Assistive Technology: Strategies for Diverse Needs

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"How can experience equity be achieved for a diverse needs audience?" My recent trawling of technical articles in our literature data bases suggests that we may need new technological approaches before we can fully achieve this goal. For example, shall we move toward use of custom user profiles when accessing a website? Shall we use multimodal methods for presenting information on our web pages? While the answers to these questions are complex, this workshop will introduce attendees to current assistive technologies that are available for a wide range of diverse needs. Emphasis will be given to matching products and strategies to a variety of need areas: (a) cognitive, (b) hearing, (c) vision, (d) autism spectrum, and (e) physical disabilities and traumatic brain injury.

WHAT IS ASSISTIVE TECHNOLOGY?

Assistive technology is any product that improves and/or maintains one's capability to function in her or his environment. Assistive technologies may vary by need and solutions may be simple or complex.

In this session, I provide usability heuristics on best practices for communicating with people with diverse needs. Then, I will make broad suggestions for technology application for each area.

Technology for People with Cognitive Disorders

Richard Gargiulo (2006) suggests that people with cognitive problems may have difficulty with the following: attention, memory, performance, motivation, generalization, and language development. They may also have difficulty with the following processes: speech, language, reading, writing, arithmetic, and other areas. Technology, however, can assist people with cognitive problems in many ways. The guidelines in Table 1 will provide guidance on how to apply assistive technologies to help people with this disorder.

Table 1. Technology Guidelines for People with Cognitive Disorders

Guideline
Provide information in small chunks when they need to remember it and offer opportunities to recall and communicate that information.
1. Are materials presented using computers, calculators, and tape recorders?
2. Are there opportunities to demonstrate recall skills?
Provide opportunities to remove deficits in knowledge or skill to enable people to practice and review when they can't remember it.
1. Is drill and practice technology available?
2. Are integrated learning support systems available?
3. Is hypermedia available?
4. Does the technology support customization of materials for practice and review?
Provide accommodation for memory deficits when people cannot remember.
1. Are there productivity tools that can help (notetaking, etc.)?
2. Is a portfolio management system available?
Provide ways for improving short attention spans when the person cannot concentrate.
1. Are gaming technologies available?
2. Are simulations available?
Provide accommodation for inefficient learning strategies when the person struggles with new concepts.
1. Is problem–solving software available?
2. Are personal productivity tools available?
Provide ways for obtaining background knowledge when the person lacks that information.
1. Is content–related software available?
2. Is hypermedia helpful?
3. Is scaffolding in use?
Provide ways for developing higher–order thinking skills when the person lacks those skills.
1. Are you using higher–order verbs when you communicate with the person? (See websites on Bloom's Taxonomy for more detail.)
2. Are there opportunities to "generate" responses to communication using higher–order thinking skills?
3. Are instructional technologies in use?
4. Are applications available that support higher–order thinking skills (wordprocessing, simulation, and problem–solving software) for content development?
5. Are productivity tools being used?
6. Are personal productivity tools available?
7. Are networks accessible?
Provide ways for reducing motivational deficits when the person is having difficulty getting started.
1. Is essential technology available?

Source: Adapted from graphical material in Gargiulo (2006).

Technology for People with Speech and Language Disorders

People with speech and language disorders use augmentative or alternative communication (AAC) symbols, aids, strategies, and techniques. In Table 2, I provide information on types of technologies that may be helpful.

Table 2. Technology Guidelines for People with Speech and Language Disorders

Guideline
Provide symbols (electronic or non–electronic) to enable people to communicate when they can't say it.
1. Are electronic communication boards available?
2. Are the symbols clear?
3. Are there a limited number of choices (two or four)?
4. Are the choices represented by real items, pictures of items, or symbols for items?
5. Are there printed words or Bliss symbols?
Provide voice to enable people to "hear" the words when they can't say it.
1. Is sound included?
2. Are the sounds capable of being changed so that they support bilingual communication?
3. Does the sound offer alternatives for voice selection (male or female, young or old, etc.)?
Provide message redundancy for those with Central Auditory Processing Disorder (CAPD) and stuttering problems so that they can communicate when they can't say it.
1. Are there opportunities for message redundancy?

Source: Adapted from textual material in Gargiulo (2006).

Technology for People with Hearing Disorders

People with hearing problems may use hearing assistive technologies (hearing aids, loop system technologies, captioning, animations of sign language, and finger spelling technologies). The guidelines in Table 3 are items to consider for people who are deaf and hard–of–hearing.

Table 3. Technology Guidelines for People with Hearing Disorders

Guideline
Provide captioning or text transcript to enable people to read audio content when they can't hear it.
1. Is captioning available?
2. Is the captioning clear and easy to read?
3. Is there contrast between foreground and background of captioned material?
4. Are captions placed beneath the person who is speaking?
5. Is a sentence with multiple lines of text broken where speech normally pauses?
Provide content–related visual cues when captioning and text don't help.
1. Is there a sign–language version of the spoken and written material?
2. Are pictorial dictionaries and glossaries provided?
3. Are links to additional information provided for on–line materials? For example, are there links to on–line help files?
4. Are visual alerts (such as Windows Show Sounds) provided for people who can't hear computer prompts?
5. Is content conveyed clearly with visuals?
6. Is content conveyed clearly with word substitution? (For example, use instead of utilize?)
Provide users with choice to enable people to process information in different ways and at different paces.
1. Is the volume adjustable?
2. Can captioning be turned on and off?
3. For electronic materials, is there a way to rewind, pause, and restart presentations?
4. Is text telephone (TTY) provided?
5. Is an e–mail address provided?

Source: Adapted from graphical material in Gillen (2004).

Technology for People with Vision and Deaf–Blind Disorders

People with vision problems access information in a variety of ways (Gargiulo, 2006; Reece, 2005, 2004, 2003, 2002): image displays (ZoomText, inLarge, and enlargement features within Microsoft Office applications), Braille (Braille Lite, Mountbatten Brailler, Duxbury Braille, Translator), synthetic speech (JAWS, DECTalk, Browsealoud), optical character recognition (OCR) Reading Edge and Open Book. hand–held camera and scanning technologies such as Optacon (Hogg, 2005).

They also use adaptive hardware, software, input, and output systems. Adaptive hardware includes refreshable Braille displays, screen enlargement peripherals, speech synthesizers, printers, Braille embossers, electronic notetakers, voice output devices, Braille input/output devices, Robotic Alphabet: Finger Spelling Hand (in pilot stage of development process), and smart boards. Examples of adaptive software includes: Braille translation software, screen readers, screen enlargement software, speech recognition software.
Adaptive output systems include enhanced image systems, synthesized speech systems, refreshable Braille displays, and Braille printers. Additionally, they may

also use adapted input systems (Braille input devices, voice recognition systems, and OCR technology). Deaf–blind people may use a variety of symbol systems for communication (Blissymbols, Rebus symbols, Makaton pictures, etc.) (http://www.sense.org.uk/publications/allpubs/communication/C01.htm).

In Table 4, I provide guidelines for people with deaf–blind disorders. Some of the guidelines listed in Table 3 may also be helpful to a deaf–blind audience.

Table 4. Technology Guidelines for People with Deaf–Blind Disorders.

Guidelines
Provide text so that it has a clear structure for wayfinding when they can't see it.
1. Are structural elements clear?
2. Do the structural elements use depth (a contrast in fonts for headings versus dense text)?
3. Are headings clear and concise?
4. Do the headings use a consistent style?
5. Do headings use a consistent placement?
6. Are the fonts familiar and easy to read?
7. Are fonts an appropriate size and style for the publication medium?
8. Can fonts be enlarged without the need for an add–on screen magnification program?
9. Do the on–line materials use sans serif fonts?
10. Does the on–line material support font substitution easily? (For example, can proportional fonts be changed to monospaced fonts easily?)
Provide color that can be selected or changed so that they can find information when they can't see it.
1. Is there sufficient contrast between foreground and background elements so that the reader can easily distinguish the elements using figure–ground discrimination strategies?
2. Is the background color easy to change to high contrast?
3. Can color contrast be managed from the "File" level of a document?
Provide graphics so that they can be customized to meet individual needs.
1. Are the graphics simple, clear, and concise?
2. Are the graphics easily customizable by the reader? For example, can the content be easily understood without the graphics?
3. Can the reader easily adjust the animations (turn off, slow down, etc.)?
Provide programs with open an open framework that allow the user to make adjustments.
1. Can speeds be adjusted?
2. Can readers create portable font resources (PFRs) from the standard system fonts so that font bits are rendered in the clearest possible manner for on-line displays? (see WebText Study (Reece 2002) for information on portable font resources. The materials are currently at this URL: http://www.georgiasouthern.edu/~greece)
3. Are there color options for cursors?
4. Is the cursor shape customizable?
5. Are frequently repeated functions easy to perform without the need for cascading menus? For example, in Microsoft Word, can you add rows to tables without having to use a menu? Is there a keyboard or menu toolbar element that will allow you to add second and successive instances of that item?
6. Are frequently used symbol functions easy to access and use? For example, in Microsoft Word, the Symbol palette is available; however, when performing a search and replace task, items from the Symbol palette must be inserted, during the replace function, which is difficult to accomplish when there is poor hand–eye coordination.
Provide programs that can be stacked or manipulated in a building block fashion.
1. Can all of the active windows be open or closed using one function?
Provide editing features in software.
1. Are editing features available in applications?
2. Can automatic editing features be manually controlled—turned on or off?
3. Can colors for settings on editing features be changed with a broad range of high–contrast colors?
Provide user choice—to enable people to process information in different ways and paces.
1. Can you adjust the volume?
2. Does the interface provide a means for rewinding, pausing, and restarting the presentation?
3. Is the audio clear without the text?
4. Is the audio portable?
5. Is there a Braille version?
6. Does the sound offer alternatives for voice selection (pitch, tone, etc.)
7. Does the audio support translation needs?
8. Is there a symbol system version?
9. Is there a finger–spelling version? (http://www.zyn.com/flcfw/fwtproj/Ralph.htm)
10. Is there a PDF version?
11. Is there a template?
12. Does the material originate from a single–source?
13. Is the material multimodal? (For example, can the material be single–sourced for multimodal delivery while also maintaining consistency in quality?

14. Does the setting permit use of laptops instead of desktop machines? (Note: desktops block visual communication (signing, speech reading, etc.)
15. Does the setting permit use of wireless technologies (networks, hubs, etc.) to promote portability, accessibility, and usability?
16. Are smart boards in use during activities to facilitate visible touch input, eliminate beams from projectors, and permit use of room lighting at full power, which facilitates communication (signed or unsigned)?

Source: Adapted from textual material in Gargiulo (2006); Reece (2005, 2004, 2003, 2002, 2001, 1993–1994); and http://clerccenter.gallaudet.edu/TecEds/index.html

People with Autism Spectrum Disorders

Gargiulo (2006) suggests that people with autism may have characteristics as follows: difficulty concentrating and maintaining attention, self–injurious behaviors, abnormal eating habits, sleeping problems, and mood abnormalities (Gargiulo, 2006). Combinations of high–tech and low–tech technologies are used to improve communication. Gargiulo also notes that little is known about the use of high–tech computers for learning with people who have this disorder. Research on assistive technology for people with autism has been placed on voice output communication aids (VOCAs). Yet, a myriad of low–tech devices targeted at visual communication strategies have been used very successfully. Such communication systems include pictorial systems and sign language. Manual sign language may be paired with the use of pictures in speech and language therapy.

Grandin's hug machine is another device that allows those with autism to self administer lateral body pressure to induce a calming effect during times of high arousal or anxiety and are perceived as being safer than physical contact.

Technology for People with Physical Disabilities and Traumatic Brain Injury

Gargiulo (2006) identifies five types of technologies that are frequently used by people with physical disabilities and traumatic brain injury: productivity tools (computers, wordprocessors, spreadsheets, etc.), information technology (data bases, computer–information systems, the Web, etc.), instructional technology (computer–assisted instruction, multimedia presentations, etc.), medical technology (dialysis machines, ventilators, suction machines, etc.), and assistive technology (adapted keyboards, augmentative communication devices, computers with alternate input devices (switches, voice recognition), scanners, screen readers, etc.)

CONCLUSIONS AND ADDITIONAL WORK

This work suggests that many of the technologies used by people with diverse needs and varying sensory and physical abilities are also helpful to most everyone. Currently, we can identify specific usability guidelines for three of the five disorders. From this work, usability guidelines for people with autism spectrum disorders and people with physical disabilities and traumatic brain injury are least clear and have been presented at a very top level. While some of the guidelines for other disorders may also apply to people in these groups, more work needs to be done in these areas before guidelines can be fully reported. We can learn a lot about how to communicate with people with diverse and varying physical and sensory needs from existing educational and web design standards. To learn more about additional assistive technology resources, strategies, and relevant standards data bases, please contact the author for additional on–line materials. (Please see contact information in the author's biography and Appendix A.)

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APPENDIX A: ADDITIONAL ACCESSIBILITY RESOURCES

To obtain a current list of on–line resources on this topic, please e–mail the author for a website pass key.

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