Supported eText: Assistive technology through text transformations

LYNNE ANDERSON-INMAN
MARK A. HORNEY
University of Oregon, Eugene, USA

To gain meaningful access to the curriculum, students with reading difficulties must overcome substantial barriers imposed by the printed materials they are asked to read. Technology can assist students to overcome these challenges by enabling a shift from printed text to electronic text. By electronic text we mean textual material read using a computer or some other electronic device such as a Palm, iPod, or even a LeapPad. Shifting to a computer for presenting text offers immediate advantages to readers, primarily because a computer can be used to modify the way text is viewed and read: font face, size, and color can be changed; text can be read out loud; concepts can be defined and explained; multiple illustrations can appear simultaneously; links can lead to supportive information; and documents can be accessed from different computers in different geographic locations. In short, electronic texts are malleable.

In spite of its inherent possibilities, electronic text by itself is rather limited in its usefulness to readers and learners. In order to really take advantage of its potential as an assistive technology, an electronic reading environment that intelligently transforms text into something that supports comprehension and extends meaningful learning is required. This is accomplished in a variety of ways, including embedded supports (e.g., definitions of unfamiliar terms), multiple modalities (e.g., text that can be read out loud), and links to useful resources (e.g., background information, concept map, notepad)—all of which can transform electronic text so that it is more accessible and supportive to diverse learners. We refer to text that has been altered to increase access and provide support to learners as *supported electronic text* or *supported eText*.

Supported eText

The concept of supported text was first developed by Anderson-Inman and Horney (1997, 1998) to describe electronic text that is modified or enhanced in ways that are designed to increase reading comprehension and promote content area learning. The underlying assumption of supported text is that electronic text (e.g., a word, phrase, paragraph, page, or document) can be infused with additional text or media in ways that promote better understanding of what the author intended to communicate. In addition, the concept assumes that electronic text can be structurally presented or organized in ways that accommodate individual learning needs/styles or that can facilitate the accomplishment of targeted instructional objectives. Together, it is assumed that these enhancements can help readers overcome the perceptual, conceptual, and comprehension hurdles found in the text materials they are asked to read. Although implementations of supported eText are potentially appropriate for any learner at any reading level, most applications to date have focused on the needs of students with reading disabilities that make it hard for them to access or comprehend printed text in traditional formats. The concept of supported eText aligned with discussion of assistive technologies is the focus of the present department in *RRQ*.

From multiple research and development projects focused on investigating the nature and impact of supportive electronic text, Anderson-Inman and Horney developed a typology that described the specific types of resources that can be used to transform electronic text. In previous publications they described eight types of supportive resources that can be used to make the process of reading a specific text easier or more educational (Anderson-Inman & Horney, 1998; Horney & Anderson-Inman, 1999). Unlike typologies suggested by instructional design or educational psychology (e.g., Alessi & Trollip, 2001; Mayer, 2001), the resources in this list do not focus on what media is being used to modify or enhance the electronic text, but rather what function the supportive resource plays in the reading process.

The latest iteration of the typology can be seen in Figure 1, which guides the work of the National Center for Supported eText (NCSeT), a five-year national research center at the University of Oregon funded by the U.S. Department of Education, Office of Special Education Programs.

The advantage of having such a typology is that teachers, students, and parents can use it to think critically about the modifications, enhancements, and additions they encounter when selecting or reading electronic versions of assigned texts. Likewise, eText authors and software developers can use the typology to think carefully about how to construct electronic reading materials that are in fact supportive of learners' needs and lead to increased comprehension. It is a relatively easy task to add a variety of superficial, unprincipled enhancements to an electronic version of a text originally published in printed form. It is a much harder task to add features and resources that actually enhance the reading process and promote improved comprehension. The NCSeT Typology of Supported eText Resources is an attempt to provide a conceptual framework that can guide both the selection and the development of electronic texts used as assistive technology for students with reading difficulties. Unfortunately, there

FIGURE 1
NCSET TYPOLOGY OF RESOURCES FOR SUPPORTED ETEXT

Resource	Description	Examples
Presentational	Enables the text and accompanying graphics to be presented in varying ways, hence customizable to meet the needs of individual readers	Font size and style, text and background color, line and page length, page layout and juxtaposition with other pages, graphics in relationship to text
Navigational	Provides tools that allow the reader to move within a document or between documents	Within-document links, across-document links, embedded menus, links from other resources such as Table of Contents, Glossary, Bibliography
Translational	Provides a one-to-one equivalent or simplified version that is more accessible or familiar to the reader. May focus on a word, phrase, paragraph, picture, or whole document. May be of same or different modality or media	Synonyms, definitions, digitized or synthesized text-to-speech, alternate language equivalents (Spanish), video of American Sign Language translation, simplified version at lower reading level, text descriptions for images, captions for video
Explanatory	Provides information that seeks to clarify the what, where, how, or why of some concept, object, process, or event.	Clarifications, interpretations, or descriptions that point to causes, operations, components, mechanisms, parts, methods, procedures, context or consequences; list of influencing factors
Illustrative	Provides a visual representation or example of something in the text. Designed to support, supplement, or extend comprehension of the text through illustrations or examples.	Drawings, photos, simulations, video, photos, reenactments, sounds, music, information that something is representative of its type ("...is a typical example of...")
Summarizing	Provides a summarized or condensed way of viewing some feature of the document.	Table of contents, concept map, list of key ideas, chronology, timeline, cast of characters, abstract
Enrichment	Provides supplementary information that is not strictly needed to comprehend the text, but adds to the readers' appreciation or understanding of its importance or historical context	Background information, publication history, biography of the author, footnotes, bibliography, influence on other writers
Instructional	Provides prompts, questions, strategies or instruction designed to teach some aspect of the text or how to read and interpret the text	Tutorials, self-monitoring comprehension questions, annotations, instructional prompts, study guides, embedded study strategies, online mentoring, tips for effective reading
Notational	Provides tools for marking or taking notes on the text to enable later retrieval for purposes of studying or completing assignments.	Electronic highlighting, bookmarking, margin notes, outlining, drawing. Ways to gather and group these notes for postreading review.
Collaborative	Provides tools for working or sharing with other readers, the author, or some other audience.	Threaded discussion, online chat, e-mail links, podcasts, blogs
Evaluational	Provides materials, prompts, and assignments designed to assess student learning from the text	Questions, quizzes, tests, surveys, online interviews, assignments leading to products

is still much to be learned about how best to modify and enhance electronic text so that it is maximally supportive to the largest audience of potential readers—a goal aligned with the concept of universal design for learning (Rose, Hasselbring, Stahl & Zabala, 2005; Rose & Meyer, 2002)

Research on supported eText

Research on the potential impact of supported eText first surfaced in the 1980s when pioneers such as Abelson (Abelson & Petersen, 1983), Reinking (Reinking & Schreiner 1985), Olson (Olson, Foltz, & Wise, 1986), and Reitsma (1988) explored various enhancements to electronic text as a way of improving reading fluency and reading comprehension for beginning or struggling readers. However, at that time relatively few people owned computers, only professional writers used word processing, the daily use of e-mail was just beginning to emerge, and the World Wide Web did not exist. In spite of this early start, and the efforts of a smattering of dedicated research teams across the United States, no coherent research base has evolved to guide the development, selection, adoption, or integration of supported eText documents into the curriculum. And there is still no coherent research agenda to evaluate the effects of supported eText on students' reading comprehension and content area learning.

Most of the research into the impact of supportive resources in eText documents, and the various embodiments of each type, is also still in its infancy. We know relatively little about how to construct and present electronic text in ways that have a consistently positive effect on student learning, especially when considering the diverse learning styles and needs of students with disabilities. Further, only a few types of eText supports have received attention by more than one researcher or research team. One of these is the use of graphics as an illustrative resource. In 1994, Reinking and Chanlin reviewed a small collection of studies where graphics were embedded in electronic texts for the purpose of illustrating complex information such as scientific processes, all of which compared student learning from a text-only presentation of the information to a presentation where graphics (either static, or animated, or both) had been added as adjuncts to the text. Results favored the use of graphics as a complement to electronic text.

These and other more recent studies have led researchers and instructional design experts to conclude that both static and dynamic graphics, when combined with electronic text, promote more active engagement than electronic text alone, which in turn leads to increased understanding (Clark & Mayer, 2003). On the other hand, in order for graphics to be effective adjuncts to the text, care must be taken that they are supportive of the content in that they are used to explain or illustrate key concepts, principles, or processes (Clark & Mayer; Robinson, 2002). It is also important to recognize that having no graphics is better than having the wrong graphics (Anderson-Inman & Horney, 1998), and that there is always the potential that too many graphics will interfere with learning due to cognitive overload (Mayer, 2006.)

The use of text-to-speech as a translational resource has also been studied with some vigor and consistency. This assistive technology, originally for readers who were blind or vision-impaired, enabled students who could not see the printed text to have it read out loud, using either digitized or synthesized speech. Early advocates of text-to-speech, however, quickly recognized its potential for other students with reading difficulties (Abelson & Peterson, 1983; Anderson-Inman et al., 1990; Balajthy, 2005) and research has supported its use for students with various forms of print disabilities (e.g., Abelson & Petersen, 1983; Elkind, 1998; Hecker, Burns, Elkind, Elkind, & Katz, 2002; Olson & Wise, 1992).

It is particularly relevant to note that this form of supported text seems most effective for students who need it the most. In other words, reading rate and comprehension is improved most for students whose performance without text-to-speech software is the poorest (Elkind, Black, & Murray, 1996). However, even this well-researched eText support has not produced consistent results on all measures. For example, Elbro, Rasmussen, and Spelling (1996) found a positive impact of text-to-speech on students' abilities to read words silently and read text out loud, but not on reading words out loud. Elkind, Cohen, and Murray (1993) found a significant positive impact of text-to-speech on the reading comprehension of middle school students with dyslexia, but no impact of text-to-speech on measures of vocabulary or the transfer of improved reading skills to printed materials.

With respect to the other types of supportive resources, there has been no long-term attention to parsing out the effects of each resource type on reading fluency, vocabulary development, reading comprehension, or learning academic content through text. This conclusion holds true for the general student population and for students with disabilities, students who speak English as a second language,

and students from diverse socioeconomic, ethnic, and racial backgrounds. Variations in research methodology, definitional differences in subject populations, multiple interventions, lack of experimental rigor, and the absence of a conceptual model all contribute to an inability to draw firm conclusions across existing studies.

Assistive technology specialists and reading disability experts, however, have embraced the notion of providing electronic text, often supported with multiple types of resources, to students who are struggling to read at grade level (Anderson-Inman, 2004; Balajthy, 2005; Castellani, 2001; Cavanaugh, 2002, 2006; Edyburn, 2003; Higgins, Boone, & Lovitt, 2002; Raskind, 1994.) In addition, software developers have produced an array of electronic reading systems and assistive devices designed to support reading from print materials (either scanned or downloaded as electronic text) and from the Web (see Edyburn, this issue). Most of these assistive devices (e.g., screen readers) and electronic reading environments provide some subset of supportive resources from the typology described above, and software developers are increasingly recognizing the need for research on the impact of these features on student learning. This shared interest has led to some noteworthy collaborations in which developers of eText reading environments support the work of academic researchers interested in evaluating the impact of specific supportive features (Disseldorp & Chambers, 2002; Hecker et al., 2002; Lange, McPhillips, Mulhern, & Wylie, in press; Lewin, 2000). Nonetheless, as is often true with educational technology, accepted practice has leaped far ahead of the knowledge base.

To summarize, the existing body of research on supported eText is fragmented and inconclusive on many, if not most, dimensions. There is a dire need for rigorous experimental research on all types of supportive resources in eText documents, with special attention to determining the individual and combined impact of these resources on the reading comprehension of students who are struggling in school due to poor reading skills. In addition, there is a need for systematic replications of all research studies, with the goal of finding those types of resources that are robust enough to have a consistently positive impact when implemented in multiple types of electronic reading environments and multiple school contexts. To accomplish this, the field needs common approaches to research design, measurement, and interpretation so that results can be shared and conclusions about the effects of specific supportive resources are based on multiple studies conducted by multiple researchers in multiple contexts. Finally, there is a need for widespread adoption of a conceptual model that can both drive this research agenda and provide a framework for future research.

Research directions for the future

In this section we outline four research topics related to supported eText as an assistive technology for students with disabilities. For each, we provide a brief overview of the central issues and a list of sample research questions that could help advance our abilities to design and integrate supported eText into the curriculum for the benefit of struggling readers.

Research to determine effective forms and delivery modes for each resource type and subtype

At the most basic level, it is essential to understand what impact each type of supportive resource has on students' reading comprehension. Thus, a productive line of research is to investigate the efficacy of specific eText supports within a specific electronic reading environment on a specific population of students. Although this approach sounds relatively straightforward, research on resource efficacy is complicated by the fact that any given resource type can be presented in many different ways, even within the same medium. For example, providing embedded textual definitions of unfamiliar words is a translational resource that is often implemented in an electronic reading environment. If researching the extent to which access to definitions has a positive impact on text comprehension, it is first important to identity the differential impact of accessing different types of definitions—standard dictionary definitions (often with multiple options to choose from) or glossary definitions (a single option that is context specific.) The first is an easy resource to provide, given the presence of an electronic or online dictionary. The latter is more labor intensive to produce but may be easier for students to use.

In addition to establishing the form a definition should take, it is important to identify which delivery methods are most effective, based on their impact on text comprehension, but also ease and frequency of use. Definitions, for example, can be delivered in a variety of ways. These include (but are not limited to) (a) pop-up definitions that appear as the mouse floats over a word, (b) sidebar definitions for words under the cursor, (c) defini-

tions in a new window that appears when students click on a word, or (d) a link that takes students to a new "page" containing multiple definitions, which might be in either glossary or dictionary format. The ultimate goals for this strand of research are to identify resource types that have a strong positive effect on students' ability to understand the text, forms for these resources that are easy for developers to produce, and delivery modes that are easy for readers to use.

Here are some research questions related to the efficacy of specific eText supports, their forms, and delivery methods:

1. Do students provided with a specific eText support read a specific unit of text with more fluency and more comprehension than students without access to that support?
2. Do different forms of a specific eText support have a differential effect on students' comprehension of text? If so, what form is the most effective for improving text comprehension?
3. Do different methods of presenting or delivering a specific eText support have a differential effect on students' comprehension of text? If so, what delivery method is the most effective for improving text comprehension?
4. Do different methods of presenting or delivering a specific eText support have a differential effect on frequency of accessing that resource? If so, what delivery method is the most effective for increasing access?
5. Are there forms and delivery methods for specific eText supports that are robust enough to have a positive effect on students' text comprehension across multiple electronic reading environments?

Research to identify and evaluate powerful combinations of eText resources

Some eText supports have a significant impact on reading fluency, vocabulary development, or text comprehension when used individually with a specific population of students. There is no argument, for example, that text-to-speech (a translational resource), by itself, has a powerful and positive impact on text comprehension for students who are blind or vision impaired. Far more common, however, are electronic reading environments where there is a potential for readers to access and use multiple types of supportive resources. Boone and Higgins (1993), for example, studied the effects of electronic versions of K–3 basal readers where students had access to (a) vocabulary support through embedded explanations and pictures (translational and illustrative resources), (b) reference support through the use of anaphora (explanatory resource), and (c) comprehension support through the addition of questions with feedback that focused attention on key parts of the text (instructional resource).

At the secondary level, MacArthur and Haynes (1995) compared electronic versions of a 10th-grade biology chapter in which one version provided students with an online notebook (notational resource) and the other version provided students with text-to-speech and links to glossary-type definitions (both translational resources), as well as highlighting of main ideas (instructional resource) and summarized versions of the main ideas (explanatory resource). (See also Anderson-Inman, 2004; Anderson-Inman & Horney, 1998; Anderson-Inman, Horney, Chen, & Lewin, 1994; Horney & Anderson-Inman, 1994, 1995, 1999.)

Results of these and other studies suggest that eText supports can be combined to provide students with powerful electronic reading environments that assist the process of learning from text in multiple and varying ways. The data, however, do not always support the notion that more is better. Leong (1995) for example, found no differences on text comprehension when providing text-to-speech, text-to-speech plus explanations, text-to-speech plus explanations and reading prompts, or text-to-speech combined with simplified versions. And most studies of supported eText examine the impact of an entire suite of supports, rather than assess the individual contributions of specific resources (e.g., see Lange et al., in press).

Here are some research questions related to the identification and evaluation of combinations of eText supports:

1. Which eText supports can be effectively combined into a system of supports to improve text comprehension beyond what is possible with individual eText supports?
2. Which specific eText supports and/or delivery methods complement or conflict with each other?
3. Which combinations of eText supports work most effectively for which populations of learners?
4. Does the increase in complexity of having multiple eText supports affect students' abilities to navigate or learn within the system?
5. Is it possible to design a system of eText supports that can be customized to meet the individual learning needs and styles of all students?

Research to identify appropriate levels of student control and access to individual eText supports or combination of supports

Most electronic reading environments, whether constructed for the purposes of research, or developed as assistive technology for the commercial mar-

ket (e.g., *WYNN* by Freedom Scientific, *Read, Write, Gold* by Texthelp, *SOLO* by Don Johnston, Kurzweil 3000 by Kurzweil), provide readers with a fair degree of control over when and how to use specific eText supports. The assumption is that students will learn to use the eText supports that are most helpful to them and use them in a way that is productive given an assigned task or purpose for reading. This assumption may or may not be warranted, and much depends on students recognizing the value of a given eText support. Research suggests that for some students with disabilities the value is not immediately transparent. For example, Horney, Anderson-Inman, and Chen (1995) found that some students with hearing impairments have a limited understanding of what it means to comprehend expository text. When confronted with eText supports designed to improve text comprehension, there was no motivation to access them because there was no understanding that doing so would lead to improved comprehension. At the other end of the continuum, some students become entranced with the novelty of available eText supports, especially those involving sounds and animations (Horney & Anderson-Inman, 1994) choosing them often and indiscriminately.

Removing control from students, however, suggests that software developers or teachers have the information they need to (a) design a reading environment that is effective for any specific student or population of students and (b) control student access to its various supportive features. This approach has at least three limitations. First, it risks limiting student access to resources they might find helpful. For example, Anderson-Inman and Horney (1998) found that deaf and hearing-impaired students repeatedly accessed digitized pronunciations of key vocabulary words, even though it had been recommended by specialists in hearing impairment that including such pronunciations was unnecessary for this population. Second, it risks limiting student engagement with the text. Personal choice when interacting with supportive resources can be highly motivating in itself, resulting in increased engagement with the text and the potential for increased comprehension. Even in the absence of improved comprehension, increased engagement is seen as a desirable outcome because it increases self-confidence and leads to improved attitudes toward reading (Strangman & Dalton, 2005.) And, most important, eliminating student control removes the possibility that students will develop an approach to reading in electronic environments that is personally effective and transferable to new contexts

Here are some research questions related to appropriate levels of student control and access to eText supports:

1. To what degree should students (or teachers) be able to control presentational and navigational resources?
2. What are the relative merits of allowing or forbidding students access to specific eText supports?
3. Is there a logical instructional sequence whereby students gain increasingly more control over the resources in a supported eText document as they develop the skills to use them appropriately?
4. Can instructional resources be used to guide appropriate student use of other eText supports?
5. What are the potential advantages of developing personal profiles for individual students to guide their access to and control over specific eText supports?
6. How can students best be trained to use eText support wisely and efficiently?

Research to investigate interactions between texts, resources, tasks, and students

Any type of eText support can be implemented in multiple ways, using different types of media. For example, translational resources for students with learning disabilities may take the form of simplified text or synonyms. For students who are deaf, translations in the form of video with an American Sign Language interpreter might work best. Thus, an important line of research is uncovering which types of resources, implemented in which ways, are most useful for which types of tasks, under what conditions,[LA1] and for which types of students. Not all eText supports are in fact supportive for all learners in all situations. And enhancing electronic text with multimedia can have a negative impact if not done correctly (Clark & Mayer, 2003).

The role a specific resource plays within the reading process can also vary depending upon how it is used, and the types of resources are not mutually exclusive. Thus, any specific feature in an electronic reading environment may serve more than one function for the reader. For example, an electronic concept map might provide an overview of the text's main ideas (a summarizing resource), but it might also be designed so that each node is linked to that part of the electronic document in which the ideas are elaborated (a navigational resource.) To determine the role of any given supportive resource, it is important to examine how the resource was intended to be used, how the reader in fact used the resource, and

the impact that using that resource had on the comprehension of a specific text in a specific situation.

Here are some research questions related to the interactions of text, resources, tasks,[LA2] and students:

1. To what degree should resources such as definitions, explanations, and illustrations be designed specifically for a given text, task, or student population?
2. In what types of texts and for which students should notational and collaborative resources be embedded in the text as opposed to accessed through general-purpose software?
3. Are there differences in the ways students interact with supported eText and, if so, what mediates these differences?
4. For what types of texts and tasks do the supportive resources become more interesting (or more educational) than the text?
5. To what extent do instructional outcomes accomplished within a supported eText transfer to nonsupported texts, and for which combinations of reader, text, and task?

Conclusion

Although transforming electronic text in ways that might promote text comprehension by struggling readers has generated interest in the research community for more than two decades, we are far from unraveling the complexities of how to do this well. Further, as new technologies emerge, the possibilities for new forms of text transformations and new delivery methods increase. Clearly, there is need for a national research agenda focused on the ways in which transforming text through supportive resources canfoster improved comprehension and learning by students with disabilities, as well readers of all ages struggling to learn from printed materials. Virtually all text materials used in schools today and in the future will soon be available in electronic form. . Federal legislation, for example, mandates that all required and supplementary texts adopted by schools be available to students with print disabilities in an electronic form that meets the National Instructional Materials Accessibility Standard (NIMAS, 2003). This gives the need for research on supported eText a sense of urgency , as accurate information is needed to guide the development of appropriate materials, instructional interventions, and educational policy related to this form of assistive technology. Ultimately, our vision is of a world in which supported eText is a ubiquitous and effective option for all students, not an accommodation for a select few. We hope our thoughts here about new directions in research related to supported eText as assistive technology will make a contribution toward that end.

LYNNE ANDERSON-INMAN is Director of the Center for Advanced Technology in Education (CATE), the Center for Electronic Studying (CES), the Oregon Writing Project at the UO, and the National Center for Supported eText (NCSeT), all in the College of Education at the University of Oregon. Anderson-Inman is a nationally and internationally recognized expert on the use of technology to improve reading, writing, and studying, with special emphasis on strategies to enhance the academic success of struggling learners. Anderson-Inman pioneered the concept of "computer-supported studying," conducting research and developing materials to increase students' academic achievement by using the computer as a study tool. She has directed numerous federally funded projects, and is a widely published author on effective uses of technology and a frequent speaker at national and international conferences. She can be contacted at Center for Advanced Technology in Education, College of Education, University of Oregon, Eugene, OR 97403-5265, USA, or by e-mail at lynneai@uoregon.edu.

MARK A. HORNEY is a senior research associate at the Center for Advanced Technology in Education (CATE) at the University of Oregon. At CATE, Horney is involved in a wide variety of research, development and outreach projects related to the uses of technology in educational settings. His areas of interest include hypertext-based reading and study environments, computer-based study strategies, and technology-supported historical inquiry. He can be contacted at Center for Advanced Technology in Education, College of Education, University of Oregon, Eugene, OR 97403-5265, USA, or by e-mail at mhorney@uoregon.edu.

REFERENCES

ABELSON, A.G., & PETERSEN, M. (1983). Efficacy of "talking books" for a group of reading disabled boys. *Perceptual and Motor Skills*, *57*, 567–570.

ALESSI, S.M., & TROLLIP, S.R. (2001). *Multimedia for learning: Methods and development* (3rd ed.). Needham Heights, MA: Allyn & Bacon.

ANDERSON-INMAN, L. (2004). Reading on the Web: Making the most of digital text. *Wisconsin State Reading Association Journal*, *44*(2), 8–14.

ANDERSON-INMAN, L., ADLER, W., CRON, M., HILLINGER, M., OLSON, R., & PROHASKA, B. (1990). Speech: The third dimension. *The Computing Teacher*, *17*(7), 35–40, 53.

ANDERSON-INMAN, L., & HORNEY, M. (1997). Electronic books for secondary students. *Journal of Adolescent & Adult Literacy*, *40*, 486–491.

ANDERSON-INMAN, L., & HORNEY, M. (1998). Transforming text for at-risk readers. In. D. Reinking, L.D. Labbo, M.C. McKenna, & R.D. Kieffer (Eds.), *Handbook of literacy and technology: Transformations in a post-typographic world* (pp. 15–43). Mahwah, NJ: Erlbaum.

ANDERSON-INMAN, L., HORNEY, M.A., CHEN, D., & LEWIN, L. (1994, April). Hypertext literacy: Observations from the ElectroText project. *Language Arts*, *71*, 37–45.

BALAJTHY, E. (2005, January). Text-to-speech software for helping struggling readers. *Reading Online*. Retrieved March 21, 2005, from http://www.readingonline.org/articles/art_index.asp?HREF=/articles/balajthy2/index.html

BOONE, R., & HIGGINS, K. (1993). Hypermedia basal readers: Three years of school-based research. *Journal of Special Education Technology*, *12*(2), 86–106.

CASTELLANI, J., & JEFFS, T. (2001). Emerging reading and writing strategies using technology. *Teaching Exceptional Children*, *33*(5), 60–67. Retrieved March 21, 2005, from http://journals.sped.org/ec/archive_articles/VOL.33NO.5MAYJUNE2001_TEC_castellani.pdf

CAVANAUGH, T. (2002). E-books and accommodations: Is this the future of print accommodation? *Teaching Exceptional Children*, *35*, 56–61.

CAVANAUGH, T. (2006). *The digital book: Using e-books in K–12 education*. Eugene, OR: International Society for Technology in Education.

CLARK, R.C., & MAYER, R. (Eds.). (2003). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning*. San Francisco: Pfeiffer.

DISSELDORP, B., & CHAMBERS, D. (2002, July). *Independent access: Which students might benefit from a talking computer*. Paper presented at the ASET Conference, Melbourne, VIC, Australia. Retrieved August 23, 2006, from http://www.aset/org.au/confs/2002/disseldorp/html

EDYBURN, D. (2003). Learning from text. *Special Education Technology Practice*, *5*(2), 16–27.

ELBRO, C., RASMUSSEN, I., & SPELLING, B. (1996). Teaching reading to disabled readers with language disorders: A controlled evaluation of synthetic speech feedback. *Scandinavian Journal of Psychology*, *37*, 140–155.

ELKIND, J. (1997). *Computer reading machines for poor readers* (Rep. No. 9801). Los Altos, CA: Lexia Institute. Retrieved March 28, 2005, from http://images.apple.com/education/k12/curriculumsolutions/assistive/pdf/0198_Efficacy_Study.pdf

ELKIND, J., BLACK, M., & MURRAY, C. (1996). Computer-based compensation of adult reading disabilities. *Annals of Dyslexia*, *46*, 159–186.

ELKIND, J., COHEN, K., & MURRAY, C. (1993). Using computer-based readers to improve reading comprehension of students with dyslexia. *Annals of Dyslexia*, *43*, 238–259.

HECKER, L., BURNS, L., ELKIND, J., ELKIND, K., & KATZ, K. (2002). Benefits of assistive reading software for students with attention deficit disorders. *Annals of Dyslexia*, *52*, 243–272.

HIGGINS, K., BOONE, R., & LOVITT, T.C. (2002). Adapting challenging textbooks to improve content area learning. In M.R. Shinn, H. Walker, & G. Stone (Eds.), *Interventions for achievement and behavior problems II* (pp. 755–790). Bethesda, MD: National Association for School Psychologists.

HORNEY, M.A., & ANDERSON-INMAN, L. (1994). The ElectroText project: Hypertext reading patterns of middle school students. *Journal of Educational Multimedia and Hypermedia*, *3* (1), 71–91.

HORNEY, M.A., & ANDERSON-INMAN, L. (1999). Supported text in electronic reading environments. *Reading and Writing Quarterly*, *15*(2), 127–168.

HORNEY, M.A., ANDERSON-INMAN, L., & CHEN, D-T. (1995, February). Project LITERACY: Hypermedia for hearing-impaired readers. In A. Deffenbaugh, G. Sugai, & G. Tindal (Eds.), *The Oregon Conference monograph 1995* (Vol. 7, pp. 195–208). Eugene, OR: University of Oregon. (ERIC Document Reproduction Service No. ED385018)

LANGE, A.A., MCPHILLIPS, M. MULHERN, G., & WYLIE, J. (in press). Assistive technology tools for secondary-level students with literacy difficulties. *Journal of Special Education Technology*.

LEONG, C.K. (1995). Effects of on-line reading and simultaneous DECtalk auding in helping below-average and poor readers comprehend and summarize text. *Learning Disability Quarterly*, *18*, 101–116.

LEWIN, C. (2000). Exploring the effects of talking book software in UK primary classrooms. *Journal of Research in Reading*, *23*, 149–57.

MACARTHUR, C., & HAYNES, J.B. (1995). Student assistant for learning from text (SALT): A hypermedia reading aid. *Journal of Learning Disabilities*, *28*(3), 50–59.

MAYER, R. (2001). *Multimedia learning*. New York: Cambridge University Press.

MAYER, R. (2006). *Creating extraneous cognitive overload in PowerPoint lessons*. Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

NATIONAL INSTRUCTIONAL MATERIALS ACCESSIBILITY STANDARD (2003). National Instructional Materials Accessibility Standard Report Executive Summary: National Instructional Materials Accessibility Standard Report—Version 1.0. Retrieved September 15, 2006, from http://nimas.cast.org/about/report

OLSON, R., FOLTZ, G., & WISE, B. (1986). Reading instruction and remediation with the aid of computer speech. *Behavior Research Methods: Instruments and Computers*, *18*, 93–99.

OLSON, R.K., & WISE, B.W. (1992). Reading on the computer with orthographic and speech feedback. *Reading and Writing: An Interdisciplinary Journal*, *4*, 107–144.

RASKIND, M.H. (1994). Assistive technology for adults with learning disabilities: A rationale for use. In P.J. Gerber & H.B. Reiff (Eds.), *Learning disabilities in adulthood: Persisting problems and evolving issues* (pp. 152–162). Stoneham, MA: Andover Medical.

REINKING, D., & CHANLIN, I.J. (1994). Graphic aids in electronic texts. *Reading Research and Instruction*, *33*, 207–232.

REINKING, D., & SCHREINER, R. (1985). The effects of computer-mediated text on measures of reading comprehension and reading behavior. *Reading Research Quarterly*, *20*, 536–552.

REITSMA, P. (1988). Reading practice for beginners: Effects of guided reading, reading while listening, and independent reading with computer-based speech feedback. *Reading Research Quarterly*, *23*, 219–235.

ROBINSON, D.H. (2002). Spatial texts adjuncts and learning: An introduction to a special issue. *Educational Psychology Review*, *14*, 1–3.

ROSE, D., & MEYER, A. (2002). *Teaching every student in the digital age: Universal design for learning*. Alexandria, VA: Association for Supervision and Curriculum Development.

ROSE, D.H., HASSELBRING, T.S., STAHL, S., & ZABALA, J. (2005). Assistive technology and universal design for learning: Two sides of the same coin. In D. Edyburn, K. Higgins, & R. Boone (Eds.) *Handbook of special education technology research and practice* (pp. 508–517). Whitefish Bay, WI: Knowledge by Design.

STRANGMAN, N., & DALTON, B. (2005). Using technology to support struggling readers: A review of the research. In D. Edyburn, K. Higgins, & R. Boone (Eds.), *Handbook of special education technology research and practice* (pp. 549–569). Whitefish Bay, WI: Knowledge by Design.