Australian Flexible Learning Framework

Supporting Flexible Learning Opportunities

Adaptive and assistive technologies in e-learning

An examination of the range and functionality of currently available technology and potential areas for future development

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1 Introduction

Technology is changing fast. It is changing the way we do things, and the pace at which we do them. Internet connected PCs have become commonplace in our educational institutions and workplaces. Indeed, many secondary school students carry laptops to and from every class and many workers use computer skills daily.

Those individuals, who, for various reasons, cannot use modern computer systems efficiently, will be increasingly left behind in terms of educational opportunities and job skills and employability.

A report entitled “Assistive Technologies for Online Training Delivery for People with Disabilities (R012R)” was published by the Framework in August 2003. This report, largely based on research conducted in 2001, provides a policy context, and discusses disability, online delivery and inclusive design. The reader is referred to this document for such background information.

The current paper will draw much from attachment 3 of that report which describes the technological environment with regards to assistive technology as it was in 2001. However, this paper builds upon the material found in that report by looking first at the areas of learning where disadvantaged learners may require assistance, in general terms, then more specifically in the online environment.

By looking at adaptive and assistive technologies and how they relate to the learning process, we can identify any existing shortcomings, and gaps in the adaptive and assistive technology market.

The main body of this document includes information about a selection of adaptive and assistive technologies. It deals with them first in terms of their application to the learning process, and then deals with them as technologies in their own right.

The technologies specifically mentioned in this document are only a sub-set of those available. The spreadsheet that is included as an appendix to this document may give a better overall picture of the available technologies.

2 Adaptive and assistive technologies

2.1 An initial definition

The definition of assistive technology that was used in the previous paper was developed by the World Wide Web Consortium (W3C). This international body has undertaken policy development in relation to Internet accessibility for disabled learners.

W3C defines assistive technology as ‘Software or hardware that has been specifically designed to assist people with disabilities in carrying out daily activities.’

This definition is quite broad to accommodate the wide range of technologies available. However, it is evident that the focus of W3C is firmly on web and HTML because of the proportion of information dedicated to making HTML accessible.

This paper will restrict itself to those technologies that aid the learning process for learners with disabilities, often referred to as assistive or adaptive technologies.

For the purpose of this paper, a clear distinction has been made between the two. Adaptive technologies aid by adapting content or user responses from one form to

another (e.g. screen readers and onscreen keyboards). Assistive technology helps you with understanding material presented, temporarily storing information, and composing responses (e.g. picture dictionaries, digital scrapbooks, and Word's auto-summarize tool).

2.2 A learning perspective

In order to better understand the breadth of adaptive and assistive technology, this paper does not initially focus on particular disabilities that may need to be catered for, but instead examines the overall learning context.

There are many points within a learning interaction that a learner with physical or cognitive disabilities could strike difficulties. An assistive or adaptive technology usually concentrates on one of these points, and for some learners, a suite of accessible technology is required to enable them to successfully navigate the learning interaction.

2.3 The range of adaptive and assistive technologies

Initially the range of technologies seems overwhelming. However when you delve a little deeper, you identify a number of niches into which the technologies seem to divide. Once you identify what these niches actually are, you discover some that don't seem to be supported by current technology, and there are some potential technologies that aren't represented at all.

No one piece of technology covers all needs. In fact some people may make use of 5 or more separate pieces of technology. There is good reason why such a range exists. It is not only due to the range of disabilities involved, but also due to the various aspects of the learning process that needs to be catered for.

Institutions cannot simply buy the 'best' piece of adaptive or assistive technology, because what is the best solution for one person may be entirely useless to another.

Historically products have focused on assisting blind people while assisting deaf people has come in second. However, technologies aimed at people with physical disabilities, while not the most prevalent, are often the most noticeable. These include mouth operated joysticks and speech recognition software.

3 The five modes of learning

A learning interaction can usually be split up into a sequence of steps, each of which can be categorised as belonging to one of five distinct modes:

These modes are the same in today's online learning environment as they would have been in the 19th century classroom environment. The following table lists each mode alongside a description of its "old school" equivalent.

Note: The names of the modes are always from the perspective of the learner.

Mode	Assistive or Adaptive	Traditional Example	Technology Example
Receive Instruction	Adaptive	Student receives instruction from the	• Screen readers

		teacher via the blackboard.	
Comprehend	Assistive	Student attempts to comprehend what is written, if he doesn't understand the instruction he would raise his hand to ask a question.	• Auto-summarize • Online dictionary • Glossaries
Compose	Assistive	Student composes a response in his mind.	• Picture dictionaries
Transmit Response	Adaptive	Student writes his answer down on a piece of paper and hands it to the teacher.	• Onscreen keyboards • Speech recognition
Store and Retrieve	Assistive	The student either commits what he has learnt to memory, or writes it down in his notebook for later reference.	• Digital scrapbooks

The type of technology an individual requires tends to directly relate to the mode in which the learner needs assistance.

The *receive instruction* and *transmit response* modes are similar in that they typically involve a conversion of material from one form to another. Speech synthesis, a conversion from text to speech, may be useful for a blind learner receiving instructions via email. However it has less application in transmit response mode. Speech recognition software has application across both these modes. It allows a deaf person to *receive Instruction* in the form of an audio presentation which has been converted to text. The same technology also allows a physically disabled individual to *transmit response* through speech, instead of a keyboard.

The *comprehend* and *compose* modes are separated from any physical relationship with the message. No matter how the message gets to a learner, he still has to understand it. No matter how an answer is to be transmitted back, it still has to put it into words first.

Both these modes involve the application of cognitive skills, and some individuals, either with learning difficulties such as dyslexia, language barriers or low literacy may need assistance in this area. Problems with these modes are exacerbated by irregularities in the English language such as Homophones, Homonyms, Synonyms, inconsistent rules of Grammar, overuse of acronyms, and the absorption of non-English words (See Confusables Section).

The *store and retrieve* mode could be considered a hybrid of the first two modes described. It typically involves thoughts being stored and later retrieved. This may involve conversions of material in exactly the same way as described above.

People can function differently across the different modes and may show great strengths in some. For example, Stephen Hawking is an individual with great ability within the *comprehend* and *compose* modes who while also needing some assistance in the *receive instruction* mode, is noted for the *Transmit Response* mode assistive

technology he uses to either order a coffee or explain his remarkable theories to the outside world.

Technology has traditionally focused on the two adaptive modes. This is because these modes, with respect to the mainstream user, have been influenced heavily by the introduction of technology.

3.1 Mode: Receive Instruction

Both presentation of facts and the asking of questions are examples of the *receive instruction* mode.

Example of e-learning scenarios:

- Learner is presented with an on-screen menu of topics
- Learner is presented with content containing images and text
- Learner is shown a video

Restricting our initial examination of this mode to the five human senses, we see that almost 100% of communication within this mode involves only two of our senses, which are seeing and hearing. If the learner is deficient in or completely without one of these senses they will certainly struggle in a learning environment.

For those who are deficient in one of these senses, the easiest way round is to revert to the other form. Blind people rely heavily on their hearing, while many deaf people have the ability to lip read.

Individuals who cannot see or hear could revert to using touch in the form of Braille based screen readers.

Technologies based on smell or even taste, while possible, are both impractical and beyond the scope of this document.

Adaptive technologies useful in this mode include:

- Speech recognition (If the class is presented orally to a deaf person)
- Speech synthesis (If textual material is presented to a blind person)
- Braille translation software
- Screen magnifiers

3.2 Mode: Transmit response

The transmit response mode involves the student taking the answer that they have formulated within the compose mode and converting it to a form that the teacher expects.

Example of e-learning scenarios:

- User answers a multiple choice question
- User chooses a pathway through learning (e.g. Chooses a Topic)
- User submits an essay or short essay form response to be marked by a human tutor

It is clear that some of the same technologies can be used in both the *receive instructio*n and *transmit response* modes, but they are used for different reasons, and wouldn't be used in both modes by the same person.

Speech synthesis is a good example. A blind person may use the technology in the *receive instruction* mode, while a non-speaking person could use the same technology in the *transmit response* mode. Neither person would gain benefit from the technology were it to be used in the alternate mode.

Adaptive technologies useful in this mode include:

- Speech synthesis
- Speech recognition
- On screen keyboard
- Head mouse
- AUSLAN translation device such as an Accelleglove

3.3 Mode: Comprehend

Messages received in the *receive instruction* mode are transported to the brain which then begins the comprehension process. Even individuals with highly developed hearing and sight may not be able to comprehend what is being said, or what has been written on the page.

Comprehend mode technologies should assist the learner in distilling the correct meaning from the words provided by the teacher.

Example of e-learning scenarios:

- Learner examines a paragraph, and deciphers meaning from it
- Words with multiple meanings are deduced from context
- Unknown words are looked up in a dictionary or glossary

Comprehension skills are often taken for granted. English is a difficult language, where the same word can mean lots of different things. Learners with low literacy and numeracy don't have any problems with inputting and receiving information, just in making sense of the information.

They should in particular assist the reader with 'confusable' words (see section below) by highlighting them, and helping in the determination of the meaning of the word in context.

If for example a dyslexic learner had problems telling the difference between two words, a roll over image that clearly indicates which of the possible meanings is intended may be useful.

The inclusion of Metadata placed around difficult or "confusable" words would enable assistive software to provide such correct meaning of the word to the learner.

Huge texts are often too big to be dealt with in one sitting. One technology that is useful in this regard is Microsoft Word's auto summarization tool. See "Adaptive and assistive features in mainstream operating systems".

Assistive technologies useful in this mode include:

- Online dictionaries and glossaries

- Translation services for those with English as a second language (includes AUSLAN speakers)
- Auto-summarise function to highlight key points

3.4 Mode: Compose

Any message sent between two people needs to be composed in a common language in order to be understood.

When the common language is as complex as English, it ultimately leads to frustration for people with learning difficulties, particularly when they know what they want to say, but cannot frame it in an acceptable way.

Again, many of the difficulties arise from a relatively small set of 'confusable' words, which are discussed separately.

Example of e-learning scenarios:

- Learner composes a paragraph using non-familiar words
- Learner is not sure which word to use in context
- Learner requires assistance with grammatical correctness
- Learner chooses the appropriate meaning from groups of similarly spelt or sounding words

Technology could be used to assist in the selection of the right word. For example if the user types the word 'weather' the system will recognise the word and confirm with the learner which meaning/spelling they wished to convey.

Technologies in this area could either be on-demand, or automatic. Automatic tools will pop-up a dialog both whenever a word recognised by the computer as a confusable is used, whereas on-demand would only be invoked if the user felt uncomfortable with a certain passage.

On-demand lookup requires the user to click on the confusable word to ensure the meaning conveyed is that which was intended. The problem with on-demand confusable correction is that it is only useful when the reader recognises that they have trouble with that word. They might simply not consider that WORDX may have the alternative meaning WORDY.

Assistive technologies useful in this mode include:

- Spell Checker
- Thesaurus
- Word prediction software (e.g. Co: Writer)

3.5 Mode: Store/Retrieve

This mode encompasses the processes of storing and retrieving information for later reference. This includes the ability to find content easily, either through some sort of indexing or search facility.

Example of e-learning scenarios:

- Screen reader is used to read back notes typed in by student

- Speech recognition is used to store notes in a text form, which are later read back in Braille format
- A screen magnifier is used to read notes
- Student searches digital document for instances of a key word

Most of us have used text searches at onetime or another. Computer text, by virtue of being digital, makes such searches easy, however audio, even digital audio, is not able to have text searches performed on it.

This means that people who are restricted to taking notes in a spoken form, are denied the ability to perform automated searches. This is a particular drawback as manual searches of printed text are much easier to perform than manual scans of audio presentations.

Adaptive technologies useful in this mode include:

- Screen readers such as JAWS
- Search functionality built into the operating system

4 Some notable adaptive and assistive technologies

This section examines a number of key technologies in a little more detail. A larger range appears in the accompanying spreadsheet. Some of the listed technologies are still nothing more than research projects and have yet to come to fruition.

4.1 Speech Synthesisers

Speech synthesisers are probably the most recognised form of adaptive technology. They are a necessity for blind or vision-impaired learners to successfully navigate an e-learning environment.

This technology has gone a long way in recent years. The computer synthesised voice has become more and more natural over time, a long way from the early stunted, robotic monotone voices.

Now screen readers can be assigned accents that more closely resemble those that the learner is familiar with. Small details such as this do have significant impact for the ease of comprehension of the information.

There are drawbacks to using this technology. Some software is incompatible with screen readers, usually due to inconsiderate design, although this is becoming less common with the widespread adoption of standards for accessibility such as W3C.

Microsoft Windows has an inbuilt screen reader. It is fairly primitive when compared to dedicated software such as JAWS, and it can be tiresome to use.

4.2 Speech Recognition

Speech recognition is the other end of the spectrum, having great application in the provision of assistance to learners with disabilities.

This technology has become so advanced that it has found its way into mainstream automotive systems, aiding in the hands free operation of in-car navigation systems.

This software has to understand a multitude of voices in a variety of pitches and languages. Indeed a single voice can vary significantly from day to day, whether due to mood, or the effect of a head cold.

Usually a user of speech recognition software needs to invest a reasonable amount of time up front to train the software. This usually entails the computer asking the user to speak a large number of key phrases, from which it create an individual voice file enabling it to recognise your voice.

Newer software does not require training, but does perform better if trained. These programs could conceivably self-train as corrections are made to the documents being dictated.

The two main players in this market space are Dragon Dictate and IBM's ViaVoice. Both the Macintosh and Windows operating system have been offering speech recognition modules for a number of years, but they do not match the sophistication of the two main commercial products.

4.3 Sign language interpretation

In the same way that there are two components to the speech interface, namely speech synthesis (*transmit response*) and speech recognition (*receive instruction*), there are two separate components to facilitate the use of sign language, these are sign interpreters, and text2sign programs.

Use of sign language causes its own problems in that each country has its own sign based language. In Australia we have AUSLAN and the USA for instance has ASL. Thus anybody developing a sign language interpreter would not have a globally accessible market, but would be limited to the region that understands the particular sign language dialect.

Sign interpreters are rare, but research has been conducted in these areas. One study uses gloves with sensors that recognise certain symbols and movements, and a second relies on analysis of frames from a camera that captures a video of the signs as they are being made. Such video based systems are in their infancy, but in the long run the technology could be included in future generations of mobile camera-phone.

Work in this area does not appear to have progressed for some time. The example mentioned is quite old. This contrasts greatly with the EagleEyes and EyeGaze technologies mentioned below, which have already found a commercial market.

This may be driven more by low demand for this type of translation, and the availability of more suitable alternatives. Anyone who could use a glove, could probably type, and almost definitely use a mouse.

4.3.1 Accelleglove

The Acceleglove is a portable, glove based input device that translates hand and gesture based languages into text.

It consists of a group of sensors and accelerometers that are strapped to the hand, arm and shoulder. A set of algorithms deciphers the movements of both the hand and arm to ascertain the intended letter or word.

The prototype device currently works only on American Sign Language.

http://www.gwu.edu/~research/gwnt/accele.htm

4.4 Head Mouse and Eye Trackers

The head mouse is one of a range of technologies that allows someone who cannot use a mouse to interface with software that relies on pointer based input.

The head mouse uses a camera and a reflective dot, usually attached to the front of a cap. The camera uses the location of the dot's reflection in the camera to ascertain the point on the screen at which the user is focusing. Clicking may be either by nodding a certain way, or separately controlled by a button the user can operate.

Technologies such as EyeGaze exist that use a camera to examine the eyes themselves and ascertain from that where the user is looking. Imagine right-winking on the desktop looking down to "new folder" and left-winking to select it. Then winking your way through an on-screen keyboard to name the folder.

Many people use a mouth controller, which is really just a joystick, to achieve the same effect.

5 Adaptive and assistive features in mainstream operating systems

Those responsible for providing computer operating systems are shouldering some of the responsibility for making programs written to run on them accessible.

While investigating the accessibility of Microsoft's latest OS, a user may be surprised to note that there is a wealth of accessibility tools provided either out-of-the-box or freely downloadable. Taken together these tools cover each of the 5 modes of accessibility as described in this document.

The accessibility options can be found under the Control Panel by users of Windows 2000 or XP.

Hitting Windows-U activates the Utility Manager. This gives access to a number of accessibility tools, include a built-in narrator, a screen magnifier and an on-screen keyboard.

Mode	Examples
Receive Instruction	• Narrator (This is not as nice a experience as running JAWS) • Screen Magnifier • SoundSentry / ShowSounds • High Contrast Mode
Transmit Response	• On-Screen Keyboard • Sticky/Filter/Toggle Keys • Mouse Keys • Filter Keys • Microsoft Speech Recognition Engine (downloadable) • Serial Key Devices (allows alternative access to keyboard and mouse features)

Comprehend	• Auto-Summarization (Word) • Thesaurus (Word)
Compose	• Grammar and Spell Checker • Auto-correct
Store and Retrieve	• Spoken Annotations (Word) • Text searching

6 Issues

6.1 Confusables

Due to the way in which the English language has developed over time, there are a large number of inconsistencies that lead to difficulties with both the *comprehend* and *compose* modes.

Comprehension difficulties may arise for a number of reasons. This could be due to not having English as your main language or other learning difficulties such as Dyslexia.

Many deaf learners have AUSLAN as their first language and struggle with the non-visual nature of their second language.

Even regular readers of English have problems with these words, and often need to study a word in either its sentence or paragraph context in order to decipher its meaning.

Hidden metadata attached to words could assist the reader in establishing the actual meaning of the word in this context if they are having difficulty deciding on which meaning should be applied.

For more information see Webster's page of notorious confusables at:

http://webster.commnet.edu/grammar/notorious.htm

6.2 Who is responsible for converting between mediums?

Given that the majority of adaptive technologies, (*Receive Instruction* and *Transmit Response*), are just conversions of one form of communication to another, consideration should be given to which party should be responsible for any content conversion.

Content conversion can happen prior to class in many situations (batch conversion), but when lessons become more interactive, the ability to pre-prepare content in more than one form diminishes.

Some technologies, such as ViaVoice and JAWS offer a real-time conversion of material. Such real-time technologies are essential for allowing disabled users to effectively participate in online class based collaborative sessions.

6.2.1 The Teacher

For younger learners, it is typically the teacher that is responsible for providing material in the right format.

In some situations teachers may provide a Braille version of notes to students prior to class. Indeed, in schools catering exclusively to a single specialised group, such as that found in deaf schools, it makes more sense for the conversion to be carried out once by the teacher, than to have the material converted individually by each of the students.

6.2.2 The Student

As students get older they can take over the responsibility of the conversion process, which they inevitably must do in order to fit into a regular learning institution or workplace environment.

On receiving a printed assignment, the learner scans it in to the computer using OCR software, then either converts it to Braille using an embosser, or uses a screen reader to read it.

6.2.3 The Program Developer

As developers of e-learning software, we need to decide what responsibilities our software should take on when it comes to providing for the conversion.

Should we program a synthesised voice into the software?

At the minimum we should acknowledge that the conversions will need to take place. If we understand how they will work, we can make our material in such a way that these conversions can take place seamlessly.

6.2.4 The Operating System

What responsibilities should be left to the operating system? We have seen that Microsoft has included a large range of both adaptive or assistive utilities as part of the operating system.

6.3 Why is audio content invisible to search engines?

There is immense value in search engines, such as Google, indexing the content of audio presentations. Indeed Google provides an indexing service for complex file formats such as Adobe's PDF and Microsoft's PowerPoint.

In many cases material exists in both text and audio form. In such a case the regular search engine user will find useful information. However a user who can only process audio information will not be able to locate it with a text search as its contents are not indexed.

Adaptive technology may help solve this problem. Using speech recognition algorithms, an index of words could be created that ties every word spoken to a particular moment in a sound file. Thus if you searched for a string, you would be returned all the audio files that contained that string, along with the cue points within that file where the particular word is actually spoken.

Adding this functionality to audio files not only makes the material searchable by a blind person, but as a bonus to the standard user, it also increases the audios value as a resource.

6.4 Problems caused by a lack of free demonstration versions of software

Whether producing applications or e-learning content, developers need to be able to test their software with a representative sample of assistive and adaptive technologies to ensure that they have adequately provided for disadvantaged users.

Unfortunately it seems that the majority of manufacturers of assistive and adaptive technology over zealously guard their products and do not make even time limited trial versions readily available to developers.

Surely these manufacturers will benefit from their products being usable with a greater range of e-learning content.

Perhaps it is no co-incidence, that the most prevalent products (JAWS, ViaVoice and DragonDictate) are the ones who actively support developers with trial versions of product.

7 Crystal ball gazing

Will we see direct brain / nervous system wired technologies in the future?

Each of our five senses is connected to our brain via our nervous system. Rather than using the senses themselves, we could patch into the nervous system directly and create a 6th sense.

Cochlear Implants and video glasses are not repairs to our broken senses, but the addition of new senses that mimic the missing sense. Our brains have to be retrained to use this new sense.

The nervous system also controls our muscles, our brain firing electrical impulses through the nervous system to initiate movement. Imagine being able to move a mouse, or type simply by moving imaginary muscles. You may have imaginary third and fourth arms, which you use for typing. They would never get tired, and you wouldn't suffer from repetitive strain injury (RSI).

8 Conclusion

This paper has examined the range of assistive and adaptive technologies available in the marketplace at the time of writing. The initial premise is that these technologies fit into 5 distinct modes relating to aspects of the learning process.

It could be argued that all the technologies supporting all 5 modes are assistive to their users, however because the technologies used to augment the *receive instruction* and *transmit response* modes usually rely on content or responses being adapted from one representation to another, they have been referred to here as adaptive technologies.

As we have seen, technology designed to help disadvantaged learners has traditionally been focussed on the two adaptive modes, *receive instruction* and *transmit respons*e.

The benefits of some of these technologies have begun to reach beyond their initial target audience of disadvantaged users and have begun to provide additional assistance to those who do not suffer physical or learning difficulties.

Some of the adaptive technologies described can be applied to situations where the conditions of tasks being undertaken do not allow for traditional human computer interfaces to be used.

Take for example a courier who has to follow a computer set route on his delivery run. He is driving, and cannot be constantly looking at the satellite navigation display for instructions. Instead the computer speaks the instructions, thus avoiding the need to look at the display. Some navigation systems also use speech recognition to set destinations, or “find closest pizza store”.

Mobile phones have had rudimentary speech recognition built in since 2000, which enable us to dial numbers via voice command when the phone is inserted in the car’s cradle.

These are both example of technologies developed initially to assist the disabled, that have now found a niche in the able bodied world. It is reasonable to expect that the able-bodied community has much to be gained from the further development of adaptive and assistive technologies.

During research for this paper, technologies were found that covered all aspects of the other 3 modes of learning. These are a little harder to find and are usually require no physical hardware.

Examples of assistive technology are less evident than the adaptive technologies, being less “obvious”, in that they are usually a software only solution. Assistive technology has been used in the preparation of this report. It has been provided free by Microsoft, and comes in the form of a spell-checker, grammar-checker, and auto-summarize function.

There is no doubt that there are many avenues for exploration with regards to assistive technology. Perhaps further exploration of these 3 neglected modes might offer a host of benefit’s not only to disabled learners, but to all learners, and possible to the entire population.

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Technology	Learning Mode					Cost	Relevent URLs	Description	Audience					
	Receive Instruction	Transmit Response	Comprehend	Compose	Store and Retrieve				Unsighted	Low-Sighted	Deaf	Mobility Impaired	Learning Disability	Low Literacy
Voice Synthesisers / Screen Readers or Text to Speech (TTS)	✔	✔			✔			Used more in *receive instruction* mode, but can be used in *transmit response* mode.	✔	✔				✔
JAWS	✔				✔		http://www.freedomscientific.com/fs_products/software_jaws.asp	Job Access With Speech - DeFacto industry standard for screen readers	✔	✔				✔
Connect Outloud	✔						http://www.freedomscientific.com/fs_products/software_connect.asp	Based on JAWS	✔	✔				✔
Fire Vox	✔					Free	https://webspace.utexas.edu/chencl1/clc-4-tts/clc-firevox_doc.html	Screen reader plug-in for the popular FireFox browser	✔	✔				✔
Apple Voiceover	✔					Free	http://www.apple.com/macosx/features/voiceover/	Screen reader functionality included free in latest version of Macintosh OS	✔	✔				✔
Microsoft Narrator	✔				✔	Free	http://www.microsoft.com/enable/training/windowsxp/narratorturnon.aspx	Bare bones screen reader included free with Windows.	✔	✔				✔
Talking Desktop*	✔	✔					http://www.talkingdesktop.com/	This technology includes both voice recognition and speech synthesis, with some other useful and interesting features.				✔		✔
Equalizer		✔		✔	✔		http://www.hawking.org.uk/disable/dindex.html	This is the software used by Stephen Hawking to write books and communicate with people.				✔		✔

Technology	Learning Mode					Cost	Relevent URLs	Description	Audience					
	Receive Instruction	Transmit Response	Comprehend	Compose	Store and Retrieve				Unsighted	Low-Sighted	Deaf	Mobility Impaired	Learning Disability	Low Literacy
Voice Recognition Software	✔	✔			✔							✔		✔
IBM ViaVoice		✔				Low	http://www.scansoft.com/viavoice/personal/	Very popular screen recognition program, finding many users outside the disabled community.				✔		✔
Dragon Naturally Speaking		✔				Low	http://www.scansoft.com/naturallyspeaking/	As Above				✔		✔
Talking Desktop*	✔	✔				Low	http://www.talkingdesktop.com/	This technology includes both voice recognition and speech synthesis, with some other useful and interesting features.				✔		✔
Audio-Visual Speech Recognition	✔	✔				High	http://www.intel.com/technology/computing/sw04034.htm	Allows developers to build computers capable not only of voice recognition, but that can also 'see' and 'read lips' the way people do. Requires a camera as well as a microphone.						
OCR Systems	✔				✔									
Handwriting Recognition Software	✔	✔				Med	http://www.scansoft.com/speechworks/handwriting/simpliwrite/	Processor independent code that can be incorporated into other software, e.g. word processors to enable the direct recogntion of handwriting.						✔
Mimio	✔				✔	High	http://www.innosolu.com/mimio1.html	Allows Slower Learners to Replay the Class Lesson. Zoom in on bits. Helps those who can't take notes.					✔	✔

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Braille Systems	✓				✓				✓					
ALVA Braille Displays	✓					High	http://www.alvabraille.com/BrailleDisplays/default.asp	Ergonimic design fits nicely under keyboard.	✓					
Rotating Wheel Braille Display						Med	http://www.itl.nist.gov/div895/isis/projects/brailleproject.html	This new rotating wheel design minimises the use of powered actuators, thus reducing production costs.						
Braille Printers / Embossers	✓					High	http://www.viewplus.com/products/braille-embossers/pro-embosser/	Single sided embossers, powered by Tiger software that enables the creation of tactile graphics. Ink option for mult-user documents included.	✓					
Double Sided Embossers	✓					High	http://www.brailler.com/juli3.htm	Saves paper by embossing both sides of the page	✓					
Braille-Lite Note Taker					✓	Med	http://www.blazie.co.uk/productsBrailleLite.htm	Uses Braille keyboard for input and provides both Braille and speech output. This products includes a built in diary and address book function.	✓					
Braille Music translation software	✓			✓		Low	http://members.optusnet.com.au/~terryk/toccata.htm	Allows Braille music to be easilly produced for use by blind musicians. Can convert directly from MIDI files.	✓					
MathBrailleTalk	✓			✓		Low	http://www.innosolu.com/mtb_printable1.html	Provides a speech driven interface to create matematical equations, both in MS Word, and also allows the conversion of equations to their Braille equivalents.	✓			✓		

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Screen viewing aids	✔									✔				
Microsoft Screen Magnifier	✔					Free	http://www.microsoft.com/enable/training/windowsxp/usingmagnifier.aspx	Non Microsoft alternatives are available such as ZTWin, ZoomText, CloseView and InLarge		✔				
Keyboard and Mouse Alternatives		✔										✔		
Talking Desktop*	✔	✔				Med	http://www.talkingdesktop.com	Includes voice activated mouse control				✔		✔
Trackballs		✔				Med	http://www.abilitycorp.com.au/html/Ability_Trackballs.htm	A range of trackball designs are available, with varying radius and number of buttons.				✔		
Mouse Pen		✔			✔	Med	http://www.gorillawiz.com/	Pen and software bundle including handwriting recognition and screen annotation.				✔		
Touch Screens	✔	✔				Med	http://www.elotouch.com/	Most monitors, either LCD or CRT, can have touchscreens retrofitted to them. As well as determining X and Y position, some can determine how hard the screen is pressed.						
Foot Mouse		✔				Low	http://www.abilityhub.com/mouse/foot.htm	Two foot controllers, one for cursor position and one for left-right clicks.				✔		
Sip-and-puff		✔				Med	http://orin.com/access/sip_puff/index.htm	Works standalone, but partners well with Origin Instruments Headmouse Extreme						

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Mouse Pad		✔				Low	http://www.iesproducts.com/key-mice-easyusb.html	Mousepads provide a useful alternative in some situations. They are often found on notebook computers.				✔		
Head Mouse		✔					http://orin.com/access/headmouse/index.htm	Lightweight, requires only a reflective dot be worn by the learner. Two wireless switchs are provided for click actions.				✔		
Joystick		✔					http://www.abilitycorp.com.au/html/Ability_Joysticks.htm	Huge variations in price and quality. From expensive custom hardware to cheap PC joysticks used in conjunction with conversion software.				✔		
SmartNav3 Head Mouse		✔					http://www.novitatech.org.au/product.asp?p=247&id=1741	New version with Increased speed and better accuracy of the cursor position, more options for personalising control and ability to cope with a greater range of lighting conditions.				✔		
DynaSight							http://orin.com/3dtrack/dyst.htm	The DynaSight is a compact, self-contained sensor that measures the instantaneous three dimensional position of a passive target. The sensor uses embedded signal processing to automatically acquire and track the target in uncontrolled environments.						
Membrane Keyboard		✔					http://www.abilitycorp.com.au/html/Ability_Programmable_Keyboards.htm	Range of keyboards with configurable overlays to suit different applications, or cognitive ability.				✔		

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Switches		✔					http://www.abilityhub.com/switch/switch.htm	A large range of switches are available here, including a switch based on changes between video frames.				✔		
Microsoft on-screen keyboard		✔				Free	http://www.microsoft.com/enable/training/windowsxp/usingkeyboard.aspx	Allows key presses and mulit-key combinations to be activated with a mouse.				✔		
EagleEyes		✔					http://www.bc.edu/schools/csom/eagleeyes/	Comes with customised browser that is tuned for eye driven navigation.				✔		
Sign language interpreters		✔									✔			
AcceleGlove		✔					http://www.gwu.edu/~bygeorge/041503/aslglove.html http://www.seas.gwu.edu/~gogo/papers/hernandez_SIGGRAPH_2002.pdf http://www.gwu.edu/~research/gwnt/accele.htm	A wearable glove that translates sign language into text. Currently only compatible with the US sign language.			✔			
Text to Sign		✔					http://www.dinf.ne.jp/doc/english/Us_Eu/conf/csun_97/csun97_114.htm	Allows sign language user to view a signed representation of a passage of text.			✔			
Blue Sign Translator	✔	✔					http://www.computer.org/CSIDCArchive/2002ProjectReport/Siena.pdf	A possible method of communication using sign langauge over short distances using bluetooth technology.						

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Reading Tools	✔		✔											
TeDUB	✔		✔				http://www.tedub.org/history_en.html#floor	Technical Drawings Understanding for the Blind (TeDUB) provides access to technical drawings, architectural plans and electrical/electronic schematics for blind or vision impaired.	✔	✔				
Scan and Read Pro	✔		✔				http://www.premier-programming.com/snrp/SNR_PRO.htm	Scan & Read Pro changes printed text into understandable sound. It aids in reading and comprehension by highlighting each word as it's read aloud.	✔	✔			✔	✔
Kurzweil 3000	✔		✔				http://www.innosolu.com/kurzweil_30001.html	Integrated solution for addressing language and literacy difficulties. The software uses a multisensory approach – presenting printed or electronic text on the computer screen with added visual and audible accessibility						
Read: Aloud	✔		✔				http://www.donjohnston.com/catalog/rolsolo.htm	Supports students with modeling, scaffolding and practice of research-based reading strategies to comprehend text. Allows teachers to provide additional structured support material.						

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Composition Tools		✓		✓										
KeySpell Ellipsis		✓		✓			http://www.innosolu.com/keystone_literacy1.html	The unique system is even able to handle the complex problems caused by dyslexia. Words like 'elephant' for example, can still be found when misspelt with a consonant ('lefamt').						
Keystone Screen Speaker		✓		✓			http://www.keyspell.com/Products.asp?pro=2	Any mistakes can be quickly found and corrected using advanced spelling and homophone checkers, while the work is being created or after it has been completed. Any amount of the text can be read back at any time.						
Write: Outloud		✓		✓			http://donjohnston.com/catalog/writoutd.htm	Auditory feedback, coupled with considerate learning supports, inspire students to evaluate the content of their writing and implement strategies to improve mechanics.						
Co: Writer		✓		✓			http://donjohnston.com/catalog/images/cowsolo2.jpg	Adds linguistic word prediction to exsiting word processing or e-mail programs.						
Enkidu		✓		✓			http://www.innosolu.com/tablet_portable1.html	Reconfigurable touch-screen tablet to enable phrase- and symbol-based communication						

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Writing with Symbols 2000		✓		✓			http://www.widgit.com/products/wws2000/about_wws/WWS20001.htm	Helps writers see the meaning of words. Visually explains the differences between words that look the sameand words that sound the same. It can help many other aspects of language development where images can assist understanding. A version is available with a special Australian set of symbols.					✓	✓
Other														
Teletypewriter (TTY) over VOIP	✓	✓					http://www.speechtechmag.com/issues/9_4/usingspeech/10665-1.html	General TTY is becoming less significant as users turn to the internet as their primary communication network. However, VOIP is expanding the ability to use TTY internationally, and has enabled software programs that emulate TTY.						