THE ELECTRONIC TRANSFORMATION OF
LITERACY AND ITS IMPLICATIONS FOR THE
STRUGGLING READER

Michael C. McKenna
Georgia Southern University, Savannah, Georgia, USA

David Reinking, Linda D. Labbo, and Ronald D. Kiefer
University of Georgia, Athens, Georgia, USA

This article examines how changes in the nature of text, brought about by its
electronic representation, will increasingly affect the circumstances of strugg-
ling readers. It is argued that the textual transformation now in progress
holds great promise for such readers. The emerging view of reading disability
based on developmental stage theory is discussed, and this perspective is used
to recommend instructional approaches that are appropriate to successive stages
of reading acquisition.

The 21st century promises sweeping changes not only in the way
children are taught to become literate but in the very nature of liter-
acy itself. The reason for these changes lies in the transition now in
progress from traditional, print-based literacy to electronic represent-
tations of text. No dimension of literacy education is unaffected by
these transformations, for they include not only the nature of text but
of literacy assessment, classroom practice, research, and school and
social contexts. Our belief is that these transformations generally
bode well for the student who finds learning to read difficult, but they
also pose unprecedented challenges. Our purposes in this article are
to outline the implications of these transformations and also to
describe how educators’ conceptualization of, and response to, strug-
gling readers must change in an era of electronic literacy. Our intent
here is to instill these implications and to project a comprehensive
description of how the electronic transformation of literacy will

The content of this article originated in a project of the National Reading Research
Center, resulting in the publication of an edited volume. This book, entitled Handbook
of literacy and technology: Transformations in a post-typographic world (Erlbaum, 1998),
comprises a collection of invited chapters treating an assortment of topics and issues
related to the electronic transformation of literacy. With a few exceptions, the prin-
cipal focus of the contributors was not on struggling readers, but each chapter offers
implications for their literacy development.

Address correspondence to Michael C. McKenna, 4 Tiller Point, Savannah, GA
31419, USA. E-mail: mckenna@peachnet.campus.meri.net

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essentially redefine reading disability and its effective accommodation by educators.

THE CHALLENGE AND PROMISE OF ELECTRONIC TEXT

The fact that any printed text can be represented on a computer monitor may lead to the conclusion that there is no substantive difference between reading print and reading electronic text. At a superficial level, this conclusion is correct. The same subprocesses of letter and word recognition, meaning construction, and comprehension monitoring must take place regardless of the medium. However, there are differences between print and electronic text that profoundly influence the nature of reading. Reinking (1994) identified four such differences. To begin with, electronic text is truly interactive in the sense that it can be altered in response to reader input. Such alterations may include a selection among the texts to be read and the use of options such as pronunciations and definitions that serve to support reading. Second, the reading of electronic texts can be guided by teachers or software developers in order to encourage comprehension. Such guidance can be built into the design of documents read by students. Third, electronic texts are often structured far differently than their print counterparts. Hypertextual networks are one example and the creative integration of multimedia is another. Finally, electronic texts add to the range of symbols available to writers and readers, which may be in the form of icons or multimedia presentations.

These qualities present readers with a potentially bewildering set of choices. In electronic environments, students must recognize that reading is not a matter of proceeding from the first to the last word of a fixed, linear text. It must become a strategic process of satisfying one’s purposes, a goal that is desirable in conventional texts but essential in hypertext. The necessity of plotting a course from point to point has only a crude counterpart in the realm of print. In electronic environments, this movement is nearly instantaneous and virtually effortless. Moreover, the range of choices is multiplied incalculably when students are linked to the ultimate hypertext, the World Wide Web (Bolter, 1998). Indeed, Garner and Gillingham (1998) argued that conventional textbooks may be largely supplanted in the foreseeable future by instructional resources linked through the Internet.
An additional consideration is that Web-based hypertexts are rarely networks of prose alone. Rather, engaging combinations of text and graphics comprise them (Bolter, 1998). Although even struggling readers are likely to be familiar with one of the print-based forerunners of these networks—the comic book (Purves, 1998)—the omnipresence of nontextual elements contributes further to the distinction between conventional and electronic literacy. These developments hold undeniable promise but also pose challenges that research has only begun to explore (Kamil & Lane, 1998; Miller & Olson, 1998).

How Electronic Text Can Support the Struggling Reader

Fortunately, among the myriad of options available to readers of electronic text is an emerging set of supports that may help to compensate for inadequate reading ability. Anderson-Inman and Horney (1998) outline an extensive array of resources now being investigated. Translational resources offer considerable help to struggling readers by converting what is encountered on the screen into a more useful form, such as the digitized pronunciation of a word, a glossary entry, or an American Sign Language video clip. Illustrative resources provide the reader with examples, comparisons, and visualizations that are not part of the linear text. Supplementary resources can supply additional information on demand, information that is not strictly necessary for comprehension of the source text. Resources for summarizing afford overviews or outlines of a larger text. Instructional resources can guide a reader or offer activities designed to reinforce particular skills. Collaborative resources permit more than a single student to read the same text simultaneously and to allow them to communicate with one another about it. Notational resources allow readers to take notes flexibly as they read a text, often by means of an electronic clipboard. Other resources offer access to various information sources, such as electronic encyclopedias, dictionaries, and databases as students read a particular text. The range of these options is not only impressive, it can be overwhelming. Ironically, perhaps, the struggling reader must acquire new skills needed to use such resources—resources that were designed to compensate for other skill deficits. This means new instructional goals for teachers, goals involving the effective use of resources by students (see Horney & Anderson-Inman, this issue).

In weighing the pros and cons of placing struggling students within electronic environments, teachers may feel inclined to shelter such readers by exposing them only to print. Such a strategy would remove the navigational perils of hypertext and the confusing array
of supportive resources, but it would also deny them the advantages of that support. We argue that the cost–benefit ratio of introducing troubled readers to electronic texts overwhelmingly favors their use. In addition, McKenna (1996) argued that the demands of an electronic workplace behoove educators to align their instruction accordingly and to “become increasingly cognizant of the type of world they will be educating their students to enter” (p. 35). In projects described by Askov and Bixler (1998) and by Mikulecky and Kirkley (1998), it is clear that workplace literacy programs are now becoming highly computerized, in part because of the advantages of such instruction and in part to create a better alignment between instruction and the workplace.

RETHINKING THE NATURE OF READING DISABILITY

Conventional definitions of reading disability involve performance assessment with respect to print. Typically, a child might be asked to read passages of known readability contained in an informal reading inventory so that an instructional level can be estimated. But an electronic environment challenges conventional notions of readability, instructional reading level, and, ultimately, reading disability (McKenna, 1998). When a child reads supported text equipped with some of the resources described in the previous section, performance might very well exceed what would have occurred in a print environment. As Bruce and Hogan (1998) point out, disabilities are defined by the technology required to perform a task. Just as a staircase renders a paraplegic “disabled,” the printed page disables certain children and not others. But when a child experiencing difficulty in decoding can access digitized pronunciations at will, the disability is minimized or even eliminated. And when the availability of such pronunciations becomes the instructional norm rather than the exception, then the disabling condition must be reconsidered. As the number of electronic texts continues to climb and as children’s access to them becomes easier, the distinction between who is disabled and who is not will become increasingly blurred and of questionable usefulness.

The evolution and proliferation of electronic texts come at a critical juncture, when conventional definitions of reading disability are being reexamined irrespective of technology. Traditional approaches to remedial reading instruction, involving a slower presentation of material or a deficit-oriented skills approach, have not produced results superior to best practice in regular classrooms (Walsmey & Allington, 1995). On the contrary, there is good evidence that such
students “benefit most from larger amounts of higher quality literacy instruction than is normally needed for other children to succeed” (Allington & Cunningham, 1996, p. 197). The emerging consensus, based on research, that specialized approaches offer no real advantages to struggling readers has occasioned a new theoretical position that in our view holds great promise. This position was articulated by Spear-Swerling and Sternberg (1996) and can be summarized as follows: The great majority of problem readers do not suffer from the neurological impairment traditionally assumed to afflict them but have failed to develop past a particular stage of development. As the authors put it:

We view children with reading disability as having strayed from the path of typical reading development—as having veered off track—at certain predictable points. This view of children’s reading difficulties suggests many ways of addressing these difficulties educationally, perhaps in some instances even preventing them entirely. (Spear-Swerling & Sternberg, 1996, pp. xiii–xiv)

Appropriate instructional methods are those calculated to move any reader, struggling or not, from one developmental stage to the next. Just as Allington and Cunningham called for “larger amounts of higher quality literacy instruction” (1996, p. 197), Spear-Swerling and Sternberg offer an explanation of what form such instruction should take. In the next section we describe how teachers might use technology in assisting readers past developmental milestones.

**APPLYING TECHNOLOGY AT DEVELOPMENTAL STAGES**

Our interpretation of the perspective offered by Spear-Swerling and Sternberg (1996) is that there is now relatively widespread agreement on the developmental stages through which readers progress. We therefore adapt their perspective to the somewhat more familiar terminology used to describe these stages. A widely accepted approach is that of Chall (1983), who described five major stages (following a foundation, called *Stage Zero*, which is largely congruent with the notion of emergent literacy). During Stage 1, ‘*initial reading or decoding,*’ children gain proficiency at the alphabetic code, which entails learning phonics and developing the ability to decode unfamiliar words. In Stage 2, ‘*confirmation and fluency,*’ speed of decoding
reaches automaticity, and phrasing becomes natural and adult-like. In Stage 3, 'reading for learning,' children learn to apply their skills to the task of acquiring content from expository sources such as textbooks. During Stage 4, 'multiple viewpoints,' they come to recognize that perspectives may differ on important subjects and they develop the ability to contrast these perspectives critically. Finally, during Stage 5, 'construction, reconstruction: a world view,' readers become self-actualized, are able to read for a wide range of purposes, and they develop a view of self that affords reading a major role.

Of these stages, the first (decoding) is unquestionably the most important point at which children go developmentally astray (Spear-Swerling & Sternberg, 1996). Useful substages have been described by Ehri (1991), Frith (1985), and Marsh, Friedman, Welch, and Desberg (1981). Frith’s model, popularized by Mason et al. (1992) and Stahl (1992), includes first a logographic stage, during which children rely chiefly on visual clues; an alphabetic stage, marked by the sequential application of letter-sound knowledge; and finally an orthographic stage, during which spelling patterns such as phonograms are used in making analogies between familiar and unfamiliar words.

How can teachers use technology most effectively to assist the struggling reader to move past a given stage of development? This important question is the subject of ongoing research, yet several useful insights have already become apparent. We now describe the potential role of technology at each stage. An overview appears in Table 1.

**Bringing Struggling Beginning Readers into the Decoding Stage**

Labbo and Kuhn (1998) correctly emphasize that the emergent literacy period cannot be properly regarded as a “stage” of reading development and that, in fact, children tend to follow idiosyncratic paths as their own literate behavior begins to emerge. It is for this reason that Chall (1983) described this period as ‘Stage Zero,’ an interval that occurs before the systematic acquisition of reading proficiency. Nevertheless, children who have not been exposed to optimal environments that later on facilitate formal literacy instruction may benefit from methods geared to providing them with the foundation that decoding instruction requires.

To facilitate emergent literacy (Chall’s Stage Zero), software focusing on phonological awareness, alphabet recognition, print concepts, and language development appears to have great promise. Labbo and Kuhn (1998) described the use of drawing software as young children
TABLE 1 Software applications appropriate at various stages of reading acquisition

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<th>Major stages</th>
<th>Examples of computer applications for moving struggling readers past a particular stage or substage</th>
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express themselves in an environment called Screenland. The computer helps compensate for inadequate motor skills as prereaders develop a sense of story and exercise self-expression. Electronic storybooks, when used in their listening versions, hold the potential to help beginners extend their vocabulary, their world knowledge, their concepts about print, and their story sense (McKenna, 1998). Phonological awareness software has already proved effective with learning-disabled populations and offers a means of assisting students whose decoding growth has been arrested because of a lack of such awareness (Olson, Wise, Ring, & Johnson, 1997).

Moving Struggling Readers Past the Decoding Stage

Children with an adequate foundation of alphabet knowledge, print concepts, and phonological awareness who have stalled at the decoding stage may benefit from computer-based activities aimed at enhancing their awareness of sound–symbol correspondences, though little research is available to guide teachers in selecting such activities. A series of studies conducted at the National Reading Research Center and summarized by McKenna (1998) investigated the effectiveness of phonics minilessons embedded in electronic trade books. Children who clicked on an unfamiliar word while reading were provided not only with its digitized pronunciation but with a brief description of how the word was comparable to an analogous
rhyming word. These minilessons had no discernible effect on beginning readers' knowledge of phonics. However, the repeated readings of these electronic books led to substantial gains in the number of sight words children acquired (McKenna, 1994; McKenna & Watkins, 1995, 1996). A replication with struggling second graders yielded similar results (McKenna, Cowart, & Watkins, 1997). With regard to phonics acquisition, however, software employing a direct instruction format may be more effective. An earlier study by Roth and Beck (1987) clearly showed that software can be conducive to the decoding growth of struggling readers (in this case fourth graders) when a systematic, direct-instruction model is used.

**Helping Struggling Readers Attain Fluency**

Wide reading of electronic trade books may have its greatest potential in moving children to the point of fluency. Because reading is supported by built-in resources, like digitized pronunciations, problem readers can read books at or near their listening level at classroom centers of in lab settings. The growing availability of such books offers a powerful tool to teachers faced with the dilemma of assisting children in the upper elementary grades to achieve fluency. Reitsma's (1988) work with Dutch first graders led to promising results, indicating that the availability of digitized pronunciations on demand led to increased rate and accuracy. Subsequent studies at the National Reading Research Center produced similar findings with respect to beginning readers in the United States (McKenna, 1994; McKenna & Watkins, 1995, 1996).

**Helping Struggling Readers Learn From Text**

Children who have become fluent but who lack proficiency at learning from text may benefit from electronically supported reading, from materials equipped with resources like those described by Anderson-Inman and Hornery (1998). For such students, the lower level resources, such as pronunciations and glossary entries, are likely to be less important than those that foster strategic reading, such as built-in guides and note-taking capacity. As computerized versions of commercial textbooks become more widely available, they will afford a useful classroom option for students struggling to apply their skills to the task of learning from expository materials.
Fostering the Advanced Development of Struggling Readers

Readers who are proficient at learning from text but who lack the critical ability to judge among multiple viewpoints are not often classified as “struggling,” let alone as reading disabled. However, Chall’s model postulates that such readers exist, and assisting them to recognize and differentiate multiple views is an important instructional goal. Although we know of no software that specifically targets such readers, there are nevertheless computer applications germane to accomplishing it. As the Internet grows in importance, its natural and occasionally jarring mix of perspectives provides fertile ground for moving students through this stage. The use of other forms of hypertext, such as electronic encyclopedias and menu-driven databases, provides an additional means of accomplishing this end without the necessity of being online. Stahl et al. (1996) provided a thorough background discussion of print-based instructional activities involving multiple texts at the high school level. They concluded that students tend to require specific guidance to successfully integrate information from multiple sources. This finding offers a caveat to teachers tempted to rely on their students’ ability to pull facts together from more than a single electronic source. When these students are experiencing problems to begin with, the need for teacher assistance is even stronger.

TECHNOLOGY AND SOCIAL CONTEXTS

Just as the social context of reading instruction has become a principal focus of researchers over the last decade (e.g., see Reinking, 1998), social factors related to struggling readers are now well recognized. Barr (1992), for example, recounted the stigmatization of low-group placement while Cunningham and Allington (1993) advocated ‘multilevel’ reading instruction in which children of low ability are rarely if ever segregated for special treatment. Technology may afford a means of preventing the struggling reader from being socially marginalized, and recent projects have yielded promising results. Garner and Gillingham (1998), for example, discuss a number of instances in which students used e-mail to communicate with students at distant locations. E-mail challenges social relationships in that the status of the correspondents may not be apparent. Beach and Lundell (1998) observe that this social shielding can induce ordinarily shy students to be more interactive, even to the point of adopting on-line personas that may differ considerably from the images they
project to classmates. Even when the identities of e-mail correspondents are known, however, as are identities among members of the same class working cooperatively, some of the social inhibitions present in face-to-face encounters vanish when computers mediate communication (Beach & Lundell, 1998). Neilsen (1998) reports a similar pattern of students' overcoming a fixed identity when they began to correspond via e-mail with individuals outside the school.

While technology may offer one key to overcoming the adverse social consequences of being labeled a struggling reader, its use may entail an unwelcome reexamination of instructional practice on the part of some teachers. Using the Internet and even local-area networking to link students with one another has two educational effects of considerable importance. One involves the central place it affords to inquiry-based, as opposed to direct, instruction. Lemke (1998) distinguishes the conventional "curricular learning paradigm" from the "interactive learning paradigm" inherent in Internet and LAN linkages. Teachers whose philosophy is oriented toward the transmission pedagogy of the curricular paradigm may find the transition to an interactive learning paradigm uncomfortable.

The second effect concerns the power shift that must inevitably flow from teacher to student in interactive settings (Myers, Hamnett, & McKillop, 1998; Tierney & Damarin, 1998). Teachers must anticipate the use of that power by students, sometimes in ways that challenge conventional thinking about educational propriety. Leu and his colleagues (1998) recount how students left messages filled with candid vernacular while using an interactive history program. Neilsen (1998) describes the virtual subversion of an e-mail system by a small group of students in a Canadian high school. Beach and Lundell (1998) report how personal messages are frequently interspersed with task-oriented communications in collaborative settings. These instances are a reminder that using technology to dissolve or minimize the social barriers separating the struggling reader may require adjustments in power and pedagogy.

TECHNOLOGY AND ASSESSMENT

In classrooms where electronic literacy plays an increasingly prominent role, technology can facilitate the assessment of struggling readers. The portfolio serves as a useful metaphor for describing possible applications, although electronic portfolios may eventually bear little similarity to the print-based folders now constructed by many teachers. Likewise, commercial prototypes, such as the Grady Profile
and others, tend in our view to provide a limited vision of what is possible. Kieffer, Hale, and Templeton (1998) describe one teacher’s development of a self-styled portfolio, tailored precisely to her needs. It possessed both a professional development component and a student component, the latter being co-developed by her own students. The process of involving students in the design and contents of the portfolio tended to heighten their metacognitive awareness of various aspects of their literacy growth. Although a similar effect could have been expected from involving them in the design and construction of a conventional portfolio, the digitized electronic version permitted a novel fluidity in how the contents were structured and accessed.

Portfolios of the future may also become repositories of data collected by tracking students’ interactions with software. Leu et al. (1999) report that teachers tend to find such a monitoring function extremely useful. And when classrooms are connected in LANs, electronic portfolios can automatically accumulate information with respect to library use, absenteeism, on-screen activity performance, and the like. Even oral accuracy during reading, including both miscue analysis and quantitative assessments, might be tracked. This capability will come with the perfection of voice recognition software, which will make possible the kind of process assessment that now requires a considerable investment of a teacher’s time.

When sophisticated expert systems are used to interpret tracking data, useful profiles can be generated on demand by teachers in the course of making instructional decisions about children (McKenna, 1991). Tracking data can occasionally be misleading (McKenna, 1998) and its best use remains a subject of intense research (Anderson- Inman & Hornern, 1999), but its promise as a means of monitoring literacy instruction is extraordinary. (For an extensive discussion of technological applications in the assessment of struggling readers, see McKenna, Reinking, and Labbo, 1997.)

SUGGESTIONS FOR TEACHERS

Our knowledge of how technology can best assist the struggling reader is still limited. However, enough information exists to offer a few tentative suggestions, listed below, to practicing teachers:

1. Foster electronic literacy. Provide ample opportunities for children to read and write using computers. In so doing, you will help prepare them for the literacy demands of the world they will enter. There must be a viable integration of technology into everyday
classroom activities, and it should begin as early as kindergarten. (See Reinking, 1994, for background.)

2. Use electronic trade books to help students achieve fluency. Repeated readings of electronic trade books, equipped with digitized pronunciations on demand, can assist poor decoders in attaining automatic word recognition and fluency. Centers can make limited hardware go a long way in targeting struggling readers. (See McKenna, Reinking, and Labbo, 1997, for detailed guidelines and Reitsma, 1988 for the description of an effective instructional approach.)

3. Facilitate student-to-student communication. Arrange for students to interact with one another and with others via computers. The Internet is one avenue to such communication, but it is not the only one. Local area networks can be used for this purpose as can isolated machines that are accessed alternately by students or groups of students at different times. The goal is to foster literacy development in the context of an electronic community of readers and writers. (See Garner & Gillingham, 1998.)

4. Select software critically. The spate of literacy-related CD-ROM software offers many choices, a smorgasbord that can both be perplexing and empowering. Not all products are equal in the benefits they offer struggling readers. Look for simplicity of design, true interactivity based on student choice, skill development that conforms to our knowledge of best practice, and a favorable ratio of actual literacy engagement to time spent in other ways. Finally, keep abreast of research developments involving software applications with struggling readers.

5. Gear applications to the developmental stage of the reader. Use the results of classroom assessment to determine the stage at which a struggling reader appears to have stalled. Then select software applications that appear likely to assist the student in moving to the next stage. Table 1 may be useful as a guide, although its contents are meant as examples only.

6. Choose applications that monitor student performance. Even though the vision of automated portfolios that accumulate and interpret broad arrays of student data is not yet realized, much of the literacy software currently available records useful information about student performance. Such software can supplement the other assessments you undertake.

7. Have reasonable expectations. Technology is not the panacea for all of the problems faced by the struggling reader. Although existing applications are full of promise and although many bear little resemblance to an earlier generation of electronic workbooks, the
fate of the student experiencing difficulties will remain in the hands of insightful practitioners who use technology in tandem with a full range of productive classroom experiences.

REFERENCES


