Learning From Text Across Conceptual Domains

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CHAPTER EIGHT

Learning From Text in a Post-Typographic World

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In 1981, Shel Silverstein published a book of poems entitled *Light in the Attic.* Among its many engaging, though slightly rebellious, poems is one entitled "Twistable Turnable Man." In the poem, Silverstein described the perfect man for our "bendable, foldable . . . easily moldable" society.

> He's the Twistable Turnable Squeezable Pullable
> Stretchable Foldable Man.
> He can crawl in your pocket or fit in your locket
> Or screw himself into a twenty-volt socket,
> Or stretch himself up to a steeple or taller,
> Or squeeze himself into a thimble or smaller,
> Yes he can, course he can,
> He's the Twistable Turnable Squeezable Pullable
> Stretchable Shrinkable Man. (p. 138)

About the same time this poem was published, a revolution was occurring in the computer industry that would eventually have a profound effect on how students learn from text. With the joint inventions of the electronic circuit board and the microprocessing chip, computers were suddenly small and affordable enough to be purchased by public schools as well as individual families. What was once a machine used only by the government, large corporations, and computer science departments, became an accepted and even necessary fixture in K–12 schools and a household appliance purchased today by an estimated 40% of all American families.

With this transformation in the size and availability of computing power has come a tool of unprecedented adaptability and utility—electronic text. Like the twistable, turnable man, electronic text is exceptionally flexible. Because it is composed of electronic dots on a computer screen instead of ink on paper, electronic text can easily be altered in both appearance and function. Although impermanent in form, it can be copied and shared around the world in a matter of minutes. Because it is not constrained by the limitations of the printed page, it can be sent long distances over telephone wires and even translated quickly into multiple languages. Electronic text supports society's need for a medium of written communication that is both malleable and controlled by the user, and in schools around the country, electronic text is having an impact on both how and what students learn from text.

In this chapter we describe a variety of ways in which electronic text is substantially different from traditional, typographic text (i.e., text that has been typeset and printed on paper), and we illustrate how these differences are irreversibly altering the way students learn from and with text. In addition, we present two examples of learning from electronic text, each capitalizing on different features of this new medium. Finally, we briefly outline some questions about the role of electronic text that are likely to become important in the future.

PRINTED AND ELECTRONIC TEXT

Conventional printed texts have a physical presence, and thus a permanence, that is both familiar and comfortable. It resides on paper or some other printable substance much as the author wished it to appear, being altered only when annotated by the reader or defaced by conditions leading to its deterioration or destruction. Printed texts do not invite change. Even readers' annotations have to be squeezed into margins that are not typically designed for such activity. Printed texts are static, passive, and noninteractive. They await an active agent, the reader, to peruse lines of alphabetic code to make sense of words and phrases. Whether the reader is successful in doing so or not is of no concern to texts or to books. Indeed, printed texts have no way of "knowing" what a reader carries away from the experience of reading. Moreover, without the use of machines designed to transform the text's appearance (e.g., copiers with enlarging capabilities), it cannot be altered to increase its accessibility or readability.

Electronic texts, by comparison, have no physical form and no permanence. Thus, they can be altered in a myriad of useful ways, both before and during the processes of reading and writing. Seven features of electronic texts are now discussed. Each feature highlights the malleability of electronic

texts in the service of learning. Although these features are not mutually exclusive, labeling each feature helps to focus attention on its potential contribution to reading and learning from text.

Modifiable

Electronic text can be quickly and easily modified to reflect an author's revisions or to incorporate a reader's annotations. Because electronic text can be easily extended, altered, or deleted, it allows writers to make corrections, update information, and insert alternative perspectives into existing documents. The same capabilities enable a reader to interact with electronic text, inserting comments to the writer or making notes for studying later. In addition, there is nothing to prevent the reader from assuming the role of author, perhaps substantially changing the original text. As suggested by Landow (1992) the flashing cursor in a word processing document is the visual manifestation of the readers' presence and therefore their capacity to alter the text being read. Clearly, the distinction between reader and writer is much less obvious in dealing with electronic text, which may have potentially positive and negative ramifications.

The capability to modify electronic texts can be especially useful when students are assigned a project that requires writing and revising. Consider, for example, the benefits of electronic text when students are asked to write a comparison essay on the literary versus historical personage of a character in one of Shakespeare's plays. Each student might first create an electronic outline listing the main ideas and supporting details to be covered in each paragraph and then turn this in to the teacher for feedback. (See Anderson-Inman, 1995, for a more detailed description of computer-based outlining as a prewriting tool.) Because the outline is produced in electronic text, the student can easily modify it to reflect the changes and improvements suggested by the teacher.

Once the outline is modified, the student uses a word processing program to create a first draft of the essay based on the outline. Both paper and disk copies of the draft essays are then exchanged with other students in the class, who make up a peer editing system designed to give fellow students more input as they revise their essays. Each peer editor might be charged with reading one or more essays and inserting comments and suggestions into the electronic versions of the text. After receipt of the peer editors' suggestions, the original student authors consider the feedback they have received and incorporate the new input as appropriate. Because the students are working in electronic text, these changes, whether small corrections or major restructuring, can be accomplished without tedious retyping. Before turning in the final product, the whole document can be checked for spelling errors with an electronic spell checker (Anderson-Inman & Knox-Quinn, 1996) and formatted to meet a teacher's expectations by using the word

processor's automatic styling features. The end product is an essay that has benefited from multiple levels of input and frequent revisions, all made possible, or at least easier, because students have writing tools at their disposal that capitalize on how easily electronic text is modified.

Over the previous decade, there has been considerable interest in examining how students write with electronic text and the effects that word processing or related electronic writing tools have on the quantity and quality of student writing. Results vary considerably, reflecting such parameters as the type of writing tool used, students' keyboarding skills, intensity of instruction, and prior student experience working in electronic writing environments. Nonetheless, the better-designed studies are quite revealing. Owston, Murphy, and Wideman (1991, 1992) conducted a series of studies in which they actually observed and electronically recorded students during the process of writing with electronic text. In one study, a screen-recording device was used to record unobtrusively the text entries and revisions made by 8th grade students (all of whom had considerable experience writing in electronic environments) while writing expository papers (Owston et al., 1992). These data revealed that students vary considerably in their approach to composing with electronic text, and that they revise at all stages of the writing process. By comparing the quality of students' papers written on computer with those the same students wrote on paper, the researchers also found that papers written with electronic text scored significantly higher on all four dimensions of a holistic/analytic writing assessment scale. The authors concluded that the differences in quality were due mostly to the facilitation of the writing and revising environment provided by the word processor, and that electronic text may well encourage students to adopt different writing strategies.

Enhancible

Electronic text can also be enhanced to include various forms of multimedia for the purposes of illustration, clarification, and reader support. Although paper-based textual materials have long used pictures and other forms of graphics to illustrate key concepts, places, or people, their inclusion in printed form is expensive and their use therefore is highly selective. In addition, because the printed page must rely solely on media that can be presented visually and in static form, there are serious limitations to how traditional text can be enhanced. Neither of these conditions exist for electronic text. It is no more expensive to embed multiple pictures in an electronic document than it is to embed one picture. Furthermore, the types of media that can be embedded in electronic texts may easily include sound, digitized or synthesized speech, animations, and full-motion video.

Anderson-Inman and Horney used the term "supported text" to refer to electronic documents in which the text has been enhanced with various types of multimedia for the purposes of expanding or improving student

comprehension (Anderson-Inman & Horney, 1998; Anderson-Inman, Horney, Chen, & Lewin, 1994). The rationale for selecting this term emphasizes the goal of reading and learning from text. In supported texts, the role of accompanying multimedia is seen as secondary to this goal. In other words, the very existence of the multimedia enhancements of texts is to promote increased comprehension and enriched understanding of a text to which the enhancements are attached. Although this theoretical perspective does not undergird the design and production of all, or even most, multimedia documents, it is useful as a construct for highlighting one major advantage of electronic text: its amenability to reader support. Furthermore, much of the research on electronic text enhancements assumes this perspective.

For example, in reviewing the research on informational graphics within electronic documents, Reinking and Chanlin (1994) found a small number of studies designed to address the effects of embedded graphic aids on reading and learning from electronic text. In each of these studies, the graphics were assumed to be an adjunct to the text. For example, a series of studies by Rieber and colleagues (Rieber, 1989, 1990; Rieber, Boyce, & Assad, 1990; Rieber & Hannafin, 1988) compared student learning from interactions with a text-only presentation of information on Newtonian mechanics to learning from interactions with text accompanied by either static or animated graphics. In a related series of studies, Hegarty, Carpenter, and Just (1991) found that animations attached to electronic text were especially beneficial for students with low mechanical ability, presumably by helping them to compensate for an inability to develop an adequate visual representation from text alone.

In today's world of CD-ROM books and information on the World Wide Web (WWW), electronic text is increasingly enhanced with an impressive array of audio as well as visual media. In addition to static and animated graphics, sound and speech are frequently used to enrich and to support students' reading. An electronic book on the history of music incorporates musical excerpts from composers' works. A text on contemporary poets includes the poets reading selected poems, and a WWW page on Mexican culture includes pronunciations for Spanish terms.

Although there is little research on the efficacy of these enhancements, to the reader they feel intuitively beneficial as supports to the joint processes of text comprehension and appreciation. One exception to this dearth of research is in the study of computer speech technologies to promote fluent reading and text comprehension. For more than a decade, researchers have documented the beneficial effects of enhancing electronic text by providing poor readers with computer-generated pronunciations of unknown or difficult words or even complete passages (Elkind, Cohen, & Murray, 1993; Farmer, Klein, & Bryson, 1992; Olson, Foltz, & Wise, 1986; Reitsma, 1988).

Reading to learn in an electronic environment can be a highly interactive experience because readers are usually free to select from the various sorts of

multimedia enhancements designed to enrich or improve their comprehension. While reading in electronic environments, students might alternatively elect to view an animated simulation of some complex process, hear the pronunciation of an unfamiliar word, listen to a melody as played on different instruments, and study a sculpture photographed from multiple perspectives. The text enhancements that make these types of interactions possible usually reside out of the reader's sight or hearing until selected, although they might be represented in the text by some icon or notational convention such as bold or underlined text. Whether these text enhancements are accessed is determined by a reader, thus necessitating a certain level of motivation to comprehend the text, or at least a sense of exploration. Readers who fail to exhibit these qualities are not likely to benefit from reading in electronic text environments, no matter how many quality enhancements are embedded in the text for their use (Horney & Anderson-Inman, 1995).

Programmable

The capabilities that allow texts to be modified or enhanced at the direction of the reader also allow the presentation of texts that limit readers' choices for the sake of enhancing their learning. In other words, electronic texts can be programmed to monitor the various contingencies associated with an individual reader's experience in reading a particular text, and to modify automatically the presentation of the text in specified ways for the sake of increasing attention to important information, stimulating deeper processing of textual material, shaping strategic reading and learning, and so forth.

A theoretical base for understanding and exploring this capability can be derived from the simple fact that electronic texts are displayed on a single computer screen instead of a sequence of pages that are freely accessible to the reader. The reader of an electronic text depends on the computer program, actually the person who wrote the program, to view more than relatively limited portions of text at one time. In this sense the computer screen that displays electronic texts is like a window through which one views the textual world (Wilkinson, 1983), or, as Daniel and Reinking (1987) pointed out, creating an electronic text involves taking into account three dimensions. In addition to the two-dimensional space that requires decisions about where to place textual material on the page or screen, a writer, designer, programmer, or developer of electronic texts must contend with a third dimension: time. That is, those creating electronic texts must decide when and under what conditions textual material will be available to a reader.

Some of the practical implications of this capability can be realized by considering a common limitation faced by many teachers who expect students to acquire content by reading independently. For example, students in a science class might be assigned to read a difficult chapter on cell division,

following a study guide advising that at a certain point their comprehension will be enhanced by carefully examining several accompanying illustrations of cells at various stages of division. Unfortunately, secondary teachers who make this kind of assignment are often resigned to the reality that many students will consider their reading task easier because it includes illustrations that can be ignored. An electronic text presenting the same text and illustrations, however, could be programmed to restrict students from accessing subsequent text until they had demonstrated some attention to the relevant portions of the illustrations. Another difference, of course, is that the electronic illustrations could also be enhanced in a variety of ways not possible on paper, such as animating the stages of cell division.

L'Allier (1980) was one of the first researchers to appreciate and explore the programmable capabilities of electronic texts. He developed a computer program that modified the structure and readability of texts on the basis of a complex algorithm that took into account, among other factors, readers' accuracy and response time to questions inserted into the text. He found that high school readers identified as having reading problems and who read texts under these adaptive conditions comprehended as much as average and above average readers studying conventional printed texts that were not adapted. In the work of Reinking and colleagues (Reinking, 1988; Reinking & Rickman, 1990; Reinking & Schreiner, 1985), middle-grade readers required to access various types of assistance while reading electronic texts comprehended (a) more than students who had no assistance and (b) more than students who had access to assistance but were free to make their own decisions about what assistance they needed and when to access it. For example, Reinking and Rickman (1990) investigated the effects of mandatory versus self-selected access to vocabulary definitions. They found that students required to access definitions of difficult vocabulary words while reading passages from science textbooks comprehended more and performed better on a test of vocabulary from the passages.

Likewise, Boone and Higgins (1992) conducted multiple studies on the use of hypermedia study guides to support and extend the text comprehension of secondary students reading electronic versions of material from their social studies textbooks (Higgins & Boone, 1990; Higgins, Boone, & Lovitt, 1996; Horton, Boone, & Lovitt, 1990). In addition to other features, the study guides are programmed to control student movement through the text as a function of their responses to multiple-choice questions embedded in the document. When students answer the questions correctly, they are given positive feedback and allowed to go to the next page. When students answer the questions incorrectly, their attention is drawn to the exact spot in the text needed to answer the question correctly, and the multiple-choice question is presented again. Although the research suggests that the hypermedia study guides have a positive effect on student learning, the design of the

studies makes it difficult to separate the effects of this feature from others embedded in the study guides.

The mandatory review of partially or inadequately learned information from texts has been the focus of research that illustrates how the programmability of electronic texts may be used to alter reading and study strategies. For example, Tobias (1987, 1988) found that mandatory review of relevant portions of a text after a reader has answered an inserted question incorrectly, amplified a negative effect found in previous research investigating inserted questions in printed texts. That is, readers frequently do better on posttest items directly related to the inserted questions, but they do worse on items not directly related to the inserted questions when compared with readers who read versions of the text without inserted questions (or in this case, without mandatory review). Tobias hypothesized that during mandatory review, readers were using a "search-and-destroy" strategy that prompted them to focus exclusively on information related to the inserted question in order to avoid further mandatory review.

To test this hypothesis, and to determine if the capabilities of the computer might be used to alter readers' strategies under conditions of mandatory review, Reinking, Pickle, and Tao (1996) studied the effects of asking different types of follow-up questions after mandatory review in electronic texts. By adding a condition in which mandatory review was followed by a new question related to the reviewed material (instead of the same question previously missed), they were able to study the effect that question type had on what students did during mandatory review. They found some evidence that readers receiving a new question following mandatory review of the text more evenly distributed their review time across the paragraphs they were required to review. Readers receiving the same question tended to spend a disproportionate time reviewing the paragraph that provided the information necessary to answer the missed question. This study provides an example of how the programmable nature of electronic texts has important implications for enhancing learning from texts and for shaping readers' strategies during independent reading.

Linkable

Electronic text provides new opportunities for linking chunks of information, both within and among related materials. Expository information in printed materials is presented in specific forms and genres such as an article in a magazine or journal, an entry in an encyclopedia, a chapter in a book, or an investigative report in a newspaper. Such textual units of information are written to stand alone as distinct entities, although they may exist as parts of larger, more integrated textual units such as encyclopedias, books, and journals. Some writers (Spivey & King, 1989) have used the term "intertextu-

ality" to emphasize how readers and writers build bridges across the boundaries that separate such distinct textual sources. Indeed, a major part of the educational endeavor at the secondary level is to cultivate increasing competence in the ability to analyze and synthesize information from separate sources into a new entity. Scholarship, whether it is a term paper written by a student or a published treatise by a seasoned academic, is exercised essentially by creating links between diverse sources of information to create a new unit for others to consider and possibly use in making their own links.

As we become more familiar with electronic texts, we grow consciously aware of the constraints that print technology imposes on this process of linking information across separate texts, and of how entirely new ways of structuring textual information might bring certain advantages to the tasks of reading and learning. Again, this realization has both theoretical and practical dimensions.

On the practical side, it is becoming increasingly obvious that the boundaries dividing printed texts into clearly identifiable units are beginning to dissolve, at least in the environments most natural to electronic texts. That is, the links between informational texts in digital form can be so fluid and effortless that there is little to reinforce their identity as separate textual units of information. The use of the WWW is clearly the best current example. At its simplest level, the WWW can be envisioned as chunks of formatted electronic text (often enhanced with graphics and sound) residing on computers around the world, all of which are connected to the Internet via phone lines and fiber-optic cables. Each "page" of a website is accessible to readers through a unique system of links, allowing for near seamless movement both within a document on the same computer or across documents on multiple computers. Each webpage may have hundreds of links to related information that can be accessed by clicking on "hot" portions of the text, typically indicated by text in color. Following these links may lead to relevant or irrelevant information about museums, professional organizations, hobbyists, news organizations, other students, scholars, and businesses around the world.

Although the WWW is only beginning to have an effect on how teachers and students seek information in schools, its use suggests enormous possibilities for transforming reading and writing in academic contexts. Until just a few years ago, for example, students doing a conventional report would go to the library and use the card catalog and various indexes to generate a list of individual sources related to their topic. They would then seek out their sources at various locations in the library, often experiencing the frustration of discovering that several key books or articles were missing or unavailable. Key information would then be written on note cards and assembled into an outline, followed by multiple drafts of a paper, and a listing of reference sources.

This conventional process can be contrasted with an analogous but qualitatively different process in seeking out information on the WWW. Instead of starting with the card catalog, students may enter key words into one or several search engines on the WWW to locate a much wider array of sources than they can reasonably use. A click of the mouse sends a student's computer zooming across cyberspace in search of any selected source. The source may or may not turn out to be useful, but determining this requires accessing the website, probably residing on a computer located at a great geographic distance. Serendipitous explorations are likely, given the diversity of sources displayed and the ease with which they can be accessed. Instead of being frustrated by finding too little information, students using the WWW for research will most likely be inundated with too much information. As students seek to determine which sources are valid and relevant, they have to screen and filter what they find, culling the best from the vast web of linked electronic text. When relevant information is found, it may be in any form: prose, illustrations, animations, speech, movie clips, and so forth. These can be cut and pasted into a student's own report or multimedia presentation. Clearly, not only are the products of students' research using the WWW likely to be different from conventional text, but so are the abilities and strategies needed to locate information, synthesize across sources, and attribute ownership.

The ease with which electronic texts can be linked has raised theoretical speculation about how textual information in digital and printed documents might be structured differently and how alternative structures may affect reading, writing, and learning (Bolter, 1991; Duchastel, 1986; Landow, 1992; Lanham, 1989, 1993; Reinking, 1994, 1995; Tuman, 1992a, 1992b). Printed texts, because they exist as distinct entities, are naturally linear and hierarchical, or, put another way, what separates textual documents is that each has a clearly defined beginning, middle, and end. Although readers may read a book in other than a linear manner (e.g., reading the chapters out of order or by stopping to read parts of another book before continuing), doing so runs counter to the way that printed documents are written and preserved. Structuring textual information in nonlinear, nonhierarchical formats using the capabilities of digital media has been collectively referred to as *hypertext* or, when the prose is accompanied by other forms of media, as *hypermedia.* Hypertexts and hypermedia are created, not only to permit readers to explore flexibly the links between nodes of textual information, but to encourage them to do so. A map showing the textual nodes of a typical hypertext and the links connecting them is shown in Fig. 8.1.

The impact that reading and writing in hypertext will eventually have on literacy activities remains to be seen. Some serious writers are exploring hypertextual fiction as a new genre of narrative for middle- and high school students (Larson, 1993), and futurists have predicted that teacher-assigned

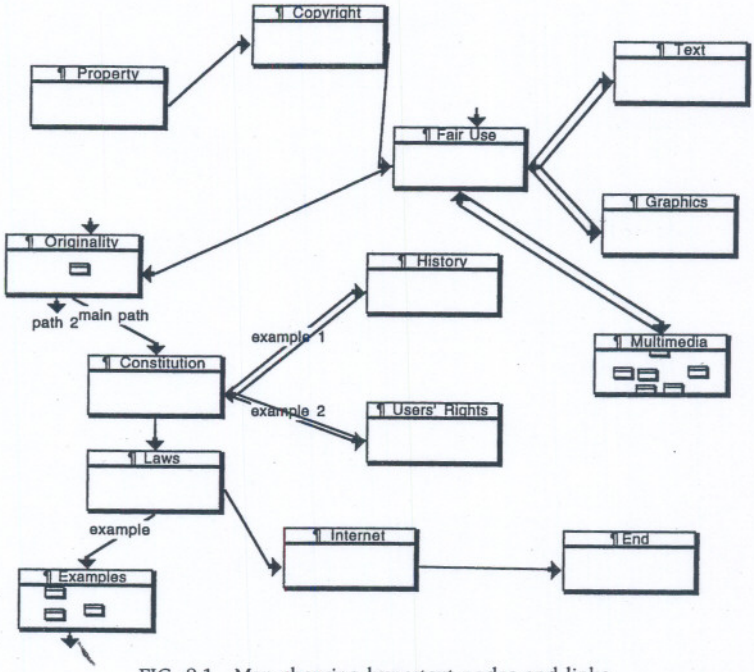

FIG. 8.1. Map showing hypertext nodes and links.

writing in hypertext will some day replace the five-paragraph essay. Such developments have important implications for reading and studying in electronic environments, for teaching and learning in schools, and indeed for defining literacy itself (Reinking, 1998).

Searchable

Electronic text can also be searched by the computer for any desired key word or phrase. Using character recognition and algorithms for matching strings of letters embedded in the text, the computer can automatically find words and phrases that match any set of letters provided by the reader. The reader simply enters a word or part of a word, and the computer will search an entire document to find matches. If multiple electronic documents are linked together, the search can be conducted across all of them.

If a word search is conducted from within a word processing document or text file, for example, the computer will display each appearance of the word, one at a time, in the order that they appear in the document. By analyzing either the words found or the text around them, a reader can answer questions about the author's use of language or gather information about a specific topic. For example, searching for the word "learning" in this document reveals that we have used the word 53 times and in three

different ways: as a verb (as in "learning from text"), as an adjective (as in "learning disabilities"), and as a noun (as in "enhanced learning"). More relevant to the educational goals of secondary students would be searching an electronic version of Hawthorne's *The Scarlet Letter*. A student, for example, might search all appearances of the word "Hester" in order to collect examples of her emotional growth under adversity and persecution. One might conversely search for all appearances of the words "Arthur" or "Dimmesdale" to explore the author's view on the destructive effects of hidden guilt.

The computer's primary role is to enhance the efficiency of the search process, although it may also increase its accuracy and richness. In a study exploring the relative speed and richness of searching an electronic version of the *Encyclopedia Britannica* (found on the WWW at http://www.eb.com:180/) with the traditional multivolume printed version, Anderson-Inman (in preparation) found that students could locate significantly more material on a given topic in a specified amount of time when using the web-based version. More important than speed, however, was the fact that searching the electronic text of the encyclopedia revealed the existence of information not located in the index.

For example, one student searched both the electronic encyclopedia and its paper-based cousin for information about Frederick Douglass, the black abolitionist born into slavery. Using the index to the printed set, the student was able to locate all three entries listed under Douglass' name in the appropriate volumes in the specified time of one-half hour. These included the main biographical article on Douglass and two references to him in other articles (one on Abraham Lincoln and one on abolitionism). Using the electronic version of the *Encyclopedia Brittanica* (accessed via Netscape on the WWW), the student was able to locate and look up the same three articles, but also found a reference to the writings of Douglass in an article on slave literature. In addition, the main biographical article contained links to four full-text electronic versions of articles or books that Douglass had written, including his autobiography. The latter was a wealth of new information because it contained not only Douglass' narrative of life as a slave, but also an introduction by contemporary William Lloyd Garrison in the form of a letter describing Douglass' work as an abolitionist. All were found under a list of "Related Internet Resources" and accessed via direct links to the Electronic Text Center at the University of Virginia. With her remaining time, the student checked out a companion volume found at the *Encyclopedia Britannica* site entitled "Spotlight: The Britannica Guide to Black History," which presented the same biographical article, but also provided a picture and a bibliography. In sheer volume of words found, either about Frederick Douglass or written by him, the contrast is startling. Not counting the duplicated article, the student found material totaling 308,407 electronic words, as compared to only 8,246 words found on paper.

Collapsible

Because of its impermanent nature, electronic text can be collapsed and hidden from view until needed. The text feels like it is still there, but appears tucked away until the reader wishes it to re-emerge on the screen. The most common use for collapsible text is the menu bar that appears across the top of many computer screens. Such hidden menus also have been employed in hypertext documents to provide readers with lists of supportive resources or notational tools for annotating electronic text (Anderson-Inman, 1989; Horney & Anderson-Inman, 1994b). When interacting with hidden collapsible menus, the reader must click on the desired menu item to expand its options and then drag the cursor down the menu list to select an operation or feature. The primary advantage of this technology is that it can be used to provide readers with easy access to many operations without having information cluttering up the screen. This feature enables readers to navigate in, and use the features of highly sophisticated applications and complex hypermedia documents, without feeling overwhelmed or hopelessly lost.

Another useful implementation of collapsible text can be seen in electronic outlining programs. Outlining in an electronic environment has numerous advantages over outlining on paper (Anderson-Inman, 1995), not the least of which is that text under a heading or subheading can be collapsed and then expanded. Figure 8.2 shows an electronic outline in three different stages of expansion. This capacity for text to be hidden and then revealed at will has at least two useful functions. The first is to facilitate creating and working with long outlines. Because any number of subheadings and text notes can be folded up under a heading that is higher on the hierarchy, information in an electronic outline can be kept hidden from view until needed. This feature prevents endless scrolling through headings and subheadings to find some piece of information or to insert new subheadings in an existing outline.

The capacity for electronic headings and subheadings to be collapsed and then expanded also makes an electronic outlining program an ideal study tool. Students can be taught to use this capacity to test their own knowledge of the content in an electronic outline. Anderson-Inman and colleagues have developed a self-testing study strategy that takes advantage of this ability to manipulate which parts of an electronic outline are visible at any given time (Anderson-Inman, 1995; Anderson-Inman, Horney, Knox-Quinn, Corrigan, & Ditson, 1997). When using the self-testing strategy, students are taught to (a) expand a heading to reveal its subheadings, (b) study the material under a heading by asking themselves a series of questions, and then (c) hide the subheadings and test themselves to see if they can remember the information just rehearsed. If they are unsuccessful in remembering the information accurately, the process is repeated. This self-testing

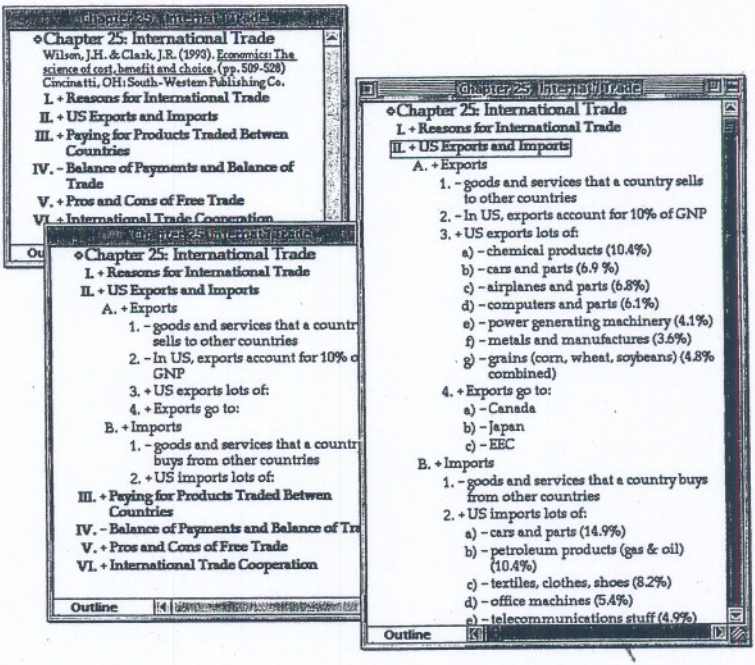

FIG. 8.2. Electronic outline of a textbook chapter on International Trade, in three stages of expansion.

process is facilitated by the act of collapsing and then expanding the text in headings and subheadings, thus making the study task highly interactive and engaging. Furthermore, students can accurately monitor how well they are learning the material and are therefore able to predict more accurately when they are ready to be held accountable for the information in a test or some other evaluation activity.

Anderson-Inman and colleagues have conducted several studies on the use of computer-based outlining as a tool for studying material from content-area textbooks (Adams, 1992; Adams & Anderson-Inman, 1991; Anderson-Inman, Redekopp, & Adams, 1992; Tenny, 1988). The study strategy has three basic steps, of which self-testing is the last (Anderson-Inman, 1995; Anderson-Inman & Tenny, 1989). The basic procedure is to (a) create a skeleton outline of the headings and subheadings found in the chapter to be studied, (b) summarize the text by inserting key words and phrases under each heading or subheading, and then (c) self-test for understanding using the process just described. In the first study to assess the effects of this study strategy on text comprehension, Tenny (1988) found much higher comprehension of material from an American history textbook when performance under this condition was compared to the performance of the same students

under a read and reread condition. Furthermore, observations of student body language indicated they were far more actively engaged while reading and studying with the computer as a "cognitive partner" (Salomon, Perkins, & Globerson, 1991) than they were on their own.

An investigation into the effects of a similar procedure on the test performance of low-achieving students in two world history classes yielded mixed results (Anderson-Inman, Redekopp, & Adams, 1992). Although some students evidenced pronounced improvement in test scores after learning to outline and self-test their understanding of text-based material, the performance of other students showed little change. This study suggests there are other factors that influence whether the strategy is effective for improving students' ability to learn from text, among them student attitude and motivation, as well as the amount of time they have to implement the strategy. Research conducted with students who have learning disabilities (Adams, 1992; Adams & Anderson-Inman, 1991; Anderson-Inman, Knox-Quinn, & Horney, 1996) suggests that not only is the study strategy effective for this population, but that computer-based studying can be conducted in a special education pull-out setting (e.g., a resource room) as a way of impacting student performance in general education classes.

Collaborative

Electronic text can be used to provide readers and writers with a shared space for communication and construction of textual documents. Traditionally, writing has been private and solitary. It is hard to imagine more than one person working on the same typewriter at the same time, or people simultaneously taking pens and pencils to a single piece of paper. Reading too is usually private and solitary. However, it is possible to design electronic reading and writing environments in ways that facilitate collaborative literacy activities. Networked computers running software that allows simultaneous access to multiple users is called *groupware*.

Anderson-Inman and Knox-Quinn (Anderson-Inman, Knox-Quinn, & Tromba, 1996; Knox-Quinn, 1995; Knox-Quinn & Anderson-Inman, 1996) described the use of one such program, *Aspects* (Group Logic, 1994), for collaborative writing and notetaking. Knox-Quinn (1995), for example, explored collaborative story writing using *Aspects* in a networked computer laboratory as a follow-up activity to reading and discussing Joseph Cambell's *The Hero With a Thousand Faces*. Students, writing in anonymous pairs and communicating only through a shared space on their respective computer screens, worked on the same document simultaneously, jointly negotiating the story line and character development. Students' responses to the collaboration were positive, and they requested that this activity continue. The instructor's response was also positive, indicating surprise about the

animation of the laboratory while students were writing and about the quality of their social interactions, which was a distinctly different scenario from the usual isolation of writing assignments.

The collaboration that is more natural to writing and reading electronic texts can also be used to enhance students' content-area literacy by supporting notetaking during in-class presentations and discussions. Anderson-Inman and Knox-Quinn have been investigating the use of networked notetaking as a strategy for assisting secondary and postsecondary students with disabilities who have difficulties taking notes in class (Anderson-Inman, Knox-Quinn, & Tromba, 1996; Knox-Quinn & Anderson-Inman, 1996). Each student is paired with a notetaker, and both are given laptop computers wirelessly connected by the use of infrared devices. Using the same collaborative writing software, the notetaker and student are able to construct class notes simultaneously, as well as communicate via a "chat box" that supports ongoing tutoring. Results suggest that having a real-time model for good notetaking results in students being able to take better notes on their own. This in turn affects their abilities to recognize key vocabulary and comprehend material from their textbooks, resulting in improved performance on class tests.

The Internet also has fostered collaboration through e-mail and bulletin board discussion groups often called "list-servs." E-mail has proven to be a major stimulus for collaborative writing. The text of a draft document can be easily and quickly shared with a writing partner, even when that partner is halfway around the world. The partner can make alterations and additions, then return the document just as easily and quickly.

The Internet also supports collaborative writing projects of larger groups, often in "real time." Anderson-Inman, Knox-Quinn, and Tromba (1996) described two types of environments in which participants are engaged in writing at the same time on the Internet: synchronous chat programs and multiuser simulated environments called MOOs. The first type can be used to foster "freewheeling chats" (Jody & Saccardi, 1996) among many people from geographically diverse locations. Because the communication mode is electronic text and not speech, there is a permanent record of each Internet-mediated conversation. Synchronous chat programs benefit the writing and learning process when the synergy of group brainstorming or discussion is needed for a project involving people who cannot get together in person.

For joint writing projects, MOOs are richer environments because they can present writers with a virtual world in which to work or a fantasy world to write about, and they offer educators a way to design teaching spaces to fit specific instructional goals and prompt specific types of collaborative writing. Daedalus MOO, for example, is a virtual classroom for users of the Daedalus Integrated Writing Environment (DIWE), providing students from geographically distant schools a place to work together on collaborative

writing projects over the Internet. The newest generation of MOOs, called WebMOOs, now incorporate graphics and sounds from the WWW to make the virtual worlds more visually interesting and realistic.

IMPLICATIONS FOR LEARNING FROM ELECTRONIC TEXT: TWO EXAMPLES

Because of its unique characteristics, electronic text has potential to have an impact on how students learn from text, as well as on what they learn from text. It may also have an impact on how they communicate or share what they have learned from text with others. These effects may transform the activities and roles of teachers and students. In this section we present two examples from many that might be selected to illustrate what may be early evidence of this promised transformation. These examples also illustrate the type of research questions that will need to be addressed in order to understand and guide the use of electronic texts for reading and learning.

Example One: Reading to Learn From Electronic Books

Electronic books have the look and feel of traditional books, but may also benefit from many (or all) of the characteristics of electronic text outlined previously in this chapter. Electronic books are increasingly available to teachers and students, usually on CD-ROM, and cover almost any subject relevant to the secondary curriculum. The WWW is a growing medium for developing and distributing electronic books and has the advantage of providing worldwide access. Figure 8.3 presents a page from an electronic book on CD-ROM entitled *Edgar Allan Poe: Selected Works.* Figure 8.4 is a page from an electronic book in the Virtual Bookshelf (Island Multimedia, 1997) on the WWW. (For a more complete discussion of selecting and using electronic books with secondary students, please see Anderson-Inman & Horney, 1997.)

Describing what students do when they read electronic books has been the focus of several studies conducted by Anderson-Inman and Horney (1993; Anderson-Inman, Horney, Chen, & Lewin, 1994; Horney & Anderson-Inman, 1994a, 1995; Horney, Anderson-Inman, & Chen, 1995). Using electronic books with varying degrees of sophistication, they have investigated how and when students access the types of text enhancements and supportive resources available to them and also how students combine their resource use into strategies for comprehending what they are reading. This research leads to the following general observations about student use of electronic books:

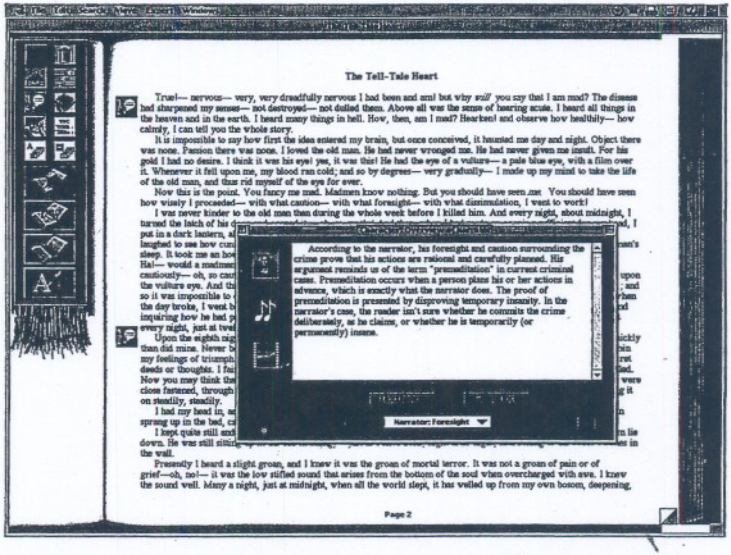

FIG. 8.3. Page from an electronic book on CD-ROM, *Edgar Allan Poe: Selected Works* (Poe, 1996).

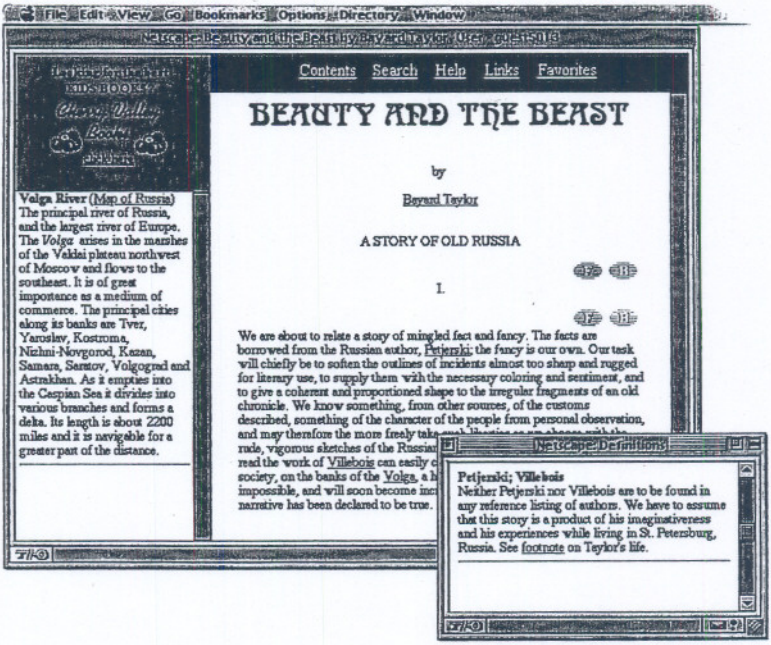

FIG. 8.4. Page from an electronic book on the World Wide Web, *Beauty and the Beast* (Virtual Bookshelf at http://www.islandmm.com/).

1. Students adopt different patterns of interacting with electronic books.
2. Students' interaction patterns are influenced by numerous factors, some of which seem to reside in the student or the educational environment, and some of which are related to the characteristics of the electronic book.
3. Students' interaction patterns change over time, as they acquire more experience reading interactive text and more familiarity with the features available to them.
4. Some interaction patterns are counterproductive to learning and may require specific interventions, either internal or external to the program.
5. Reading electronic books is more time consuming than reading printed books, especially when students access the resources embedded in the text to support their reading comprehension and acquisition of information.
6. Students who use electronic books productively have improved reading comprehension and increased learning of related content-area material when compared to their performance with printed texts.
7. Productive use of electronic books can be enhanced by providing students with clear expectations for reading and training in how to use the book.
8. Most students enjoy reading electronic books, and that enjoyment seems to increase with continued use. However, a few students find reading electronic books to be less enjoyable than reading printed books, primarily because they must use a computer.

From their investigations of electronic books, Anderson-Inman and Horney developed a taxonomy for text enhancements and supportive resources that can be integrated into electronic books for the purpose of promoting comprehension and enriching understanding (Anderson-Inman & Horney, 1997, 1998). Their taxonomy, which follows, illustrates how research may guide educators in selecting or using electronic texts:

1. *Translational resources*: The purpose of translational resources is to provide the reader with an alternate form for words or phrases that might be problematic. The translation might be into simpler language (e.g., a synonym, definition, or paraphrase), into another language (e.g., Spanish or American Sign Language), or into speech (e.g., synthesized or digitized pronunciations). Translational resources are particularly helpful if the reader does not have strong literacy skills or is not a native speaker of the language in which the electronic book is written.

2. *Illustrative resources*: The purpose of illustrative resources is to provide the reader with examples, illustrations, or comparisons to some concept or

set of concepts. Although illustrative resources can be in the form of more text, they may take advantage of the multimedia nature of electronic books and appear as graphics, animations, or sound. Illustrative resources also help students who lack strong literacy skills, and can be used to promote a greater in-depth understanding of unfamiliar concepts and processes.

3. *Summarizing resources*: The purpose of summarizing resources is to provide an overview of the text's structure, content, or major features. This overview might be presented to a reader as an outline (e.g., a table of contents with each title linked to its appropriate page in the text) or in graphic form (e.g., a concept map of key ideas in the document or a timeline of major events). It is helpful if the summarizing resource also provides access to the parts of the document being summarized, thus serving as a navigational aid.

4. *Instructional resources*: The purpose of instructional resources is to prompt student learning by guiding the way they interact with the text. For example, questions might be embedded in the text to help students assess their comprehension; tutorials might be provided to teach students how to access the book's features; or assignments might be included to promote information synthesis. Instructional resources in electronic books are usually included to help students study the material more in-depth or over a longer time.

5. *Enrichment resources*: The purpose of enrichment resources is to augment the main body of text with material that is related, but not actually necessary for comprehension. Enrichment resources can be of any media, and multiple enrichment resources might be attached to any single concept or chunk of text. For example, enrichment resources for the text of the Gettysburg Address might be a photo or drawing of Lincoln at Gettysburg, a sound clip of someone reading the speech, and an analysis of its rhetorical features. None are essential to understanding the speech, but all might augment the reader's appreciation or enhance motivation.

6. *Notational resources*: The purpose of notational resources is to enable students to support their reading by such activities as recording observations, summarizing main ideas, or marking parts of the text. Actions often fostered in electronic books for these purposes include marking pages, tagging and saving favorite photographs, writing annotations or margin notes, taking notes in a notebook, and highlighting text with color.

7. *Collaborative resources*: The purpose of collaborative resources is to promote the process of joint construction of meaning when reading from text. Electronic books that support file sharing allow readers to communicate back and forth over a local or wide area network while reading the same book. This enables discussions while reading and even joint work on comprehension activities.

8. *General purpose resources*: General purpose resources support the content of an electronic book with information that is relevant to, but never designed to be, a part of the book. A good example of a general purpose resource is the full text versions of Frederick Douglass' writings available to readers of the web-based version of the *Encyclopedia Britannica* from the Electronic Text Center at the University of Virginia's website. These electronic text materials exist for a multitude of reasons, but if linked to an electronic book, they provide a useful and enriching extension to the book's content.

Example Two: Synthesizing Information With Electronic Study Tools

Learning from text often requires students to synthesize information gathered from multiple sources. The expectation that such synthesis will occur usually underlies requests by teachers that students write a research paper or report on some topic relevant to the curriculum. Students are expected to locate multiple sources related to a topic, extract information from each source pertinent to a paper's thesis, and then synthesize this information into a final product that is both original and representative of the students' understanding. Teachers hoping to promote interdisciplinary understanding will often assign topics that require searching sources from multiple disciplines and synthesizing information across conceptual domains.

Research by Anderson-Inman and colleagues at the Center for Electronic Studying suggests that many students have considerable difficulty with the expectations just outlined. They are often hesitant to separate information from the context in which it is presented, and they frequently are immobilized by the need to construct a product that reflects how they have turned that information into a representation of their personal understanding and knowledge. In short, students often express a fear of thinking for themselves, or rather, a fear of putting the results of their thinking into print. This fear leads to unoriginal papers using borrowed phrases and sentences to present a compilation of details as opposed to a personal synthesis.

To address this difficulty, Anderson-Inman and colleagues have investigated the effects of providing students with computer-based tools for gathering, organizing, and synthesizing information in preparation for writing a paper or report. Two types of tools have been explored: computer-based outlining programs and computer-based concept mapping programs (Anderson-Inman, 1995; Anderson-Inman, Knox-Quinn, & Horney, 1996; Anderson-Inman & Zeitz, 1994). Both types of programs provide students with a flexible vehicle for recording the information they find while searching through multiples sources for relevant material. In an outlining program, the information is recorded as headings and subheadings; in a concept-mapped program, it is recorded as nodes and links. The advantage of recording

information in an electronic environment is that the tools are infinitely expansive, details can be inserted anywhere in the outline or concept map, and the environment expands to accommodate the new material.

Another advantage of outlining and mapping software is that it helps students to state information in their own words. Outlines and concept maps encourage brevity, and to achieve this, students must pick out key words or rephrase content into text capturing the essence of the information to be recorded. The need for brevity helps students to separate a main idea from supporting details, thus enabling students to insert supporting details derived from multiple sources under the same heading. Under normal circumstances, this level of semantic analysis is difficult for students to do, and is probably the reason why students often resort to borrowing the arguments and synthesized ideas of the experts they are reading. Because the electronic tool supports this process of decontextualization, students are more willing to engage in it.

Software tools for studying also support and promote information manipulation, leading students to synthesize the ideas and facts they have gathered and recorded. Electronic environments such as outliners and concept mappers are ideal for this type of information manipulation because they enable text to be expanded and contracted; headings and subheadings to be inserted, deleted, or rearranged; and even whole sections to be dragged to new places or copied to multiple locations. The software tool becomes a "cognitive partner" (Salomon, Perkins, & Globerson, 1991), helping students think in new ways about the information they have gathered. The experience of imposing a new structure on someone else's ideas or a new spin on details gleaned from numerous sources is often intellectually stimulating for students. Moreover, the papers they write after engaging in this task of information manipulation reflect a more personal process of knowledge construction and ownership.

Thus, using electronic tools for information manipulation and synthesis promises to provide important new options for helping students of varying abilities to process and organize information and to write better research papers. Indeed, that has been the experience of researchers at the Center for Electronic Studying (Anderson-Inman, Knox-Quinn, & Horney, 1996).

A FINAL WORD

As these two examples illustrate, the use of electronic texts has important implications for the future of reading and learning in schools. Considering what those implications might be requires first an awareness of the unique features of electronic text, particularly in comparison to more traditional typographic text. In this chapter we addressed that first step by presenting

several characteristics of electronic text that we believe are especially relevant to reading and learning from text-based material. Identifying these characteristics provides a conceptual framework that sets the stage for the next step: considering the potential implications of electronic texts for teachers and students in today's schools. It is crucial to ask how electronic text can be used to enhance reading and learning given current educational contexts and practices. In other words, how can an understanding of electronic text contribute to the development of new options for helping students to be more successful in learning with text given the demands created by existing or emerging models of instruction? Electronic books and tools for synthesizing information, discussed in the preceding section, are but two examples of how that question might be answered. Moreover, as we have shown throughout this chapter, empirical evidence is beginning to accumulate that, under certain conditions, electronic texts can enhance the conventional goals associated with reading to learn in our nation's schools.

However, more difficult-to-answer, and ultimately more important, questions remain: Do electronic texts and their increasing prevalence contribute to, perhaps even demand, a fundamental transformation of conventional instruction? More specifically, does their existence require a reconceptualizing of the role of text in instruction? Will alphabetic prose no longer be the "organizing spine" of texts as Lemke (1998) has argued? That is, should we begin to assume that helping students to become literate means adopting broader conceptions of literacy, conceptions that encompass skills in reading and interpreting a broad range of media or symbolic modes of expression? (Cognition and Technology Group at Vanderbilt University, 1994; Flood & Lapp, 1995.) What strategies will readers need for locating and processing information in digital environments? What kind of instruction and learning will emerge in schools if students have unlimited and immediate access to information from diverse sources? Will the textbook survive? What will happen to conventional understandings of concepts such as intellectual property, copyright, and plagiarism (Reinking, 1996) when digital information is easily shared and modified, and when reading and writing become more naturally collaborative?

In this chapter we did not directly address these and similarly consequential questions related to reading and learning from text, but we have hinted at their relevance. We believe such questions will acquire increasing relevance as we move beyond the horizon separating long-standing conceptions of reading and learning from printed texts and into an era that McLuhan (1962) and others have referred to as a post-typographic world (Ong, 1982). The evidence that we are crossing a threshold from a world dominated by print to one dominated by digital media is increasing. Literacy in general, and learning from text in particular, are not likely ever again to be as they were. The portent of crossing that threshold cannot be overestimated.

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