spectrum of learning disabilities.[45] These include:

- Improved writing – Standard word processors contain built-in tools for checking grammar, spell-checking and predictive typing.[46] Specialized writing support programs, such as Clicker

[41] WebAim article on "Software for creating captions" http://www.webaim.org/techniques/captions/software.php

[42] Note: this service is still in beta (test) and has a low rate of accuracy http://www.google.com/support/youtube/bin/answer.py?answer=100077

[43] Include note on deaf culture and Deaf with a capital "D"

[44] Webaim Project [WWW document] http://www.webaim.org/techniques (retrieved 1 March 2008)

[45] http://www.bltt.org/index.htm Charlie Danger is a freelance technology assessor and occupation al therapy (OT) student at Brighton University

[46] MS Word or OpenOffice

5, can aid word recognition and writing through the use of symbols or pictures and speech-supported grids.[47]

- Multimedia - The use of multimedia such as graphics, sound and video can stimulate and encourage interaction and some degree of learning for people with more profound cognitive impairments, as well as for pre-literate children. Much of the software required to create multimedia is freely available online.

- Sensory stimulation - The use of switches, combined with specialized software games can enable some people with profound and multiple learning difficulties to play basic cause-and-effect games and even develop some basic computer interaction skills.

In addition to these computer-based activities, the use of augmentative and alternative communication strategies and devices, particularly those employing symbols, can aid communication for persons with more profound and multiple learning impairments.

3.6 Inclusive Schools through Accessible ICTs

The clear position of the United Nations, UNESCO and the WSIS Plan of Action is that children with disabilities should be able to receive an inclusive education through the use of accessible ICTs. National policies should avoid the development of a two-tier educational system consisting of "normal" schools and special schools for children with disabilities.

Schools that accommodate the needs of their students with disabilities will likely have more need for Internet access. Economies associated with bulk purchasing should be realized through centralized procurement, using appropriate public procurement policies wherever possible. However, each school should be equipped according to the needs of that school's children. Blanket provision of AT should be avoided in favor of each school defining its own requirements.

Within resource-limited countries, careful research and planning is required to help prioritize the main types of support and AT required. The main challenge is to "make products and services available, accessible and affordable."[48] Consideration should be given to reducing or waiving import duties and taxes on the ICTs required to enable persons with disabilities to access an equitable education. An AT ecosystem is needed to ensure that the infrastructure, personnel and products are available. Assessment and support services, such as installation, training and follow-up (to ensure safe and efficient use) are an important part of this ecosystem. The next section deals with the development and implementation of accessible ICTs within an inclusive school system, and the stakeholders and roles involved in the development of a sustainable AT ecosystem.

4 Developing and Implementing Accessible, ICT-Connected Schools

[47] http://www.cricksoft.com/uk/products/clicker/

[48] *Borg, J., Assistive technology in developing countries: national and international responsibilities to implement the Convention on the rights of Persons with Disabilities.* Available at http://www.thelancetglobalhealthnetwork.com/wp-content/uploads/Disability-REV-3.pdf

Inclusive education cannot be built and delivered all at one time.[49] To develop a sensible and practical policy that is properly embedded into the educational and AT environment of a country, policy-makers must consider how to transition from their current model to an inclusive model. This will involve considering the development of a national-level statement of principles, intentions, means, objectives and timetables relating to the provision of accessible ICTs in inclusive schools. Evidence-based policy on the successful provision and use of ICTs will require identifying the gaps as they currently exist; research into the current landscape is critical.

4.1 National Policy Reform

National "e-strategies," framed within the WSIS Principles and Goals (Section 8), include policy areas such as connectivity, (e.g. broadband rollout), capacity building (e.g. training in use of ICTs for all sectors of society, including teachers and persons with disabilities), and education (provision of ICTs in schools). Policies and programmes in support of accessible ICTs in connected schools will therefore cut across several policy areas, including:

- Education,
- Telecommunications,
- E-government,
- Finance and public procurement,
- Import/customs duties and taxation,
- Welfare and employment, and
- Equality.

UNESCO's Institute for Information Technology in Education (IITE) views policy development for the use of accessible ICTs in schools as a "complex proposition based on the principle that technology is not only a tool," it also requires "a shift in the focus from technology provision to the design of learning environments."[50] Policy development has, therefore, moved from an exclusive focus on the provision of hardware and software to the effective use of ICTs in different educational contexts. UNESCO suggests four stages for the successful integration of accessible ICTs in an inclusive educational environment. This includes the design and development of the accessible ICTs, their implementation and improvement, and the assessment of their benefits (Fig 4.1)

Figure 4.1 Stages for policy development

[49] Lynch, P. (2007) *External Trends on Education.* (Sightsavers international (internal document). Cited in GeSCI page 6.

[50] UNESCO IITE *ICTs in Education for People with Special Needs*. http://www.iite.ru/pics/publications/files/3214644.pdf page 95

In conjunction with the four stages of policy development, policy-makers should consider several key elements. Based on a study by the European Agency for Development in Special Needs Education,[51] the following six elements are particularly important for national-level accessible ICT policies:

- Infrastructure – This addresses statistics on connected schools with Internet access, the number of computers available in schools, the availability of assistive technologies, the use of computers and other forms of ICTs as pedagogical tools by teachers.

- Availability of support – Closely related to infrastructure, this looks at the range of support available to teachers and students from national agencies for ICTs in education. This can extend from support services that work directly with children and teachers, to in-school supports, to access to specialist resource centers.

- Needs assessment -- While needs assessment systems for children identified as having a disability may already be in place, they should incorporate a clear statement of needs that covers the ATs and related supports required to enable the child to receive an education in an inclusive school environment.

- Training – A key element of support is in training specific to the teaching of children with disabilities. A key element of that will be the use of accessible ICTs, which includes training during initial teacher orientation and in-service training. The availability of relevant support and training is often cited by teachers as an area of equal importance to the availability of appropriate hardware and software.

- Co-operation/research – A key element in building capacity within a country's educational system is the development of a sustainable AT ecosystem. This includes ongoing research into the needs and experiences of both learners and teachers, sharing of experiences and expertise, and research into the development of new and better AT solutions and service-delivery models.

- Evaluation – Implementation of various policy reforms must be monitored to determine whether they will achieve their stated goals and to analyze and interpret the results and inform further policy intervention.

4.2 Supporting teachers and students

While it is not necessary for teachers to have in-depth knowledge of assistive technologies and devices, it is important that they receive support in developing educational material and resources that are accessible for all students. One of the first things teachers should learn is about the accessibility features in technologies they already know and use. The Microsoft guide, *Accessibility: A Guide for Educators*[52], provides information about accessibility and accessible technology to help educators worldwide ensure that all students have equal access to learning with technology. The guide provides:

- Detailed guidance on using the accessibility features in Microsoft products,
- An understanding of accessibility and how it impacts the classroom,
- Definitions of impairment types and technology solutions for each type of impairment,

[51] http://www.european-agency.org/publications/ereports/key-principles-in-special-needs-education/key-principles-in-special-needs-education

[52] http://www.microsoft.com/enable/education/

- Guidance on choosing accessible technology solutions, and
- Resources for more information.

UNESCO defines curriculum as "what is learned and what is taught (context): how it is delivered (teaching – learning methods); how it is assessed (exams, for example); and the resources used (e.g. books used to deliver and support teaching and learning)."[53] Curriculum development and teaching practices have received much attention in the movement toward inclusive education. In general, curriculum in inclusive schools must be "flexible and adaptable, [and] designed to reduce environmental barriers of students who may disadvantage [sic] from regular education."[54]

Accessible ICTs can help transform static curriculum resources into flexible digital media that students with a variety of abilities can access once they have the appropriate AT. For example, class notes developed in electronic text can be converted into a variety of formats such as audio, Braille, accessible HTML, DAISY audio book etc. Assessment methods need to be flexible and adaptable to students' needs.

The introduction of any new ICT or AT should be complemented by sufficient technical support in order to reduce the risk of abandonment. The mostly likely source of this ongoing support is through centers of specialized knowledge located within local or regional school networks. It is important to differentiate between (a) the specialized support and training required by both students and teachers in the use of specific ATs in classroom settings, and (b) the use of accessible ICTs generally to improve access to curriculum.

4.3 Funding Strategies

One of the key research findings on ATs in developing countries is the need for a sustainable funding model. While the initial capital needed to provide the equipment and software is of course necessary, it is vital that consideration also be given to ongoing support and maintenance of this equipment.

Several projects around the world provide computers and other ATs to schools and telecenters in developing countries, at a significantly reduced rate or for free. Charitable organizations and multinational companies provide heavily subsidized or free laptops and computers with ATs.

Another important procurement consideration for policy-makers is the choice between proprietary or open-source software and AT. Proprietary software is developed and licensed by a private company, and is supplied on a for-profit basis. Typically, the software code cannot be reused or shared because of licensing arrangements. Open-source software allows the reuse and repurposing of code under certain licensing conditions.

Many open-source software products are available free of charge, but governments or schools may have to incur a cost for this software to be developed into a service or solution that meets their needs. For example, an organization using an open-source content management system (CMS) may need to pay a Web developer to develop the website using that CMS. So while the source code of the CMS is available free of charge, the organization may have to pay for a specialist to develop and perhaps maintain the website. Similarly, a school system that chooses to supply open-source ATs to its students may need to pay for services such as teacher and staff training in the use of the ATs, as well as support for maintaining and upgrading them.

[53] UNESCO 2004. *Changing teaching practices using Curriculum Differentiation to Respond to Students' Diversity.*
[54] UNESCO IITE page 110

4.4 Public Procurement

Public procurement has long been used by many governments to achieve social inclusion goals.[55] National public procurement policy has the potential to positively influence the availability, affordability and quality of AT and other accessible ICTs such as Braille, DAISY books and accessible websites.

Public procurement provides educational and school authorities with a means to incorporate accessibility requirements at the earliest stages of developing a school IT infrastructure. This also has an impact on the wider accessible ICT eco-system by creating a demand, and therefore a capacity within the market, to develop, produce and maintain accessible ICTs. The greater the demand, the lower the end cost is likely to be. Public procurement policy can, therefore, act as a means to promote the development and availability of accessible ICTs.

Educational authorities could, for example, include accessibility as a criterion in the purchase of all educational software, such as teaching programs or content management systems. This would help ensure that all users, including persons with disabilities, would be able to use and access content from the start, avoiding costly provision of specialized learning resources for these students at a later date.

4.5 Trends in Technology Development

Cloud Computing

Cloud computing is a current technological paradigm shift in which computing resources such as software are distributed over the Internet and made available to computers and other devices on-demand.[56] The implication here is that AT software applications do not have to be installed on a particular machine, but rather can be accessed through the Internet from any computer. Preliminary approaches, such as online screen-readers, have "yielded promising results towards an inclusive Web by removing both economical and accessibility barriers."[57]

Mobile Learning

Lack of access to a computer in developing countries restricts many people's access to the Internet. Mobile phone ownership is far greater in developing countries than PC ownership. Mobile learning, or *m-learning*, is an array of e-learning over mobile devices such as mobile phones, which is of potential benefit to users in developing countries, especially those living in remote rural locations.

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[55] Waddell, Cynthia. Meeting information and communications technology access and service needs for people with disabilities: Major issues for development and implementation of successful policies and strategies. Available at http://www.itu.int/ITU-D/sis/PwDs/Seminars/Zambia/Documents/Presentations/009-Waddell%20Cynthia-Background%20paper.pdf Where governments insist on procuring only accessible ICTs, manufacturers respond by producing only accessible ICTs. It is simply too expensive for manufacturers to produce two lines, one for the government and another for the public. Public procurement requirements in countries that are major producers of ICTs have resulted in more accessible features being included in mainstream ICTs.

[56] http://en.wikipedia.org/wiki/Cloud_computing

[57] http://www.w4a.info/

The challenges of providing content on a mobile phone include "how to efficiently render visual Internet content into short, precise, easily navigable, meaningful and pleasant-to-listen-to audio content."[58] Still, the penetration of mobile phones in developing countries does present a potential opportunity for reaching more people than the current provision of content to desktop computers. Any country developing policy or initiatives to promote the provision of services over mobile phone networks should consider the implications for persons with disabilities, for example, using accessible books stored on mobile phones.

Broadband Connectivity

Connecting all primary, secondary and post-secondary schools to ICTs by 2015 was one of the targets set by world leaders at the World Summit on the Information Society (WSIS). The lack of fixed-line telecommunication infrastructure has been an obstacle to accessing the Internet in many under-served and remote parts of the developing world. The increasing levels of connectivity to the Internet through wireless broadband -- a growing trend in developing countries -- promises to improve Internet connectivity in developing countries, including in schools. For students with disabilities, the possibility of accessing educational content online will significantly improve their ability to participate in mainstream education.

Learning Platforms

Learning platform is a generic term used to describe a broad range of ICT systems that are used to deliver and support learning. These include Virtual Learning Environments (VLEs), which combine several functions such as delivering course work over the Web or an intranet to students or allowing students and teachers to interact. VLEs are regularly used for 'blended learning' that supplements traditional, face-to-face classroom activities. VLEs are most often used in higher (second or third level) education. Some VLEs are capable of producing content that conforms with the Web Content Accessibility Guidelines from the Web Accessibility Initiative.[59] One such open-source VLE is called "Moodle."[60]

Open Educational Resources

Open Educational Resources (OERs) are learning materials that are freely available for use, repurposing and redistribution. The term was first adopted at UNESCO's 2002 *Forum on the Impact of Open Courseware for Higher Education in Developing Countries*.[61] While many OERs are available over the Web, many are not accessible to persons with disabilities. Policy considerations in this area could include international cooperation with other countries, establishing projects to develop OERs that are accessible to persons with disabilities, or developing strategies to systematically provide existing OERs in accessible formats.

5 Leveraging Accessible ICT-Enabled Schools as Community Hubs

While equipping connected schools with assistive technology (AT) is a worthy goal in and of itself, the benefits can be multiplied by taking advantage of ATs and computer equipment, as well as the

[58] http://www.internetspeech.com/rendering_whitepaper.htm
[59] W3C WAI, 2008. *Web Content Accessibility Guidelines version 2.0.* Available at http://www.w3.org/TR/WCAG20/
[60] http://moodle.org/
[61] http://en.wikipedia.org/wiki/Open_educational_resources

administrative and management structures of the school, to provide services to the broader community, in particular to provide job training in school-based multi-purpose community centres (MCTs).

One of the primary aims of the UN *Convention on the Rights of Persons with Disabilities* is for persons with disabilities to become active members of the workforce at all levels of industry, commerce, administration, governance and education. Accessible ICTs hold the potential to enable persons with disabilities to receive job skills that would otherwise be inaccessible to them. For example, assistive technologies can enable access to mainstream office applications commonly used for business management and administration. Traditionally, persons with a disability such as blindness, were often given specific and somewhat limiting roles within an organization, such as answering telephones as a receptionist. However, when sufficient and appropriate training is provided, persons with disabilities can reach their own personal potential once they have support and the required accommodations.

5.1 Multipurpose Community Telecenters

Multipurpose Community Telecenters (MCTs) are promoted and supported by the International Telecommunication Union (ITU) as a means to facilitate universal access to telecommunication services -- particularly access to the Internet via ICTs.[62] This, in turn, enables people to become active participants in the emerging Information Society. MCTs are a shared facility for access to ICTs, along with user support and training. MCTs can reduce access costs for larger numbers of people than the provision of individual solutions such as laptops. MCTs also promote awareness of the potential benefits of the Information Society and "connectedness."[63]

One of the advantages of using schools to house MCTs is that much of the infrastructure, such as the school building and computer room, can be made available at no cost to the community. Schools equipped with AT for persons with disabilities may already have made the necessary accessibility investments required for persons with disabilities, for example, where there is an accessible computer room that can be used after school hours as an MCT open to the public. Of course, careful planning will still be required for funding ongoing ancillary services such as hiring trainers and providing job skills training in the MCT.

In order to enable the use of school-based MCTs for the social and economic development of adult persons with disabilities, many of the same requirements as those identified above for schools will be necessary. This includes the need for:

- adaptive equipment, such as input devices or workstation adaptations, to help overcome common accessibility barriers;
- the development of screen readers in local languages; and
- the operators of the MCT will need training in the use of AT and accessible web design (just as teachers require training in the use of AT for their students)

[62] ITU http://www.itu.int/ITU-D/univ_access/telecentres/
Multipurpose community telecentres: Lessons Learnt http://www.itu.int/net/itunews/issues/2010/05/30.aspx
[63] Johan Ernberg ITU/BDT *Universal Access - by means of Multipurpose Community Telecentres.* Available at http://www.**itu**.int/**ITU**-D/univ_access/telecentres/papers/mctbrief.pdf

Center staff could also be encouraged to develop low-cost AT solutions, which could include developing

- screen readers in the local language to reduce operating costs. Any locally developed solutions could also benefit the related school and its students.

5.2 Best Practices: TVET Programmes

One of the key roles an MCT can play is to provide job training for persons with disabilities. This can be accomplished via Technical and Vocational Education and Training (TVET), which enhances productivity and sustains competitiveness in the global economy.[64] TVET is not just a means of preparing young people for the world of work, it is also a "means of reaching out to the marginalized and excluded groups to engage them in income-generating livelihoods."[65] TVET for poverty alleviation has become a priority for many governments in developing countries. The success and future expansion of TVET programmes in developing countries depends on the continued expansion of existing training programmes and continued cooperation among national and international bodies. TVET best practices for persons with disabilities include:

- Providing qualifications that are part of the educational qualifications framework of the country;
- Providing certification that is valued by employers;
- Acting as a bridge to return to further, more formal education, should the person wish to; and
- Taking into account the low levels of literacy, numeracy and ICT skills among persons with disabilities, and recognizing that previous educational experiences may have been negative.

In addition, MCTs providing training for persons with disabilities should foster strong relationships with local employers, and could provide some level of support in placing graduates in jobs. They could also support employers by identifying workplace accommodations and helping find appropriate ATs. Job-placement support enables prospective employers to overcome negative perceptions about employing a person with a disability. Employers can also receive advice and practical support in making workplace adjustments, which can include procuring and installing ATs required to enable the person to work. This is the key to facilitating the transition from education and training to employment.

6 Conclusion

Persons with disabilities remain one of the most excluded groups in society. Equitable access to education is a vital part of enabling people to reach their full potential, and this has been emphasized as a human right for persons with disabilities in the *UN Convention on the Rights of persons with Disabilities*. Accessible ICTs hold the potential to facilitate access to education, job training and employment

[64] Bharat, *The Role Open and Distance Learning in Vocational Education and Training in India*

[65] Alhaji, Ibrahim Hamra. Revitalizing Technical and Vocational Education Training for Poverty Eradication and Sustainable through Agricultural Education. Avaialbe at http://www.afrrevjo.com/print/sites/default/files/Volume_2_Number_1_art_9.pdf
Published in African Research Review - AFRREV, January 2008, Volume 2, No. 1

opportunities for all persons with disabilities and enable them to become productive, visible and integrated members of society.