Chapter 21: Assistive Technology and Individuals with Dyslexia

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Educators know that technology holds tremendous promise to lower the barriers between students and knowledge, but how do we really use it? What do we need to do to make it an integral part of teaching and learning? How do we get students to use it enough to know it is beneficial to them? How much do we require it? How much is too much?

Assistive technology is a broad term that refers to accommodations for both physical disabilities and cognitive differences. The Assistive Technology Act of 1998 (PL 105-394) defines assistive technology as "any item, piece of equipment, or product that is used to increase, maintain, or improve functional capabilities of individuals with disabilities." In fact, all technology can be assistive, depending on how it is used. In this chapter, we address the role of technology in assisting students in comprehending and manipulating written language to achieve academic success. Assistive technology offers a bridge between a student's needs and his or her abilities. It connects a student's abilities with an educational opportunity that would otherwise be blocked by a disability. Assistive technology offers students access to books, information, and critical thinking about a world of concepts that are otherwise inaccessible to them. For educators to effectively integrate assistive technology into a curriculum, student needs must be carefully assessed and matched with available technologies. Matching students with appropriate hardware and software is not enough to ensure success. Students must be taught how to use the software strategically to benefit from the curriculum.

Although the possibilities for assistive technology are commonly known, they have only recently begun to achieve their promise. Today there exists a myriad of choices for assistive technology software of all kinds. For students with language-based learning disabilities, assistive technology software falls into these categories:

- Word processing software
- Voice recognition software
- Text-to-speech software
- Visual mapping software

Essential to successful use of software is the hardware that allows it to run. Anyone wishing to integrate technology into an academic program must pay strict attention to the hardware requirements that the selected software requires. By necessity, restrictions on hardware use and distribution will determine what software can be used. The availability of technical support is as crucial to successful use of assistive technology as having the hardware and software itself. The resources appendix to this chapter provides links to software companies that can provide prices and hardware requirements.

Another essential ingredient to successful implementation of assistive technology is teacher training. Teachers must first learn to use the software programs and then apply their knowledge of it to specific educational tasks. Teachers need a supportive environment in which to practice with the technology and its applications. If teachers work with each other in groups to develop their technology-infused curriculum, they can avoid some of the frustrations of using unfamiliar technology for which no help is available to troubleshoot the glitches.

Sometimes, students with learning differences reject the assistance that certain educational technologies offer them. For students who have been isolated from their peers in resource rooms and stigmatized by accommodations within the classroom, the use of text readers and voice recognition software raises fears that they will once again be labeled as different. Following are helpful steps to help students adjust and embrace technology:

- Give students a clear understanding of their learning strengths and weaknesses.
- Be clear about the rationale for using the technology. If a student fears that using a text reader will prevent him or her from learning to read independently, discuss the need for developing vocabulary and background knowledge to be an independent learner.
- Support students in learning the technology and individualizing its use to become independent and automatic with it.
- Help students to make adjustments to their computers that simplify their use. Examples are *shortcuts* on the desktop, changes in *tracking pad settings* to make laptops easier to manipulate, and the use of an *external mouse or keyboard.*
- Encourage students to pursue remedial strategies to achieve their goal of independence.

The power of digital media has expanded higher education beyond the text- and teacher-centered curriculum of the past. Technology offers the ability to adjust learning environments by making classroom materials more flexible and the ability to expand access to the curriculum to a greater range of students.

WHAT RESEARCH SAYS ABOUT ASSISTIVE TECHNOLOGY

Although assistive technology is a relatively recent addition to the educational toolbox,

there is a small but growing research literature that examines its benefits to students with LD in a variety of academic tasks. Use of assistive technology provides a bridge between students' current skills and the tasks they must perform by supporting them in skills they have not yet acquired, and there also is emerging evidence that some assistive technology tools can contribute to strengthening students' basic skills in decoding, comprehension, and spelling and in reading and writing fluency. Assistive technology, however, is generally not effective for students with LD unless it is combined with instructional and learning strategies that permit students to take advantage of the power of the technology. Assistive technology is often unused by the students who could benefit from it, even though the combination of assistive technology and learning strategies has been shown to work effectively.

Using Assistive Technology

Two major reviews of the research on assistive technology (MacArthur, Ferretti, Okolo, & Cavalier, 2001; Okolo, Cavalier, Ferretti, & MacArthur, 2000) cover research published since 1990 on the use of technology to teach or support literacy among students with learning disabilities (LD) and attention disorders. These confirm the utility of computer-assisted instruction and synthesized speech feedback to improve students' phonemic awareness and decoding skills, as well as the benefits of electronic texts to enhance comprehension by compensating for reading difficulties. In particular, studies by Elkind (1998); Gehrmann and Kinas (2002); Montali and Lewandowski (1996); and Wise, Ring, and Olson (2000) support the benefits of using text-to-speech software to support students' reading rate, fluency, and comprehension. In addition, a study by Hecker, Burns, Elkind, Elkind, and Katz (2002) established the benefits of text-to-speech software for improving reading stamina and concentration in students with attention disorders.

Anderson-Inman's group at the Center for Electronic Studying at the University of Oregon has contributed important research on the use of assistive technology to promote successful studying and learning in content-area courses, particularly for students with LD. The group's work has emphasized the potential of assistive technology, when embedded in a pedagogically sound context of explicit strategy instruction, to "support student strengths and enable new types of academic behavior" (Anderson-Inman & Szymanski, 1999). They have concentrated on using electronic outlining and graphic organizer software to facilitate activities such as time management, analyzing and completing assignments, note taking, studying for tests, and writing research papers.

In the area of written output, several studies by MacArthur (MacArthur, 1999, 2000; MacArthur & Cavalier, 2004) support the efficacy of computer-supported writing tools such as word processing, word prediction, voice recognition, and other tools that aid transcription (e.g., spell checkers) to improve the quality and efficiency of students' writing. Follansbee (2003) conducted research on voice recognition that validates its usefulness in increasing writing ease and fluency while pointing out its significant limitations. In addition, work by Haynes and McMurdo (2001) provided evidence for using graphic organizer software to create templates to help students understand and better incorporate text structures.

Combining Assistive Technology and Learning Strategies

Assistive technology is most effective for students with LD when it is combined with instructional and learning strategies that permit students to take advantage of the

power of the technology. This general principle has been demonstrated in research involving assistive technology for reading and writing. MacArthur (1999, 2000) has made this point strongly in his reviews of assistive technology for writing. For example, word processing alone does not change the revising behavior or overall writing quality of students with LD (MacArthur & Graham, 1987). However, word processing in combination with instruction in a revising strategy was found to improve the amount and quality of revision and the overall quality of students' writing in three studies (Graham & MacArthur, 1988; MacArthur, Graham, & Schwartz, 1991; Stoddard & MacArthur, 1992).

In the area of reading, Wise, Olson, Ring, and Johnson (1998) found that synthesized speech feedback during oral reading practice supported the development of students' reading skills and phonemic awareness. This technology support was more effective, however, when combined with instruction in phonemic awareness. Studies of the effects of text-to-speech software by students with LD have found positive effects on fluency but not on comprehension without integrated instruction in comprehension and study strategies (MacArthur et al., 2001). Preliminary studies by Engstrom (2004) at Landmark College and by researchers at the Center for Applied Special Technology (CAST) (Pisha & O'Neill, 2003) have similarly explored the benefits of combining instruction in research-proven comprehension strategies such as SQ3R and reciprocal teaching with text-to-speech software and electronic texts with built-in scaffolding such as maps, illustrations, dictionaries, and prompts to employ those strategies at appropriate times.

In conclusion, research on assistive technology and learning strategies provides strong evidence of the potential of programs that integrate the two methods. To date, however, such integrated methods have only been studied for individual reading or writing strategies and computer tools. The National Institute at Landmark College is undertaking the study of a comprehensive program that integrates assistive technology and learning strategies to improve the reading and writing skills of high school students with LD, but results will not be available until 2006.

USING TECHNOLOGY TO ASSIST WITH READING

Although research on the causes and effects of students' failure to read well has provided us with greater knowledge and understanding of this phenomenon, vast numbers of children continue to move through school without gaining the literacy knowledge and reading skills they need to allow them to successfully engage in higher level problem solving. Poor reading skills are a result of multiple factors:

- Insufficient instruction in decoding and comprehension strategies
- Slow processing of text, leading to poor fluency
- Lack of exposure to written text, leading to background knowledge deficits
- Poor comprehension

Although the need for effective code-based reading instruction remains great, assistive technology can help students to bridge the gap between their poor reading

skills and their ability to comprehend higher level concepts. Text-to-speech software programs remove the burden of decoding text. The reader can focus all of his or her attention on understanding the text and making connections to background knowledge. Without the burden of decoding, the reader is free to think about and gain control over reading and to use active reading strategies and concept mapping to support comprehension.

A text-to-speech screen reader can convert computer-based text into spoken words. It also allows readers to engage with text-based information aurally and visually and enables slow readers to process text more quickly and efficiently. Screen readers vary widely in terms of features, from the most bare-bones versions with no features other than the ability to read the text, to the most sophisticated, which include features for scanning text, highlighting, note taking, and writing, and range from little or no cost to $1,000 or more. To choose the appropriate screen reader, student needs must be carefully evaluated.

What Can Screen Readers Do?

Text-to-speech screen readers can do the following:

- Read digital text aloud
- Highlight text as it reads
- Allow the reading rate to be adjusted
- Provide options for voice type
- Read text files
- Read text on web pages and in e-mails
- Allow text to be edited and altered
- Alter the text color
- Alter the background color
- Include options for writing
- Conduct spell checking
- Provide word prediction
- Provide reference tools, such as a thesaurus and dictionary
- Provide scanning and optical character recognition software
- Provide tools for highlighting and note taking
- Have the ability to scan graphics

Students who need to read textbooks are likely to need a screen reader that has note-taking and highlighting features to support their study skills. Students who need to hear what they have written to revise and proofread their work need a screen reader that includes a writing feature with spell checking and word prediction. Students who use the Internet for research need a screen reader that is designed to read text blocks and special formatting characteristic of web sites on the Internet. Students who need a screen reader to read articles and textbooks need a screen reader that includes reliable scanning and optical character recognition features to convert their reading passages into a digital format that the screen reader can then convert into electronic speech. Choosing an appropriate screen reader for a student with reading difficulties requires careful consideration of the tasks the student is required to do, the cost of the software, the availability of technical support, and the ease of use.

How Screen Readers Convert Text to Speech

In order for a screen reader to convert text to speech, the text must be in digital form. The simplest form of digitized text is a Rich Text Format (.rtf) file, which all screen readers can read. The problem with .rtf files is that they do not retain the original formatting of the text. Sophisticated screen readers such as Kurzweil 3000 (Kurzweil Educational Systems) or WYNN (Freedom Scientific) can read text that has been scanned and converted into a graphic file, such as a .tiff picture file. The advantage of this type of file is that it retains its original formatting, so a scanned textbook looks the same on the computer screen as it does in its original form.

Scanning text can be a time- and labor-intensive activity. The most efficient way to convert texts into scanned documents is to use a high-speed scanner, which can scan a textbook and save it to a CD-ROM in a short period of time. Some schools and colleges use the high-speed scanner to scan commonly used textbooks and save them in a digital library. In accordance with copyright law, students must still purchase their textbooks, but if students provide proof of ownership, they can also receive a digitized version of their text.

In addition to scanning text, there are a number of on-line sources for digitized text. Some sources provide texts that are available for free; others charge a membership fee. Sources for digitized text are available in the appendix to this chapter.

Commonly Used Screen Readers

Kurzweil 3000 is a software program that includes reading and reference tools; support for study skills, test taking, writing; ability to read text from the Internet; and scanning and editing capabilities to convert textbooks, articles, and .pdf, .tiff, and .html files into image documents that retain their original layout. A variety of voices are available, the reading rate is adjustable, and many options exist to customize the tasks that students perform most often. Text is highlighted as it is spoken aloud. Kurzweil 3000 has the most features of any screen reader, and it is also the most expensive.

WYNN is a software program that includes reading and reference tools, study tools, test-taking features, writing supports, ability to read the Internet, and scanning capabilities that allow documents to retain their original layout. Text can be edited, and the program allows users to modify the speech to get the best fit with an individual's auditory processing style. Text is highlighted as it is spoken aloud.

Read & Write Gold (textHELP) is designed as an integrated text reader that works in conjunction with Microsoft Word. It features a floating toolbar that includes speech feedback and writing support. It is designed specifically for use with Microsoft Windows XP. It highlights text as it is spoken aloud, and it reads text directly from the Internet. It includes some editing and reference tools, but it does not include scanning capabilities or study skills tools.

Screenreader v4 (textHELP) is a text-to-speech software program that works in conjunction with Windows-based applications. Screenreader v4 provides a toolbar that appears on top of whatever application is currently open. The program opens and reads text files through a word processor, and it reads text on the Internet. Screenreader v4 is an example of a basic text-to-speech program that does not have scanning, editing, or study skills capabilities but that is relatively low cost.

CAST eReader (CAST) is a text-to-speech software tool that uses a human voice on MP3 sound files to support .rtf, .html, and DAISY 2.02 files. CAST eReader speaks digitized text, and it can read text on the Internet. It highlights text by word, sentence, or paragraph as it reads. It also has a type-and-talk feature that assists with writing. It does not include any study skills or reference tools, although text can be edited.

USING TECHNOLOGY TO SUPPORT STUDY SKILLS

Study skills are practices that offer a concrete way to represent how the mind processes and retains information. Because short-term memory is not equipped to retain all the information read in a textbook or heard in a lecture, good study skills strategies help students to process new information and transfer it into long-term memory (see Chapter 18 of Birsh, 2005, for more on study skills and students with LD). One study skill, *active reading,* is a series of steps that foster interaction between the reader and the text and provides a process for comprehending and retaining information in written text. The active reading process offers the reader an effective system for processing the meaning of the text in progressively deeper stages. The steps of the active reading process are as follows:

Preread	Read the title, note pictures and diagrams, and read any headings or questions posed.
Read	Read the text carefully. Highlight main ideas and supporting details.
Margin note	Paraphrase the most important ideas in the text, and write them in the margins.
Chunk	Reflect on the text as a whole, and note where topics change within the text.
Summarize	Create a written summary, an outline, or a concept map that reflects the main ideas in the text.

For students with reading difficulties, the barriers to using an active reading strategy are many. Poor decoding skills, a slow reading rate, or inconsistent attention

can interfere with a student's ability to gain knowledge from textbooks or other academic reading. Strategic use of software programs can bridge the gap between reading deficits and successful active reading. Using a text-to-speech program such as Kurzweil 3000, students have the capability not only to read a text fluently but also to annotate it. In Figure 21.1, a student has highlighted headings from a text passage (Seifert & Hoffrung, 1997) in magenta, main ideas in yellow, supporting details in green, and vocabulary in cyan. In addition, the student has written a margin note that paraphrases the information provided in the paragraph. If the student extracts the highlights, he or she has a rudimentary outline from the text that Kurzweil 3000 will read aloud (see Figure 21.2). If the student extracts the margin notes, he or she has paraphrased notes that Kurzweil 3000 will read aloud (see Figure 21.3). With these text marking and annotation features, students can create study guides for test taking and/or a summary of the text's content.

The act of summarizing a text offers students the opportunity to make and explain connections among the concepts expressed in the reading. Traditionally, summaries are created in essay form. With the assistance of visual mapping software, summaries can reflect the concepts of a reading in a visual format. Figure 21.4 is a concept map and study guide that shows Erik Erikson's theory of adult development.

Another key study skill is the ability to take notes on a text or a lecture. The two-column note strategy provides students with a system for capturing important concepts from a text or from a lecture and processing those concepts in a format that becomes an effective study tool. Like other effective study skills strategies, the two-column note strategy mirrors the memory process in the brain by separating note taking into discrete stages of perceiving, recording, reviewing, and summarizing.

A two-column note template (see Figure 21.5) is easily created in Microsoft Word, which makes this highly effective system more accessible for students who have graphomotor difficulties and language-based difficulties. The portability of laptop computers allows students to bring them to lectures or use them in a library. The note-taking template can be used in combination with voice recognition software, making note taking available to students with severe dysgraphia.

At the Center for Electronic Studying in Eugene, Oregon, Lynne Anderson-Inman and her colleagues have developed and studied a number of strategies using the software program Inspiration (Inspiration Software). These strategies include note taking, brainstorming, and synthesizing information. Information on these strategies is available at http://cbss.uoregon.edu.

USING TECHNOLOGY TO ASSIST THE WRITING PROCESS

Rationale for Using a Writing Process

There are myriad assistive technology tools that can assist students with the challenges of writing, but to be effective, instruction in the use of technology must be embedded in an understanding of the writing process, as well as the forms and conventions of written text. For students with LD, most successful writing instruction begins with the writing process—a methodical approach to composition that employs a series of strategic activities that break the act of writing into discrete steps. The strategies that lead to successful writing outcomes include brainstorming and generating ideas, organizing ideas, drafting, revising, and proofreading. Teaching the

writing process involves acquainting students with a variety of strategies for each stage of the process.

Writing is an extraordinarily complex act, heavily influenced by cognitive and affective factors. Teaching writing explicitly as a process encourages students to see writing as a task that involves a series of mental activities. It also helps students to gain awareness of their strengths and weaknesses throughout the various stages of written composition. Students can evaluate their own composing habits, choosing those strategies that work best for them.

What Are the Barriers to Writing?

Barriers to successful writing fall into three categories:

1. *Language-based difficulties,* which include problems with spelling, handwriting, sentence structure, paragraphing, and punctuation.

2. *Attention-based difficulties,* which include random errors in spelling, punctuation, and syntax; difficulty sustaining a consistent effort throughout the writing task; and anxiety that results in writer's block.

3. *Executive function difficulties,* which include poor planning, disorganization of time and materials, difficulty narrowing a topic, and procrastination.

How Can Technology Improve Writing Outcomes?

Most modern writers use word processing software to complete their writing tasks, without even thinking of it as assistive technology. Word processors offer flexibility, spelling and grammatical help, and time efficiency. Inexpensive portable word processors can provide immediate access to these tools in classrooms or other environments where desktop or more expensive laptop computers are not available. Visual mapping software offers enhanced opportunities for brainstorming and organizing. Word prediction, synthesized speech feedback, and voice recognition provide alternatives to handwriting or keyboarding while drafting text. Strategic use of software programs can bridge the gap between the varied needs of writers and their abilities. Technology offers the chance for students whose potential was overlooked in the past to become successful writers.

Tools and Strategies for Teaching Writing

It is useful to look at the each stage of the writing process in terms of barriers to success and assistive technology tools that address those barriers. This section treats each stage of the writing process in turn, using the following format:

- A summary chart of barriers to success and assistive technology tools

- A more detailed discussion of assistive technology tools appropriate for that stage

Keep in mind that many assistive technology tools assist students at multiple stages of the writing process, as indicated on the summary charts, even if they are discussed in detail under one particular stage.

Brainstorming and Generating Ideas

Table 21.1. Brainstorming and generating ideas

Barriers to success	Assistive technology tools
Poor spelling Poor spelling causes the writer to be so focused on spelling individual words that writing fluency is lost and the writer's ideas are blocked.	***Word processing software*** Word processing software provides spelling support through spell checker.
Difficulty expressing concepts in writing Difficulty with written expression results in frustration and writer's block when the writer fails to produce the words to express his ideas.	***Word prediction software*** Word prediction software predicts words that the writer is most likely trying to spell. Software can be trained to predict words based on the writer's style of writing.
Difficulty with working memory Difficulty with working memory prevents the writer from managing more than one aspect of the writing task at a time. The writing task takes a long time to complete.	***Voice recognition software*** Voice recognition software allows the writer to use oral language to express ideas, which are recorded and saved in a word processing file. Spelling concerns are reduced. Fluency is greatly improved when concepts can be expressed and recorded orally. ***Visual mapping software*** Visual mapping software allows the writer to generate ideas in a visual map, which can be converted to an outline and exported to a word processing file. Less writing is required at the brainstorming stage. Visual mapping software takes some of the burden off of working memory so that the writer is able to focus on the primary task of generating ideas. Visual images provide stimulation and reinforcement, which may reduce boredom and increase motivation.

Software Focus: Visual Mapping Software Brainstorming is the process of associative thinking that leads to the generation of ideas. Many students who have difficulty expressing thoughts in writing find that visual mapping of concepts frees them from the limitations of their working memory, as well as the limitations of syntax, and capitalizes on strengths in visual-spatial thinking. Visual mapping is often used as a strategy for prewriting, but it is also an effective strategy for activating prior knowledge before a lesson, a reading, or a research project.

Visual mapping software allows for visual representation of ideas and reduces

the need for writing because concepts can be expressed in brief phrases while the visual array does the cognitively and linguistically taxing work of representing relationships among concepts. Coupled with technology, visual mapping offers an intuitive and effective way to generate ideas and represent them visually.

Visual mapping software is readily available, easy to use, and relatively inexpensive. The most commonly used versions in school settings are Inspiration and Kidspiration, a version for younger students. These programs, both created by the company Inspiration Software, allow writers to brainstorm ideas in a visual format, supported by an enormous choice of colors, symbols, and easy-to-insert graphics. One feature of Inspiration and Kidspiration that makes them especially useful in the writing process is that graphic displays can be automatically converted to outlines with the click of one button. This helps students move from the brainstorming and organizing stages of the writing process into the drafting stage because it puts the ideas students have generated into a linear sequence that can be used to guide writing, sentence by sentence. Although Inspiration and Kidspiration are the best-known products in this category, most graphics programs can be used for creating visual maps.

Organizing Ideas

Table 21.2. Organizing ideas

Barriers to success	Assistive technology tools
Difficulty identifying relationships between concepts Difficulty identifying relationships between concepts results in writing that lacks a logical connection between the ideas expressed. Thesis is unclear because ideas are not prioritized in terms of importance to the topic.	***Visual mapping software*** Visual mapping software allows written concepts generated in the brainstorming stage to be moved and reordered within an outline or a map. Visual templates for rhetorical patterns can be created to assist in structuring essays. Visual maps make the relationships between concepts clear and explicit.
Difficulty with time order and sequencing Topics and subtopics are not distinguished. Paragraph structure is weak.	***Word processing software*** Templates provide structure for beginning writers who prefer not to work with visual maps to help them organize ideas. Outlines are easily generated and topics can be moved and sorted within the outline.
Poor planning strategies The writer may avoid the organizing stage of writing altogether.	***Integrated writing software*** Integrated writing software prompts writers to follow stages of writing process. Integrated writing software provides graphic cues to planning steps.

Software Focus: Programs that Extend Visual Mapping with Templates

Inspiration and Kidspiration are excellent tools for the organizing stage of the writing process because of the ease of adding, deleting, and organizing topics and enhancing them with graphics. However, much of the academic writing assigned to students needs to follow a specific organizational pattern, sometimes called a rhetorical pattern. For instance, students may be required to write a persuasive essay, a compare/contrast paper, or a process analysis, each of which has a distinctive

organization and flow of ideas. Therefore, software that scaffolds students' writing by reminding them of these patterns and of the relationships between the pattern and the content can be invaluable in developing students' ability to produce higher level writing.

Inspiration and Kidspiration both come with numerous templates. A template is a blank pattern that can be filled in by the student. It defines the structure of essential elements for writing. For instance, a template for a generic paragraph would indicate blank boxes for a title, a topic sentence, several supporting sentences, details for each supporting sentence, and a concluding sentence (see Figure 21.6).

Some of the writing templates available in Inspiration include comparative analysis, persuasive essay, definition, and autobiographical event. The templates include notes to the student that prompt the student with ideas about how to complete each box or section of the template. For example, in the autobiographical event template shown in Figure 21.7, students are directed to explain the significance of the event.

Haynes and McMurdo (2001) developed a manual and accompanying CD-ROM, titled *Structured Writing: Using Inspiration Software to Teach Paragraph Development*, which capitalize on the power of Inspiration-based templates to create a sequence of lessons that move students from mastering the elements of basic paragraphs through increasingly complex rhetorical patterns such as reasons, examples, process, classification, and compare/contrast, by using predictable visual and color patterns to identify key elements of paragraph structure (see Figure 21.8).

Another promising software that builds on visual mapping strategies is Draft:Builder (Don Johnston). It models the sequential and recursive nature of the writing process and uses split screens, prompts, cues, and visual maps to help students move seamlessly through the stages. Draft:Builder offers three different screen views, which mirror the steps of creating a draft: Outline/Map View for generating and organizing ideas (see Figure 21.9), Notes View for adding details and elaborating ideas, and a Draft View (see Figure 21.10) for converting the map or outline into connected text.

One of the strengths of this program is that the Outline/Map and Notes views are integrated and remain on the screen during the drafting stage and can even be dragged and dropped verbatim into the draft, eliminating the need for rewriting information that has already been created. Students have the option of hearing text as they enter it, or at any point during drafting, to check their progress and accuracy. Draft:Builder includes a number of templates, such as compare/contrast, 3- and 5-paragraph essays, and specific types of common reports (animals, food groups, states), and a spell checker.

Drafting

Table 21.3. Drafting

Barriers to success	Assistive technology tools
Reading difficulties Reading difficulties interfere with a writer's ability to read and reflect on his or her writing.	***Text-to-speech software*** Text-to-speech software reads the essay, allowing the writer to hear it and reflect on its content.

Poor sentence structure Writing may be so garbled that the writer may not remember what he or she was trying to express.	***Word prediction software (often included in writing software programs)*** Word prediction software predicts the words that the writer is trying to spell. This kind of software is good for poor spellers who can spell enough sounds in words to allow the prediction of likely words. Word prediction software aids word retrieval and vocabulary expansion.
Poor spelling Poor spelling interferes with language production.	***Voice recognition software*** Voice recognition software improves sentence structure for writers whose oral language is clearer than their written language. Voice recognition software reduces spelling problems. This kind of software improves writing fluency. The use of this software results in more language production.
Graphomotor difficulty Graphomotor difficulty interferes with writing and typing.	***Word processing software*** Keyboarding assists with handwriting difficulties. Spell checkers and grammar checkers assist with some spelling and sentence structure problems.
Poor word retrieval or limited vocabulary Problems with word retrieval and vocabulary limit diction and ability to express concepts.	
Poor working memory Poor working memory makes it difficult for the writer to manage the multiple tasks necessary to produce writing.	

For many students with LD, drafting represents the Waterloo stage of the writing process. Students may be adept at generating ideas and organizing them using visual mapping tools, but the difficulties begin when students have to convert images or discrete concepts into coherent, grammatically correct sentences that are logically sequenced, with clear transitions, correctly spelled vocabulary choices, and accurate punctuation and paragraphing conventions. For many students the mechanics of transcription—whether by pencil and paper or by keyboarding—are an insurmountable hurdles. For students with the multiple challenges of LD, word prediction and voice recognition software may represent the means to the previously unattainable end of effective composition.

Software Focus: Word Prediction Word prediction software uses spelling knowledge, grammar rules, and context clues to predict what word a student is thinking of as he or she enters the first few letters. Students who struggle with keyboarding, spelling, and word retrieval may increase writing fluency using a word prediction program. Most of these programs can be used in standard word processing applications; one simply opens a word processing document and then opens the word prediction program while using the word processing program. Most word prediction programs can also speak aloud the word choices that are offered so that students are

not hampered by poor decoding in selecting among visually similar words. Some word prediction software programs, such as Don Johnston's Co:Writer 4000 (see Figure 21.11), also offer grammar support in the form of checking for subject–verb agreement, capitalization, punctuation, word usage, and correct word forms. Dictionaries can be customized according to the level of the writer from beginner to advanced and also by topics, such as sports, school subjects, or holidays, so that the word choices generated are appropriate to the writer and the subject. Users can create their own specialized dictionaries. Good word prediction programs adjust to the writer's style and diction so that the word choices grow increasingly accurate with use.

As helpful as word prediction may be for some students, others are frustrated by the number of decisions they must make to complete words as they are entered. For a student who has reasonable keyboarding skills and is only a moderately poor speller, word prediction may seem like an interruption and more of a hindrance than a help. Many word prediction programs allow the writer to turn off the program altogether or to use it only on demand for particular words. If the software is going to be used by a variety of students, this flexibility is a very important feature to look for.

Word prediction is a feature of some integrated writing software packages. Read & Write Gold, like Co:Writer4000, combines word prediction with text-to-speech software that reads back what has been written so that students can check their work aurally. These programs also have spell checkers specialized for students with LD, which recognize a wider range of phonetically misspelled words than typical spell checkers.

Software Focus: Voice Recognition It sounds like a dyslexic's dream: Talk to the computer and have it transcribe speech into a beautifully formatted, accurate essay that reads as brilliantly as one can speak. Dream on; it's not that simple! Although voice recognition (or voice synthesis) has been a life-changing tool for some students (one college student claimed that he "never would have wound up in jail if he'd had access to voice recognition software in high school"), other students have stopped using it in frustration. The technology can perform remarkably well, but only under some conditions with some profiles of writers. Students who use voice recognition software do not automatically improve the quality of their writing, but they can usually produce more writing with less effort and can focus more on ideas and organization than on the mechanics of handwriting, keyboarding, or spelling.

It is important to recognize the limitations of voice recognition and also the time and effort required to train the software to accurately recognize an individual's voice and diction. According to Follansbee (2003), an expert on voice recognition, students who may be good candidates for successful use of voice recognition

- Have strong oral composing skills and a level of ease and fluency dictating their thoughts
- Have relatively clear articulation and speak in a manner that is not heavily inflected (students with speech impediments or very strong regional accents may have trouble training the software)
- Be able to analyze and then modify their speech patterns and articulation for higher accuracy
- Show patience and persistence in training and correcting the

software

- Recognize the purposes of literacy

Follansbee concluded that most successful users are at least 10 years old.

We would add that students who are good candidates for using voice recognition software

- Understand that voice recognition accomplishes only one stage of the writing process—drafting—and realize that producing acceptable writing still requires planning, organizing, revising and proofreading

Because students are likely to give up in the early stages of using voice recognition without adequate training, guidance, and encouragement, teachers and parents need to be committed to providing a supportive environment, graduated practice, and a sophisticated level of technical expertise as students strive to achieve accuracy. Voice recognition never misspells words, but it may misrecognize them, sometimes producing gibberish that must be diligently corrected and trained out. The latest versions of voice recognition that are generally available include Dragon NaturallySpeaking (Scansoft), which works in Windows only, and IBM ViaVoice, which comes in versions for Windows and Macintosh. (ViaVoice products are available through ScanSoft, http://www.scansoft.com/viavoice.) There is a newer Macintosh-only software product, iListen (MacSpeech). These recent versions use *continuous speech recognition,* which allows speakers to talk fluently at a regular conversational pace. Older versions used *discrete speech recognition,* which required a pause between each word. Although many users objected to the unnatural pace of discrete speech recognition, there is evidence, discussed previously in the research review section of this chapter, that this version of voice recognition promotes improved spelling and word recognition, as students watch the words they speak get transcribed, word by word, on the monitor.

Revising

Table 21.4. Revising

Barriers to success	Assistive technology tools
Difficulty with decoding text Students have difficulty reading handwritten comments by teachers. Once revisions are made, students cannot effectively read and evaluate their revisions.	***Text-to-speech software*** Text-to-speech software allows students to listen to drafts to improve their logic and fluency.
Trouble with attention to visual detail Students have trouble tracking which corrections have been made and which corrections remain to be made.	***Word processing software: the Reviewing toolbar on Microsoft Word*** Use of the Reviewing toolbar eliminates problems with reading teacher handwriting. Comments can be read with text-to-speech software. Graphic nature of working from teacher or peer comments in the revision process (highlights and comments can be

	deleted after changes are made) simplifies the task of tracking corrections.
Poor working memory Students have trouble tracking and utilizing teacher comments while revising drafts.	***Word processing software: the Reviewing toolbar on Microsoft Word*** Students do not have to rely on memory of teacher comments to revise their drafts.
Executive function problems If corrected drafts are lost, students have no record of teacher comments.	***Word processing software: the Reviewing toolbar on Microsoft Word*** Teacher comments are recorded electronically and are available if student draft is lost.

Software Focus: Word Processing Word processing is so commonplace that people scarcely recognize it as a form of assistive technology. However, in the act of writing before the computer era, before cut and paste computer functions were available, revision literally entailed rewriting large blocks of text, either by hand or typewriter. Correcting even small errors in spelling or punctuation was laborious. Today, the capacity of word processors to easily add, delete, and move limitless amounts of text, as well as insert tables, graphics, and symbols, has brought revision within the reach of most students. Spell checkers and grammar checkers, of varying degrees of usefulness, are built into most word processing programs, and a variety of talking word processors, such as Read & Write Gold and Don Johnston's Write:Outloud, give immediate speech feedback as students type so they can hear as well as see what they have written. Macintosh computers and recent versions of PCs have built-in speech feedback.

One feature of Microsoft Word that is especially useful in the revision process is the Reviewing toolbar, which lets multiple readers add comments and suggestions to a draft, assigning a different color font to each reader. Teachers can encourage students to rethink the organization of a paper, elaborate on certain points, or change wording or sentence clarity, simply by inserting comments or highlighting portions of a student's writing. It is easy to establish an electronic dialogue between the student and teacher, and as students systematically review their text from start to end, responding to teachers' comments, they have the added incentive of deleting those comments while creating a finished paper.

Software Focus: Portable Keyboards Laptops are expensive and fragile; not every classroom has a computer available for every student at all times; and students often need to take notes or write in class, while riding on a bus, or while sprawled in bed. The solution to these challenges can be found in a specialized group of hardware called portable keyboards. These are relatively inexpensive (several hundred dollars, compared with $1,200–$1,500 for a laptop), durable, lightweight tools that do simple word processing and not much more. Thus, they do not offer the array of distractions and options found on fully functioning computers: no games, Internet connections, no multiple pathways for performing functions such as saving and opening. In the past, portable keyboards were not able to support word prediction and voice recognition, but even that is changing. Don Johnston now offers Co:Writer SmartApplet, which adds word prediction and a choice of topic dictionaries to the AlphaSmart 3000 (AlphaSmart). Other versions of portable keyboards include the Laser PC6 from Perfect Solutions.

Proofreading

Table 21.5. Proofreading

Barriers to success	Assistive technology tools
Reading difficulties	***Text-to-speech software*** Listening to writing makes the writer aware of awkward phrasing and poor sentence structure.
Poor spelling and attentional difficulties	***Word processing software*** Spell checkers and grammar checkers bring misspelled words and some awkward phrases to the writer's attention.

Software Focus: Text-to-Speech Software Listening to an essay is an effective strategy for editing and proofreading it. Because text-to-speech software programs can read documents aloud, students can easily use them to check for missing words, sentence structure errors, garbled syntax, and other writing problems that may be hard to spot without auditory input. Text-to-speech software is discussed at length in the Using Technology to Support Study Skills section of this chapter.

CONCLUSION

Assistive technology offers tremendous access to multisensory learning experiences, but it does not belong at the center of every lesson in every class. In the end, you will have to decide how much you want to integrate technology into your teaching, based on the individual profiles of your students and their specific academic tasks. This chapter has offered an overview of assistive technology tools and some suggestions on how to incorporate them into well-established pedagogical contexts. Be sure to evaluate the successes in your classroom, not just the frustrations. If you take an inventory of the positive changes since you started using technology, you may be surprised at the length of the list. You may find that students communicate with you more than ever through e-mail, are more aware of which software strategies work best for them, are more engaged in classroom work, and are completing work more consistently because they can submit work electronically.

The technology is evolving at a dizzying rate, so applications that work inconsistently or crankily today may perform brilliantly before the end of the next academic year. It is critical to keep abreast of new developments and upgrades. The resources for this chapter that are listed in Appendix B of Birsh (2005) will point you to updated on-line resources that keep pace with technology as it changes.

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