Assistive Technologies: Inclusive Teaching Guidelines for Educators

knowledge
Series

A TOPICAL START-UP GUIDE TO DISTANCE EDUCATION PRACTICE AND DELIVERY

Introduction

The National Education Association in the United States reports that the number of students enrolled in special education programmes has risen 30 per cent over the past ten years, with 75 per cent of students with disabilities spending part or all of their school day in a general education classroom (Neese, 2020). In contrast, research from the World Bank and the Global Partnership for Education (GPE) found that primary school completion for children with disabilities in 19 developing countries is just 48 per cent, and as many as three in ten children with disabilities have never been in school.
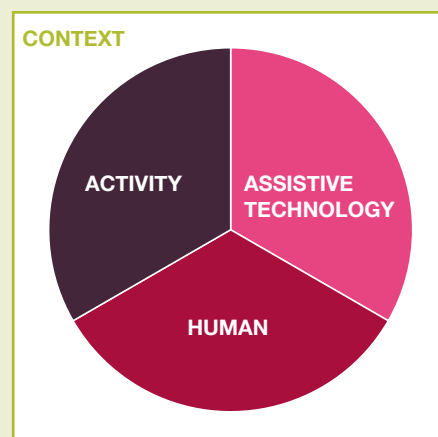
The United Nations Convention on the Rights of Persons with Disabilities recognises the right of all children with disabilities both to be included in general education systems and to receive the individual support they require (WHO, 2011).

According to Cook, Polgar and Hussey (2008, p. 5), the concept of assistive technologies (AT) "applies to a broad range of devices, services, strategies and practices that are conceived and applied to ameliorate the problems faced by individuals who have disabilities." In education, using AT creates an inclusive environment to accommodate the different ways students assimilate information and learn. This document provides an overview of how specific technologies can be used for an inclusive classroom.

## Assistive technology models and overview

The HAAT (Human Activity Assistance Technology) model is a way to consider AT. It has four components: the human, the activity, the assistive technology and the context in which these three integrated factors exist.

The human component includes physical, emotional and cognitive aspects of the technology user. The activity is the task or actions that the human is performing, while the assistive technology is the means through which it is achieved. These components are located in an environment that includes social and cultural aspects, and physical conditions. According to Nicolle (2014), drawing upon Cook and Hussey (1995), by following the model, an AT system should consistently meet the

CONTEXT

ACTIVITY | ASSISTIVE TECHNOLOGY

HUMAN

specific needs of the individual with a disability. The assistive system is unique and should be adapted to meet human skills and abilities (e.g., speaking, using hands), the assistive technology (e.g., voice recognition), the activity (e.g., writing) and the context (e.g., at work in a noisy office or classroom). Given this uniqueness, the challenge for the educator is to determine how assistive technology can be applied in an inclusive way so that its use can benefit many children or students.

ANALYSIS

EVALUATION

DESIGN

IMPLEMENTATION
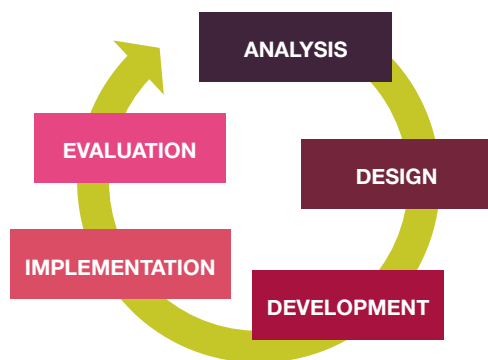
DEVELOPMENT

The ADDIE (Analysis, Design, Development, Implementation and Evaluation) model is simple but very useful; its linearity provides a step-by-step framework for each sequence of learning, to ensure specific objectives are met. According to Bates (2015, p. 141), although good AT design can be achieved with or without the ADDIE model, it encourages a systematic approach and the use of design principles that are identified and implemented on a systematic and thorough basis.

Low-, mid- and high-tech assistive technologies

Low-tech AT is the most commonly available. It is used by educators who may be unaware of its real purpose, and includes items such as adaptive pencils (weighted, fat, skinny, triangular), adaptive papers (graph, specially spaced, or textured), pencil grips, binder clips (for turning pages), squishy balls or sensory input, tactile rulers, graphic organisers, highlighters, coloured transparencies, slant boards, Post-It notes, and jumbo materials (pens, words, etc).

Mid-tech AT, although not as common as low-tech, is implemented in many classrooms. Some examples are:

- electronic spellers or dictionaries
- adapted games or toys
- adapted seating (bouncy balls, chairs with seatbelts, wiggle cushions)
- screen magnifiers
- audio books
- voice amplification
- Braille translation software
- adapted keyboards

High-tech AT is primarily considered to be "plug-in" tech, which is the most expensive. It includes electronic tablets, alerting devices, voice recognition devices (e.g., smart speakers) and screen-reading software, such as JAWS (Job Access With Speech). Screen readers are designed for people whose vision loss prevents them from seeing screen content or navigating with a mouse.

Users can read out (or provide Braille output for) screen content using keyboard commands. Screen readers generally work for common computer applications such as web browsers or Microsoft Office products.

Guidelines for inclusive teaching

The following are key principles to consider when adopting an inclusive approach to classroom teaching and ensuring that teaching materials and teaching styles are accessible and effective for all children or students. It should be noted that these guidelines can also be relevant for older learners, who may struggle with printed or electronic materials and thus may benefit from the ways technology can support their needs.

1. Assess the whole class to determine their accessibility needs.

It is recommended to start by reviewing the entire class of children and listing the range of needs they have. Although the teacher will generally know whether particular children have a medical condition that affects their learning (e.g., autism, dyslexia, dyscalculia, Downs syndrome), it is important to concentrate on their functional challenges (e.g., has a visual impairment, is easily distracted, struggles to remember numbers, has

limited hearing ability) so that practical solutions can more easily be found for the whole class. This approach avoids singling out individual students as disabled and enables all students to benefit from the use of AT.

2. Define general steps that can help the whole class.

There may be simple actions that can be taken to increase overall inclusion, such as simplifying the lesson content, producing enlarged worksheets, showing the class how to select "reader mode" on a computer or tablet, or using mind-mapping before writing an essay.

3. Identify specific needs where specialised assistive technology for individuals is required.

Teachers should consider whether students:

*   can gain information from print-based educational materials used across the curriculum — for example, to support oral presentation;
*   need materials in a specialised format (e.g., Braille, large print, audio, digital text); or
*   need modified content or alternative materials.

It may be helpful to ask the students themselves what accessible format or technology they would like or need. For example, nowadays, many people with visual impairments may prefer electronic text over Braille.

4. Choose assistive technology to meet needs.

Having created a list of needs for individuals and across the classroom, the teacher can select and use appropriate techniques and/or AT. The table that follows can assist with this process, although it is also a good idea to search online to see what new products or applications are available. In the context of the classroom, it is generally better to choose technology aids that are not too complex and can be used flexibly for different lessons.

Assistive Technologies

1. SPEECH RECOGNITION

Speech input can potentially assist students who have visual, physical or learning disabilities, producing benefits such as:

- improved access to the computer
- increased writing production
- improved writing mechanics
- increased independence
- decreased anxiety around writing
- improved core reading and writing abilities.

As students speak, then see their words appear on the screen, the speech-to-text tool can demonstrate directly the relationship between how a word looks and how it sounds.

DESCRIPTION

Microsoft Word and PowerPoint both include a dictation option, allowing students to input text using voice. Encouraging students to use speech input to enter the main body of text, and then use normal keyboard editing controls to correct any errors, may be a useful strategy (National Center for Technology Innovation, 2010).

It is important to pair speech-recognition technology with instructions on writing strategies, brainstorming, drafting and organisation.

EXAMPLE

- Dictate text in Microsoft Office using speech recognition: https://support.microsoft.com/en-gb/office/dictate-text-using-speech-recognition-05725ee2-ae2e-438f-847c-b80e754eb50b (Microsoft, 2020b)
- How to use the dictate feature in Microsoft Word: https://www.youtube.com/watch?v=nh6Bs3gCY9M (Microsoft, 2020d)
- Speech recognition in Google Docs (speech to text): https://www.youtube.com/watch?v=GGDELeDEWJ4
- How to use Google search by voice: https://www.youtube.com/watch?v=7NUh-CM53No

Cost: Free if built into the operating system or application. Smart speakers start from USD 40.

2. ADAPTED STANDARD TECHNOLOGY

Standard keyboards and mouses are the most common devices for interacting with computer technology and, increasingly, with other devices such as tablets. These devices can pose difficulties for many people, especially users with physical, sensory or cognitive challenges, but lots of other options are available.

DESCRIPTION

Examples of available adapted devices include: early learning keyboards, large-key and high-contrast keyboards, Braille and chording devices, and key guards to hide unnecessary keys.

Other examples include: switches for simple input; specialist larger mouses for children with limited strength, limited movement, or tremors; joysticks; and tablets with a stylus that can be fixed in position for easier control.

Other potentially useful devices are touchscreens that can be tailored to learners' needs in software, and/or head-tracking and eye-tracking devices.

For learners with hearing impairment, software with speaking characters can utilise a subtitling option.

EXAMPLE

- Keyboard and mouse alternatives and adaptations: https://abilitynet.org.uk/factsheets/keyboard-and-mouse-alternatives-and-adaptations
- BJOY assistive technology products: https://www.youtube.com/watch?v=cXXP_KVBm-E
- Five tips for teachers of students with hearing impairment: https://mediaaccess.org.au/latest_news/education/five-tips-for-teachers-of-students-with-hearing-impairment

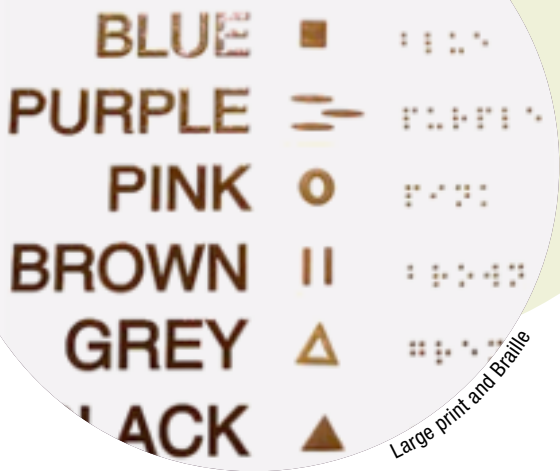Cost: Prices will vary (e.g., a high-contrast keyboard costs around USD 35).

BLUE ■

PURPLE

PINK O

BROWN II

GREY △

LACK ▲

Large print and Braille

👁 Ⓛ
3. ENLARGING CONTENT

Much of the information that is presented, either physically or on screen, is in a small format, making it difficult for visually impaired learners to perceive and causing problems for those with learning disabilities.

DESCRIPTION

A convenient way to enlarge different types of content on a computer is to use the control-scroll wheel on a mouse, or the "pinch zoom" gesture on a touchscreen tablet.

There are also ways to change the text size via the computer operating system, as described in the two sources whose URLs are provided below.

Some website content is still designed in a fixed format, so the size cannot be increased. In such cases, a screen magnifier is useful software that interfaces with a computer's graphic output to present enlarged screen content.

Content magnification is built into Windows, Mac OS and most mobile devices. Third-party software such as Magnifying Glass Pro is also worth trying to see how these programmes compare with built-in tools.

A simple method, often used by teachers for making materials and worksheets large enough for the whole class, is to print it on paper and then enlarge it on a photocopier (e.g., from A4 size to A3).

EXAMPLE
- Change the size of text in Windows 10: https://support.microsoft.com/en-us/help/4028566/windows-10-change-the-size-of-text (Microsoft, 2020a)
- How to make text larger on a Mac: https://www.youtube.com/watch?v=mlk51wwIVGE

Cost: Free if built into the operating system or application. Specialist magnification software can be low-cost, but more expensive systems also exist.

👁 Ⓛ
4. TEXT-TO-SPEECH SOFTWARE

Text-to-speech (TTS) software can help students who have difficulties reading standard print or have common reading-related disabilities, including:
- blindness or visual impairment
- dyslexia or another learning disability
- a physical condition that impedes the ability to read.

Other students who can also benefit from TTS technology include those with autism, attention deficit hyperactivity disorder (ADHD) or an intellectual disability.

DESCRIPTION

This software scans and reads words to the student in a synthesised voice. This works for documents prepared on Windows or Mac devices and for web pages and Adobe PDF files.

Built-in functions sometimes have controls that are not easily accessible. Third-party software can offer readily accessible alternatives that work across different content types (see links below).

It is usually best to choose a tool or mode whereby a reader can select the text passage they want read out, rather than the whole document.

In PowerPoint, narration can be recorded over a slide presentation to make the content easier for a learner to absorb.

EXAMPLE
- Hear text read aloud with Narrator: https://support.microsoft.com/en-gb/help/14234/windows-hear-text-read-aloud-with-narrator (Microsoft, 2020c)
- Have your Mac speak text that's on the screen: https://support.apple.com/en-gb/guide/mac-help/mh27448/mac
- The best free text-to-speech software: https://www.techradar.com/uk/news/the-best-free-text-to-speech-software
- Five ways to make your computer read documents to you: https://www.makeuseof.com/tag/5-ways-to-make-your-windows-computer-speak-to-you/

Cost: Free if built into the operating system or application.

It is recommended to start by reviewing the entire class of children and listing the range of needs they have.

5. 3D PRINTING

3D printing is a process for making a physical object from a three-dimensional digital model, typically by laying down many successive thin layers of material onto a flat base. The cost of 3D technology is dropping, allowing it to be used by mainstream educators. Consideration is now being given to how to apply it in special-needs teaching.

DESCRIPTION

Buehler et al. (2014) report that in special education, 3D design and printing can

- encourage engagement in science, technology, engineering and mathematics (STEM) topics
- support the creation of educational aids for providing accessible curriculum content
- be used to create custom adaptive devices.

3D printing can stimulate children by giving them the freedom to design what they think might work and then 3D print their idea to test it.

Note that 3D printing requires careful adherence to safety guidelines, which are available online (Burrows, 2020).

EXAMPLE

- Top 15 best cheap 3D printers 2020: https://www.3dnatives.com/en/low-cost-3d-printer290320174/#!
- How can students and teachers benefit from 3D printing in schools?: https://www.3dnatives.com/en/students-teachers-benefit-3d-printing-in-schools-061220185/

Cost: The cheapest 3D printers start at around USD 200. Materials start at USD 20 per kilogram.

3D printing blocks with relief symbols

6. FINGER READERS

People with visual impairment find it difficult to access text documents in different situations, such as reading text, or accessing text in non-ideal conditions (e.g., low lighting, unusual layout, non-perpendicular page orientations). Finger-worn devices (e.g., FingerReader; see Shilkrot et al., 2015) can assist visually impaired users with reading printed text in a variety of locations.

DESCRIPTION

A finger reader consists of a camera attached to the finger by a rubber strap. As the user scans across a printed page or screen with their fingertip, each word is read out. It gives the user audio cues to feel where the print is located and tries to infer the next word to say.

A prototype of the device has been tested with visually impaired and blind users. Testing indicated that it was most appropriate for shorter sequences of text. However, it has potential as a flexible tool for readers of different abilities.

EXAMPLE

The Finger Reader: https://www.youtube.com/watch?v=1vKoePuMR8E

This technology is still under development but may become a marketed product in the future.
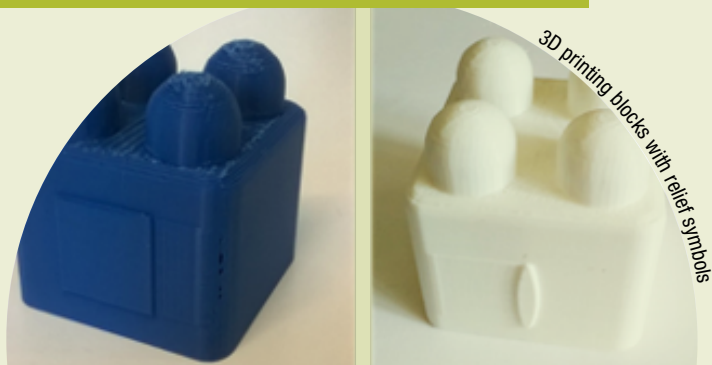
KEY TO ABILITY CODING: vision   hearing   physical + dexterity   learning   beneficial for all

Embossed labelling with swell paper

7. MICROCAPSULE PAPER OR SWELL PAPER

This is a special type of paper with microcapsules of alcohol embedded into it, which burst when exposed to heat and make the surface of the paper swell, so that images can be printed and made into tactile diagrams.

An image can be transferred to swell paper using a photocopier, inkjet printer, marker or heat pen. Lines and dots are also created by drawing directly on it using a carbon-based pen.

DESCRIPTION

Swell paper provides raised interpretations of pictures, drawings or objects, enabling visually impaired people to identify them by touch.

The tactile profile produced enables blind and partially sighted people to explore several surfaces and objects that would otherwise not be possible for them to identify (Robinson & Nagar, 2010).

These include paintings and drawings, building facades, machinery, maps, statues and monuments. Braille can be added to tactile graphics, providing additional explanatory information.

EXAMPLE

Swell touch paper:
https://www.youtube.com/watch?v=peg7L_8PHCc

Cost (example): USD 100 dollars for a pack of paper, USD 400 for a heater (Zychem Ltd.).

8. ASSISTIVE LISTENING SYSTEMS

Assistive listening systems, or hearing assistive technology, can help students who are deaf or hard of hearing, as well as those with other auditory and learning difficulties.

DESCRIPTION

Assistive listening systems use a microphone, a specific transmission technology and a device for capturing and bringing sound to the ear.

The presenter or teacher speaks into a microphone transmitter, and the pupil uses a lightweight earphone-receiver to hear the message.

Technology such as FM radio wave systems work using radio broadcast technology. With a transmitter microphone and a receiver, the teacher and student can maintain a consistent sound level, regardless of distance and background noise.

Other systems use infrared and induction loop technology, which employs electromagnetic waves to help project the sound to the class and can be set up to suit specific students or to encircle an entire room.

EXAMPLE

- Types of assistive listening devices:
  https://www.captel.com/2019/03/
  types-of-assistive-listening-hearing-loss-devices/
- Classroom assistive listening devices:
  https://www.californiaearinstitute.com/hearing-device-
  center-listening-device-classroom-bay-area.php
- Assistive listening devices for the classroom
  (Oxford University Press, 2016): http://www.
  raisingandeducatingdeafchildren.org/2016/10/06/
  assistive-listening-devices-for-the-classroom/

Cost: Starts at around USD 45 per device for each pupil.

> The challenge for the educator is to determine how assistive technology can be applied in an inclusive way so that its use can benefit many children or students.

(L) 9. BROWSER READER MODE

Cluttered webpages with extra graphics and advertisements can be distracting for students who are autistic, find it hard to concentrate or have other learning difficulties.

DESCRIPTION

Browsers normally have reader modes that display only the article content and hide other items, such as adverts.

This can be supplemented using the mouse scroll wheel and control key in reader mode to enlarge text so that it fills the window (Rosenberger, 2019).

EXAMPLE

- How to use Google Chrome's hidden reader mode:
https://www.howtogeek.com/423643/how-to-use-google-chromes-hidden-reader-mode/
- How to turn on reader mode on your browser and read without distraction:
https://www.maketecheasier.com/enable-browser-reader-mode/

Cost: Free if built into the operating system or application.

(L) 10. MIND MAPPING

This well-known technique helps students organise their thoughts before they start a piece of writing or other activity that needs planning.

Mind maps can help students:
- develop ideas
- think about different aspects of a topic
- explore creative and structured thinking.

Mind mapping benefits all students but is especially helpful for students with autism, dyslexia, dyspraxia and other learning difficulties (Brandner, n.d.; Strickland, 2012).

DESCRIPTION

There are many mind mapping apps available for download. It is important to choose a tool that is simple and age appropriate (McClaskey, 2020).

General-purpose software such as PowerPoint can be used to create a mind map. This can be accessed by clicking the Insert tab and selecting the Smart Art tool, or opening a new slide and choosing the Smart Art option for the slide template.

EXAMPLE

6 mind mapping examples for students and teachers:
https://www.ayoa.com/ourblog/6-mind-mapping-examples-for-students-and-teachers/

Cost: Free if using standard software such as Microsoft PowerPoint, Visio, or Apple Keynote. Some free apps are also available (e.g., iMindMap Kids).

KEY TO ABILITY CODING: vision | hearing | physical + dexterity | learning | beneficial for all

Having effective and affordable assistive technology is now critical to ensure that disabled learners are not left out.

beneficial for all

11. VIDEOTELEPHONY AND ONLINE CHAT

Videotelephony comprises technologies for the reception and transmission of audio-video signals by users at different locations, for communication between people in real time. A related technology is online chat, which allows real-time communication between users via text messages.

Videotelephony has become a popular tool for remote teaching and learning and can be helpful in providing online education for children with mobility impairments, or children who have difficulty travelling to school.

DESCRIPTION

Videotelephony requires the user to have a computer, tablet or phone with an integrated camera, speaker and microphone. Plugging in an external headset with a microphone can improve the communication.

Videotelephony tools are developing all the time and becoming more functional as educational support tools. Using them, teachers can share with the class any content located on their computer. Class members can raise a virtual hand to ask a question, or type it as a message for the teacher.

Accessibility features of videotelephony tools such as Zoom include: closed captioning, automated transcription, keyboard accessibility and screen reader support.

A virtual whiteboard facility allows the teacher to write, draw or sketch content to support the lesson. They can also pass control to a pupil so the learner can share their work. A group-work facility allows the class to be divided into groups for working in teams.

EXAMPLE

Three popular videotelephony tools are Zoom, Microsoft Teams and Adobe Connect.

Links for further information about these tools or access to download them are as follows:

- Adobe Connect: https://www.adobe.com/products/adobeconnect/meetings.html
- Teams: https://www.microsoft.com/en-gb/microsoft-365/microsoft-teams/group-chat-software (Microsoft, 2020e)
- Zoom: https://zoom.us/
- Zoom accessibility features: https://zoom.us/accessibility

Cost: Videotelephony software is usually free; subscription versions provide extra facilities.

Conclusion

Most educators will already be familiar with the need to tailor their teaching to the different requirements of their students. One of the challenges in doing this is that assistive technology and software are constantly changing. The aim of this document has been to provide general guidelines for reviewing the needs of students in the classroom, and for employing methods and technology that will benefit the majority of learners without singling out individuals or making them feel different to the rest of the class in terms of needs. With the onset of the coronavirus pandemic, new forms of teaching and learning such as video communication, online learning, and home activities to support school education are here to stay. Having effective and affordable assistive technology is now critical to ensure that disabled learners are not left out.

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Useful resources and websites

AbilityNet: supports people of any age living with any disability or impairment to use technology to achieve their goals at home, at work and in education: https://abilitynet.org.uk/search?key=assistive%20technology

Accessible education and student support: https://www.bates.edu/accessible-education/assistive-technology/free-and-low-cost-assistive-technology-resources/

BBC guide to accessibility of TV content: http://www.bbc.co.uk/accessibility/

Oxford Library Guides. Supporting disabled readers: freeware - assistive technology: https://ox.libguides.com/c.php?g=423209&p=2889755

Web Accessibility Initiative. Introduction to web accessibility: https://www.w3.org/WAI/fundamentals/accessibility-intro/ and https://www.w3.org/WAI/Resources/

The Commonwealth of Learning (COL) is an intergovernmental organisation created by Commonwealth Heads of Government to encourage the development and sharing of open learning/distance education knowledge, resources and technologies. COL is helping developing nations improve access to quality education and training.

Commonwealth of Learning, 4710 Kingsway, Suite 2500, Burnaby, BC

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