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Reading and the Web: Broadening the Need for Complex Comprehension

This paper takes the position that the Web and online reading have not created new literacies. Rather, what the Web has done is to make explicit aspects of reading and text comprehension that have always "been there" but which have gone largely unattended in traditional curricula, large-scale standardized accountability testing, and most reading research. Traditional curricula, assessments, and much of the reading research are based on assumptions that reading is an individual act, conducted on individual texts, in isolation from others to answer questions posed by teachers, test constructors, and researchers. Learning to read has largely focused on word recognition, consistent with a Simple View of Reading (Gough & Tunmer, 1986). Instruction in reading comprehension and learning-through-reading has been dominated by generic strategies largely focused at the word, sentence, and paragraph levels with some attention to the overall text level. Examples of generic strategies include summarizing, finding main ideas, learning vocabulary in context, and making inferences (Alvermann, 2001; Beck & McKeown, 1985; Bean, 2000; Guthrie, Anderson, Aloa, & Rinehart, 1999; Guthrie & Ozgungor, 2002; Meltzer, Smith, & Clark, 2002; Palincsar & Brown, 1984; Pressley, 2002; Rosenshine, Meister, Chapman, 1996). These kinds of strategies have had limited success in improving the reading achievement of the nation's children, especially with respect to advanced levels of reading in core disciplines such as science, history, and literature (Biancarosa & Snow, 2004; Carnegie Council on Advancing Adolescent Literacy, 2009; Council of Chief State School Officer (CCSSO), 2010; National Assessment of Educational Progress, 2009; Organization for Economic Co-operation and Development, 2004, 2006).

Advanced levels of reading in the disciplines, as well as reading to accomplish functional life tasks, have characteristics that are consistent with the demands of the Web and online reading. Efforts to understand the trends in advanced levels of reading achievement for adolescents point to the importance of disciplinary literacy for learning in the content areas and the reality that teachers of science, history, and mathematics do not teach the literacy practices of their disciplines (Moje, 2008). As a result students struggle to apply generic reading strategies to subject-matter texts but without the requisite knowledge to apply these strategies appropriately (Goldman, et al., 2011; Lee & Spratley, 2009). Analyses of the disciplinary literacy practices of experts in specific disciplines reveal that they align with the literacy demands of Web-enabled online reading. That is, specialists in different fields engage with multiple texts and multiple forms of representations in their typical reading practices and they alter their reading practices depending on the purpose for which they are reading (Bazerman, 1985; Moje, 2008; Shanahan & Shanahan, 2008). Differences in the literacy practices between disciplines reflect differences in the way knowledge is constructed in the different disciplines and the forms of representations that are important in different disciplines. For example, chemists pay more attention to multiple representations and how they relate to one another than mathematicians do whereas

mathematicians engage in very close reading of text, especially where formula and derivations of proofs are involved (Shanahan & Shanahan, 2008).

Furthermore, each disciplinary community has established discourse genres and communication norms that govern communication among the members of that community. These are socially constructed and help to maintain the validity and credibility of new knowledge claims and arguments (Goldman & Bisanz, 2002). Thus, from the social perspective the literacy practices within a discipline reflect social, collaborative aspects of literacy. Similarly, Web-based technologies provide opportunities for the formation of collaborative social networks, often dubbed *affinity groups* (Squire, 2006), that operate much like disciplinary communities. They are brought together by common interests and develop norms and language for communicating within the group. Many of these collaborative spaces employ text-based chat rooms, blogs, or comment functions so that "conversational" exchanges employ both reading and writing skills. Much like disciplinary communities, then, the Web enables communities that employ literacy practices to form around shared social and personal as well as intellectual concerns.

The disciplinary perspective on literacy indicates that multiple texts, multiple media, adapting reading practices to meet specific purposes, and collaborative communities are characteristics of the literacy practices of disciplinary specialists and experts. There are clear parallels to Web-enabled reading: The Web and online reading involve purposeful use of resources on the Web to accomplish specific tasks. In the course of doing so, users are frequently confronted with multiple texts, multiple media, and collaborative communities that introduce consistent but also conflicting information on the same topic. Thus, from both the cognitive and social perspective, it is not that Web-enabled learning-through-reading has introduced *new* literacies. What *is* new is that all citizens need to engage in advanced literacy practices and need opportunities to learn them. Thus, the Web and the online resources it makes available are redefining what it means to be literate as a citizen in the 21st century. Like the printing press that made books more widely available, Web technology is raising the bar on what it takes to be literate. There are clear implications of this change for literacy research, scholarship, and instruction.

Implications for Reading Research, Instruction, and Assessment: Opportunities and Challenges

The redefinition and new criteria for being considered literate bring with them opportunities as well as challenges. They challenge our assumptions about models of reading comprehension but provide opportunities for expanding them. They raise the importance of research on gathering and choosing materials to use for particular tasks but provide opportunities to examine such search and selection activities in online contexts. Finally, the challenges and opportunities present us with the need to develop and employ a broader array of methodologies in our attempts to understand literacy as purposeful learning-through-reading multiple sources of information, often in interaction with others.

Models of Reading Comprehension and Text Processing

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The Rand report issued in 2002, depicted a view of reading as an interactive process involving the reader, the text, and the task that occurred in a sociocultural context (RAND, 2002). All four components of this view of reading are impacted by the Web-related changes discussed above. For one, social media and networking sites expand the range of contexts, text types, and purposes of reading as well as writing. In many of these contexts, knowing something about the author of the message is very important to the interpretation and use of the information. For example, people post reviews of restaurants, travel destinations, movies and books. To interpret and know whether or how to act on such information, a reader needs to determine whether or how much to "believe" the review. Knowing something about the background of the review author is information that would be relevant to this evaluation process. There are also interactive websites such as FanFiction.net in which users mimic and expand on published works, creating new details, events, or twists of plot around the original work. Users can build on the contributions of each other, compare contributions to each other or the original work, and enter their own contributions. Comprehension in all of these situations involves thinking and reasoning across multiple texts, the exact nature of which will depend on the user's purpose, prior knowledge, and the types of texts involved. In some of these contexts, the purpose will be to share knowledge; in others, to acquire or modify it.

Similar types of collaborative spaces exist for specific topics in other disciplines (e.g., American History, Chemistry, etc.) although the emphasis tends to be on collaborative discussion of resources such as documents, diagrams, graphs, and visual images to achieve understanding of various events and phenomena rather than on "mimicking" the style of literary works. However, just as with users' reviews or FanFiction contributions, information *about* the source as well as information *in* the source need to be attended to, processed, and represented so they can play a role in what the reader "makes" of the sources in the context of the task or purpose.

Implicit in the discussion thus far is the assumption that readers create mental representations of what they read and try to understand. These mental representations serve as the basis for long-term memory and learning, i.e., knowledge acquisition. They are the *what*—the content—on which thinking and reasoning processes operate. However, the bulk of the research on text representation and use of that information has focused on single texts. To be relevant to reading in the many Web-enabled ways already discussed here, research is needed that expands existing models of text processing and learning to incorporate representations of multiple texts and their interrelationships. These representations will need to include information *about* the source such as who wrote it, when, for what purpose, and in what type of publication outlet, as well as what is *in* the source (Goldman, et al 2010, 2011). A number of researchers have outlined the nature of the expansions that are needed (e.g., Goldman, 2004; Perfetti, Rouet, & Britt, 1999; Rouet, 2006), but most start from what might be termed a modal model of text processing and representation based on the seminal work of Kintsch and colleagues (Kintsch, 1988, 1994, 1998; van Dijk & Kintsch, 1983). According to this model, sentences in text are processed in cycles that produce a single mental representation consisting of multiple levels that reflect

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different aspects of the text, typically referred to as the *surface level,* the *textbase,* and the *situation model.* The surface level is a representation of a more or less verbatim text string. The textbase represents a set of propositions that reflect the explicit content of the text with minimal elaboration and resulting from syntactic analysis and information retrieved via passive activation processes of lexical knowledge (Perfetti & Britt, 1995). The situation model level is a coherent representation of the events or concepts described by the whole text, elaborated with relevant information from memory, activated by resonance mechanisms (Gerrig & McKoon, 1998; Myers & O'Brien, 1998) as well as more strategic mechanisms that help resolve coherence gaps (Coté & Goldman, 1999; Kintsch, 1998; Zwaan, Magliano, & Graesser, 1995). The textbase reflects the meaning of the text whereas the situation model reflects the interpretation of the meaning.

In multiple text situations, readers need at least one additional level, the intertextual level, to capture interrelationships among texts. Information about the source also needs to be represented because it plays a role in interpreting the source and in understanding interrelationships among sources (Rouet, Britt, Caroux, Nivet, & Le Bigot, 2009). Information about the source includes author(s), date of publication, type of publication, and may include the purpose for which the source was written. Such information helps to "locate" the source in time and place and provides insights into the author's intent in producing the source. Source information provides information relevant to determining the reliability and validity of the information in the source. Whether readers can take advantage of this information about the source and how they use it depends on prior knowledge of the content, the function of different text types within the content domain, and the epistemology of the content domain.

Information about the source and how it is used interacts with the types of intertextual relationships among sources of information. Research is needed to develop taxonomies of intertextual relations, how readers process multiple texts to detect these, and what features of texts might "cue" intertextual relations. Examples of intertextual relations include where they agree, where they disagree, where they overlap in terms of content coverage, and whether one elaborates on some subset of information in the other. Furthermore, the types of intertextual relations, as well as their importance can be expected to vary from discipline to discipline, from text set to text set, and across different tasks and purposes, with implications for how discrepancies and inconsistencies are detected and resolved. Suppose, for example, that a reader is searching for a specific piece of information (e.g., the number of planets in the Earth's solar system), and consults three online sources all of which say essentially the same thing. There is no need to process any of the three sources further or look for other sources. However, if the sources provided different answers, the reader might attempt to figure out why they disagreed. This might involve reading more of the information in the source as a whole to see if there is an explanation for the discrepancy; it might involve checking the author, publication venue, and dates of the sources to see if that might explain the discrepancy and be used to resolve it; it might involve reporting that there was a discrepancy that the reader could not resolve. Contrast that with a case in history, where a discrepancy might be explained by when and

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by whom it was written. If source documents were produced at the time of the event by authors who might be assumed to be on different sides of an issue, then differences in how the event is portrayed might be explained by the different perspectives of the two authors. Thus, the resolution of the "discrepancy" could be attributed to the perspectives held by the different authors. Both the science and history examples provided here assume prior knowledge that enables detection of discrepancy, decisions about whether the discrepancy "matters" or not, and strategies for resolving or explaining discrepancies among sources.

The science and history examples illustrate that models of reading comprehension need to be expanded to account for the representation and processing of information about a source and information about the relationships among sources. A similar analysis could be applied to everyday life examples, as in the conflicting movie or restaurant reviews referred to above. In the science and history cases, and sometimes in the case of everyday life examples, readers may lack at least some of the content knowledge as well as knowledge of the types of sources and reasoning heuristics relevant to the content. Here the Web provides an opportunity to support advanced reading comprehension: Its capabilities for linking to related information, background knowledge, and reasoning supports can potentially provide readers with "just in time" assistance.

Research on Search and Selection of Sources

Search and selection of sources is one area of reading comprehension that the Web and availability of online resources have pushed to prominence. Regardless of whether online or in physical library stacks, the information search and selection process consists of two distinct but interrelated phases: specification of search criteria and evaluation of the results of searching (Goldman, et al., 2010). Prior to the dominance of the web, teachers did much of the work of search and selection, although students did have "library classes" where they often learned about the organization of library stacks. However, typically teachers would pre-select sources and bring them to the classroom for the students to choose which they would use to address their particular questions. This resulted in "baskets" of source materials where most of the sources were relevant to at least one area of the larger class inquiry project, few if any sources were completely irrelevant, and the sources covered the range of reading levels reflected in the classroom. Under these circumstances, students often picked sources based on the ones they thought would have the most information about the topic or which contained one of the key words in the title or table of contents (Goldman, 2004; Goldman, Meyerson, Mayfield, Coté, & Bloome, 1999; VanSledright, 2002). If the word was not there, students tended to conclude that the source had nothing on their topic. The idea of generating additional search terms and checking the index of the book were strategies not often observed in classrooms. Thus students used relatively gross screening criteria based on topic relevance and key word searches.

Content and keyword strategies were also evident in early studies of search behavior in hypermedia environments and electronic web-based environments but strategies were not optimized for success (Hirsh 1999; Wallace, Kupperman, Krajcik, & Soloway, 2000). Search terms tended to be too vague or overly specific and there was little

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evidence that results of one search systematically feed into developing the search terms for the next (Wallace, Kupperman, Krajcik, & Soloway, 2000). Nevertheless, keyword strategies are very resilient and drive the selection behavior of both adolescents and undergraduate students (e.g., Wiley, et al. 2009). Even when adolescents had only 25 word summaries of the source content, along with author, date, and place of publication, they relied on keywords and content relevance to select sources to use in an inquiry task (Braasch, et al., 2009).

Evaluation of sources tends to be based on real or apparent content relevance. Many of the studies on source evaluation have asked learners to rate the sources that were available for use in a particular task after the task has been completed (e.g., Britt & Aglinskas, 2002; Goldman, et al., 2010; Rouet, Favart, Britt, & Perfetti, 1997; Wiley, et al., 2009). Findings indicate that evaluation is typically based on relevance of the content to the topic and task, with little reference to other source attributes such as author, publication date, or place of publication. For example, Goldman et al. (2010) asked middle school students to read five social studies texts and to choose the two best sources for answering a target inquiry question. They were additionally asked to provide a post-hoc, open-ended response regarding reasons for their selections. As with older students (Britt & Aglinskas, 2002; Britt et al., 2000; Rouet et al., 1997), Goldman et al. (2010) found that, after reading the full set of sources, middle school students explained their choices based primarily on content information, rarely referring to other attributes of the sources.

The extant research provides a sound evidentiary base for the conclusion that learners make decisions about sources to gather and use based on their apparent content relevance, using the presence of keywords that match with the wording of the task. Although this is a useful initial strategy, readers also need to be able to decide when a source really is not useful to them, even though on the basis of apparent content relevance it seemed initially that it would be. In other words, they need to evaluate whether the information they are getting as they are reading is actually task-relevant. This question is not one on which there is a great deal of research, in part, because simply looking at navigation logs or eye movements is insufficient to understand how and why people choose to leave sources they are reading. For this information, it is necessary to get think-aloud or structured interview data in which readers are encouraged to state the basis for their decisions about continuing on a site as compared to leaving and going to other sites. Some preliminary data on this point do indeed indicate that better learners as compared to poorer are more likely to leave pages that have unreliable information on them and to leave reliable pages with new goals in mind (Goldman, Braasch, Wiley, & Graesser, under review).

A Broader Array of Methodologies. As indicated in the introduction, the Web and online reading expose individuals to a broader array of source materials than was ever possible before the electronic age. This situation means that we need effective ways of understanding how different types of texts and tasks interact and provide readers with access to the content and interpretations they need to address their purpose(s) in reading. When purposes involve disciplinary content (e.g., explaining why some historical event

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occurred) text and task interactions are intimately connected to how knowledge claims are made and supported within a specific discipline, including the thinking and reasoning schemes and text genres used by the discipline (Moje, 2008; Lee & Spratley, 2010; Shanahan & Shanahan, 2008). The Web provides the potential infrastructure for supporting readers in acquiring the competencies they need to engage with the information sources available to them electronically. But there are also challenges around how to support readers in acquiring the habits of mind for learning-through-reading disciplinary text genres, in understanding how they acquire them, and in gathering evidence that they have acquired them. We discuss the opportunities and challenges for developing methodologies for capitalizing on the opportunities afforded by web enabled technologies.

Supporting Disciplinary Learning-through-Reading: Designing Tasks and Text Sets for Complex Comprehension

The multiple source environment created by the Web provides an authentic context for engaging readers in complex comprehension that requires synthesis and integration of information from multiple sources. Even questions of historical "fact" that at one time would have returned single sites and single answers now present a more historically accurate view of the contested nature of history (Wineburg, 2001). A simple demonstration illustrates this point. The website "Ask Jeeves" answers the question "Who discovered America?" with a paragraph explaining that:

> "America was first discovered by the ancestors of Native Americans. Leif Eriksson and Christopher Columbus are among several other people credited with the discovery. Many people have discovered America. Only one can claim to be the real discoverer, because all the others discovered a land already occupied by people. Sadly, the original discoverer's name is lost in the mists of time."
> http://www.ask.com/web?q=Who+Was+the+First+Person+to+Discover+America%3F&o=2821&l=dir&qsrc=3053&dm=all&rq=on" Retrieved 8/8/2011.

This paragraph is followed by a series of Find a Person sites and then by links to eight sites as shown below.

> **Who was the first person to discove**
> **America**
> The **first person** or **people to discover** North **America** was Lief Erickson, about 500 years before Columbus. Lief Erickson established the first settlement on **...**
> wiki.answers.com/Q/Who_was_the_first_person_to_disc
> er...
> Was Christopher Columbus Really the **First** to **Discover America**?

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Did Columbus **find the Americas first**? The short answer is, "No. **....** OMG An evening with Buliwyf, the most beautiful **man** on earth. **...**

shadesbreath.hubpages.com/hub/Was-Christopher-Columbus-...

How Did The Vikings **Discover America**? - Softpedia

Mar 20, 2007 **...** These **people** did not land in North **America**, but they were the **first** to make it out. One of Erik's sons got very interested in the story told **...**

news.softpedia.com/news/How-Did-Vikings-Discove Americ...

John Cabot - Wikipedia on Ask.com

One, from a London-based Venetian, gives Cabot's **first** name as Zuam. **....** a loan from an Italian banking house in London 'to go and **discover** new lands'. **...** In 1897, on the 400th anniversary of Cabot's discovery on North **America**, **...** The letter has a slightly gossipy air to it, written by a **man** who may or may not **...** View article on Wikipedia »

wiki.ask.com/John_Cab

Who really **discovered America**?

Everyone recognizes that many **people** were in **America** long before Columbus. The Asiatic peoples who became Native Americans were certainly the **first**, **...**

www.columbusnavigation.com/disc r.shtml

The point of this demonstration is to illustrate that the Web provides opportunities to expose readers to doing history and not just to some historical canon provided in textbooks. To benefit from the opportunities provided by the Web and Web searches such as this, readers need strategies and heuristics to analyze single texts and integrate across multiple texts in accord with the strategies of reasoning used by historians, specifically sourcing, corroboration, and contextualization (Wineburg, 1991). The Web thus provides opportunities to support students in developing disciplinary literacies.

Of course, tasks such as these, and search queries, need to be designed to provide opportunities for students to learn how to systematically read and evaluate each of the sources and then construct a coherent response based on integrating across sources. The guidance needed for this phase of the work is not afforded by the Web and needs to be an explicit focus of instruction. Otherwise, research indicates that middle school students (Goldman, et al., in press) are very likely to extract one or two lines from a specific source and reproduce it, even if it gives a limited historical view. Furthermore, care needs to be taken to construct questions and tasks that introduce and require the consideration of multiple points of view and/or tap into events and phenomena whose “causes” are contested or about which there exists legitimate alternative claims and evidence that can

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be evaluated according to the norms and principles of knowledge generation in a specific discipline.

Thus the resources provided by the Web, in conjunction with tasks and texts that introduce alternative perspectives and accounts, provide opportunities to engage students in deep and meaningful interaction with multiple sources of historical information. An analogous argument can be made for content information in other disciplines. Supports, tasks, and texts would vary from those in history to reflect the habits of mind, inquiry frames, content, and communication norms for the particular discipline.

Assessing Disciplinary Learning-through-Reading: Expanded Methodologies and Analytic Techniques. Ideally, we would like to know how learning-through-reading happens during a single and over multiple opportunities to engage with multiple sources, how supports function to enable readers to engage in complex comprehension without such supports. Web-enabled technologies provide opportunities to collect data that can address these questions. They make it possible to collect a variety of information about how readers navigate through sites and pages within sites. Eye-tracking systems allow researchers to follow eye-movement patterns across pages and sites. Software such as Camtasia® allows simultaneous screen and audio capture and playback and enables talk-aloud information to be captured and synched with screen movement. These technologies make it possible to track the detailed movements of a reader through a site as well as explanations for those movements. Traditional video or systems like Camtasia® can also capture the interactions of multiple parties at the same site. Online chat and blog environments generate trails of text messages, each tagged to the particular users so that the interaction can be tracked over time. These advances in the data that can be collected using Web-enabled technologies are a distinct advantage for research. But there are also disadvantages to these methods, the most notable of which is the burden of analyzing these data.

To address the analysis burden, we need to turn to automated systems for detecting patterns, displaying multimodal data, and automating or assisting the analysis of oral discourse and written work products. Although humans acquire their first language simply by operating in a linguistic environment, building computer systems to do the same has proven to be quite a challenging problem. Nevertheless, more and more sophisticated data mining systems are under development that should ease the burden of making sense of the data that we are now able to collect. One thing that may facilitate the development of such systems is to have theoretically driven initial hypotheses about meaningful patterns as opposed to having patterns be completely emergent from the raw data. Ultimately for such data mining to be useful beyond research purposes, classroom friendly visualizations and data displays will need to be developed so that the information can be used formatively to guide instructional planning and decision making.

IMPLICATIONS FOR POLICY AND PRACTICE

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Despite the need to develop better tools for research and to make the information more classroom friendly, Web-enabled reading provides many opportunities for meeting the challenges of 21st century literacy. The interactive Web provides opportunities to bridge formal and informal learning environments and build on the knowledge and skills individuals bring to learning situations, a strategy that has proven successful in non-computerized environments (e.g., Lee, 2007). For example, the Web might provide access to cultural artifacts familiar to readers as a means of activating prior declarative and procedural knowledge. Other links might provide expanded explanations of technical terms. In addition, as tools for processing language and patterns become more and more refined and developed it becomes more feasible to elicit information from students in open-ended responses and then automate the analysis of these responses to determine the kind of information or difficulty of text resources that address particular students' strengths and areas in need of improvement. In restricted domains, such systems already exist (Caccamise, Franzke, Eckhoff, Kintsch, & Kintsch, 2007; Graesser, McNamara, & VanLehn, 2005; Meyer & Wijekumar, 2007). Such differentiation of instruction has proven to be difficult for teachers to implement on a consistent basis for a variety of reasons, not the least of which is having accurate and reliable ways of knowing what students know.

Taken together, Web-enabled learning-through-reading creates greater opportunities for producing high school graduates who are prepared with the learning and literacy skills and confidence they need to face the challenges of the 21st century knowledge society. At the same time, Web-enabled learning-through-reading demands that teachers know more about the disciplines they are teaching. They need deeper knowledge of the important ideas in their disciplines and of the patterns of thinking and reasoning about domain specific information that guide the disciplines. We need to think creatively about ways to employ advances in the affordances of technology for professional development for teachers.

Web-enabled access to information resources and the increased prevalence of online reading have redefined what it means to be literate in the 21st century but not by introducing new literacies. Rather, they have made it clear that while the reading "basics" are important, literate citizens of the 21st century must have access to the knowledge and skills that have until now been the purview of only the most highly educated in their disciplines. The expansion discussed in this paper is reflected in the recently published Common Core Standards in English Language Arts, History and Science (CCSSO, 2010) and will soon be reflected in newly designed assessments aligned with these standards.

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