Technology for Teaching Reading

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Framing the Issue

A written text and the acts of writing or reading a text are and have always been instances of interacting with a technology. This is true whether we think of technology as a quasi-industrial process involving tools and procedures, or in the broader sense of artifice as opposed to nature, involving an extended learning curve and arbitrary representations. This argument was proposed by Ong (1982) and updated by Cobb (2012). Speaking and listening are natural acts, which everyone in a social environment masters at roughly the same pace and to a similar level, but writing and reading are "unnatural acts" (so named by Gough & Hillinger, 1980) that are acquired unevenly, uncertainly, and with variability of outcome. All people of normal intelligence learn the spoken version of their first languages (L1s) to the extent needed to function in their typical environments; the same cannot be said of writing and reading. This is especially true in learning to produce or comprehend texts in a foreign language or L2 (L2).

What was arguably true until recently, that reading is an interaction with a technology, has now become manifestly true, as the majority of texts consumed come literally out of machines, namely networked computers, and live in machines, are passed from machine to machine, are experienced mainly on screens. Further, the arbitrary code of any written language has been joined by several other layers of coding made possible by text computation both at and below the level of the obvious. Texts are increasingly linked to other texts, by somebody, under a variety of motivations. Links range from clicking to look up words to clicking to depart one text for a more attractive other text, such as an advertisement.

Reading as a technology has always produced different degrees of success but with more technology the differences have probably become greater. While strong readers profit from text technologies and hypertextual environments, integrating texts cognitively as the coding integrates them physically, weak and L2 readers experience the docuverse of linked texts mainly as distraction, confusion, and disintegration. DeStefano and Lefebvre (2007) reviewed studies on the cognitive consequences of hypertext reading "in order to test the hypothesis that activities

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specific to hypertext can increase cognitive load and impair learning" (p. 1617). The researchers wonder whether, "when people follow links, they may lose track of where they are in the text, of their reading goals …" They found that this was generally the case in the 38 studies they looked at, at least for "less-knowledgeable readers and for readers with low working memory capacity." L2 readers are by definition working with less (usually lexical) knowledge and more challenges to working memory (through lack of lexical automaticity).

Fortunately, for every challenge of reading with technology there is also an opportunity which can turn the challenge to an advantage. Unlike the challenges however the opportunities do not happen by themselves as a by-product of technological change—they require focus and design, an understanding of both the needs of learners and the nature of text technologies.

Making the Case

A number of text technologies can help the L2 reader experience on-screen reading more as opportunities than challenges. These are in the areas of access, selection, reader preparation, reader scaffolding, research, and testing.

Technology and Access to Texts

Anyone in reach of the Internet can pretty much access any text in existence at the present time for low or no cost. The value of this enormous increase in accessibility can hardly be overstated, particularly in areas of the world where texts have hitherto been inaccessible (Cobb, 2006). L2 learners in remote regions who once read the same dog-eared book over and over—not a bad strategy in itself—can now access texts of every kind on a host of common electronic devices. Educational programs using particularly English but also other languages as instructional medium can access whole libraries of academic materials with no need to house or maintain them. As well as the information transfer all this affords, universal text access also brings numerous opportunities not just for reading but also for learning to read for anyone with pedagogical imagination. Hemingway's strategy of reading the day's news in English and then in several French newspapers can be replicated by any learner or teacher with a wide range of online news sources.

Technology and Text Selection

Against this bonanza of text must be set the fact that for L2 readers the vast majority of it is likely to be difficult or impossible to read. Rather neatly, the same technology that makes all this possible also makes it possible to turn this bonanza to pedagogical advantage. There are a number of highly evolved and well-researched schemes for evaluating the level of a text, changing the level of a text, or scanning the World Wide Web for all the texts of a particular topic and level. These involve varying levels of expert support. At the support level of a national or regional curriculum

committee, Crossley, Greenfield, and McNamara (2008) discuss a number of technologies that evaluate text readability, which could be used to choose reading materials where the numbers would warrant this. At the level of individual program designers or even teachers, the present author's Vocabprofile program on The Lexical Tutor website (http://www.lextutor.ca) deploys the word frequency lists compiled from the British National and Contemporary American corpora to produce a lexical profile of any text, as well as a fairly simple means to modify that profile, such that learner and text can be matched. The system supports research-validated cut-offs for reading as fluency building, reading with resources (see below)—in other words, for both learning to read and reading to learn. Learners also use the profiler, in conjunction with the published vocabulary tests on the same Web site, to choose level-appropriate texts for themselves. Even more firmly in the user-control camp is the REAP (2010) system of Heilman, Collins-Thompson, Callan, Eskenazi, Juffs, and Wilson, which tests the learner's vocabulary level and topics of interest and then scans the Web for a selection of reading options.

Technology and Reader Preparation

A principal feature of computational reading is the ability to coordinate two or more texts at the same time, which provides an advantage for some readers and a challenge for others. The notion of clicking on something in one text to access something in a different text was till recently a rather unusual feature but is now ubiquitous on electronic devices. The challenge here is to hold in memory the main text while incorporating information from another, and the research suggests that for many this operation is destabilizing, especially when the second screen overlays or replaces the first. One solution is to offer trainee readers designed practice in integrating two texts where both remain clearly visible. Figure 1 shows Lextutor's integration of a text from the "Engines of Our Ingenuity" Web site with click-access to the WordReference Dictionary (discussed with findings in Cobb, 2006).

Many other instances of learners' preparation can be imagined, some of which are implicit in the following section.

Technology and Issues Identification

Text technologies have enabled us to penetrate many longstanding issues in L2 reading. One is the proportion of known words a text must have for various levels of comprehension to occur. Previous estimates ranged from hardly any words needing to be known to almost every word. Current research, involving both the corpus frequency data already mentioned and empirical studies with learners (Cobb, 2007; Schmitt, Jiang, & Grabe, 2011), is focusing on a figure between 95 and 98% known words depending on the comprehension level desired. Another discovery has been the different lexical and other challenges of different types of texts, including those most relevant to learning contexts, narrative, and expository texts (Gardner, 2004).

A reading issue once identified via one text technology typically leads to a problem to be solved, and the solution is commonly to be found in another text technology.

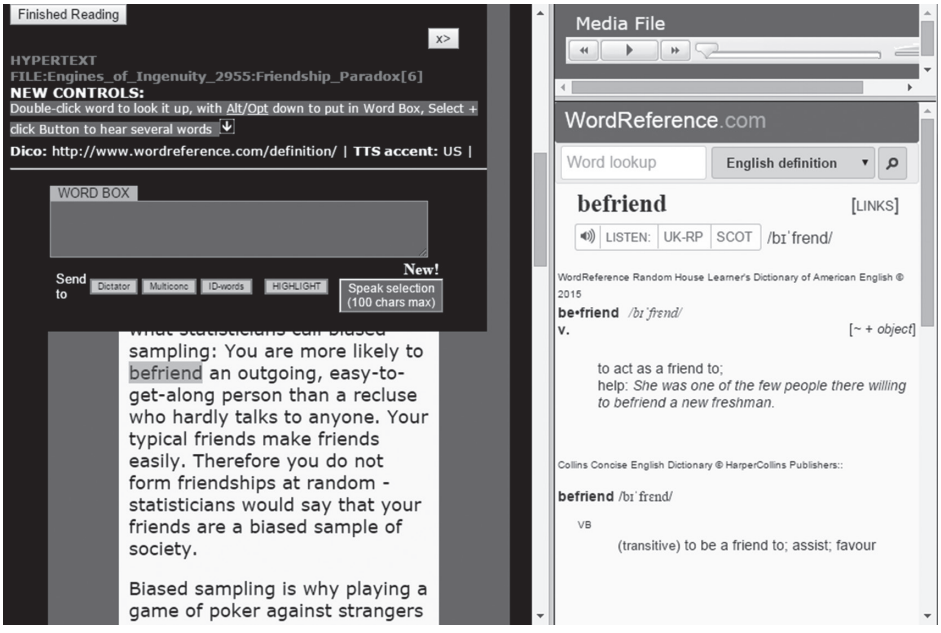

Figure 1 Training wheels for hypertexters.

In the case discussed, rapid vocabulary growth is often indicated, and for this there is a growing number of interesting electronic flashcard options available (discussed in Cobb, 2012). A vocabulary growth strategy that involves both text technology and actual text processing (reading) is Lextutor's List_Learn (http://www.lextutor.ca/list_learn/), wherein learners take a corpus-informed vocabulary test, obtain the indicated vocabulary list, look up its unknown items in one of several corpora, and save comprehensible examples and definitions to their own "dictionaries."

Another reading skill recently identified, or rather specified, is that of rapid word recognition. The notions of sight words and automaticity of recognition have been standard notions in reading pedagogy for decades, but only with modern text computing instruments has it become clear that word access of greater than about 800 milliseconds will impair text comprehension even when all the words in the text are known. Once again, a need identified by one text technology can be met by another. Numerous electronic games, from Space Invaders to Word Coach, record and reward high-speed word-level processing, many with strong and replicable results (Cobb & Horst, 2011). Other software presents a learner or teacher selected text with sentence-level timing and encouragement to increase the speed of reading, including the Hot Potatoes authoring suite (https://hotpot.uvic.ca/).

Technology and Reader Scaffolding

Carrying on from the idea of learner training with hypertexts, we can systematically expand the number of resources that can be integrated into a text and accessed via clicks. In addition to the WordReference dictionary already discussed, those

available on Lextutor under the rubric "RA-Reading" (resource assisted) include the following (many of which are prefigured in Figure 1):

- text-to-speech renditions of individual words and phrases;
- sound files for whole texts or parts of texts where available;
- concordance lines for selected words or phrases either from a standard corpus or a corpus of the current author's other works;
- storing of words and phrases for future consultation or for use in games or other learning operations (Figure 1's "word box");
- sending of words and phrases to linked games or other learning operations;
- sending of words and phrases to a "group lexicon" where the acquisitions of an entire class or other group can be collected and further manipulated.

All of these resources are supported conditionally and to various degrees by empirical research with L2 readers, but as already mentioned, outbound links are also classed as challenges in other research and so it is important to build up the electronic resourcing of texts gradually, with guidance, and to assure they are supporting reading and learning to read rather than distraction and text-exiting. Research by Cobb (2006) shows that in a range of resource-assisted reading approaches, memory of looked-up items typically increases by from 70% to 80%. Whether this attention to individual text features is purchased at the cost of global comprehension is a current live issue.

Technology and Comprehension Testing

The testing of reading comprehension is probably not conducted as much as it should be, other than by the large testing companies, owing to the time it takes to compose either good multiple-choice questions or long-answer questions that employ synonyms such that they cannot be answered simply by copying from the text without comprehension. A simple alternative is to employ one of the many online cloze-passage builders (which remove every n-th word from a text for a learner to replace) as a comprehension measure with at least some plausibility in the reading research.

A complaint against this approach to testing is that the tests are too difficult if the computer insists on a correct answer for a gap or too easy with a menu of random words from the text. The too-difficult problem can be avoided by printing the test for scoring by a teacher so that half-points can be awarded. The too-easy problem can be alleviated by offering the test taker a menu of only four or five choices. Normally this would lead to a low-grade question with an obvious answer, like "The car came (driving, big, a, expensive) down the street." Lextutor's cloze builder (http://www.lextutor.ca/cgi-bin/cloze/n/index.pl) responds to this problem by putting together choices of a similar length for each gap, which normally results in a question asking for at least some degree of comprehension. For example, "The car came (driving, expensive, serious, walking) down the street" requires distinguishing *driving* from *walking*. Another approach is to build the choices list from words with a similar corpus frequency. Going far beyond any of these rustic approaches to

automatic question generation are the topic modeling and main-idea identifying routines of NLP (natural language processing) researchers underway at ETS (Educational Testing Services) and other large testing organizations. ETS is making some of these reading technologies available for teachers (such as TextEvaluator, at https://www.ets.org/c/23491/). For a flavor of the topic modeling work, see https://code.google.com/p/topic-modeling-tool/.

Pedagogical Implications

There is really no way to avoid the integration of reading and technology at the present time. If avoided or unplanned, this integration will happen randomly, producing the discrepancy of ability outcomes we have always known but more so. Fortunately, it is to be hoped that enough examples have been provided here to convince the reader that, for every challenge of new text technologies there are solutions created by these same technologies. The challenges come without bidding, while the solutions require deliberate action and an understanding of the technologies and options involved.

SEE ALSO: Assessment Literacy; Hypermedia Design; Teaching Vocabulary Before, During, and After Reading; Technology Enhanced Learning Environments

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Suggested Readings

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