DIGITAL LITERACY

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What is literally *digital* about literacy today is how much of what is read and written has been electronically conveyed as binary strings of one and zeros, before appearing as letters, words, numbers, symbols, and images on the screens and pages of our literate lives. This digital aspect of literacy, invisible to the naked eye, is the very currency that drives the global information economy. Yet what we see of this literacy is remarkably continuous with the literacy of print culture, right down to the very serifs that grace many of the fonts of digital literacy. So begins the paradox that while digital literacy constitutes an entirely new medium for reading and writing, it is but a further extension of what writing first made of language.[1] On the one hand, long-standing scholars of this new medium, such as Donald Leu, favor treating digital literacy as itself a "great transformation," holding that such technologies do nothing less than "rapidly and continuously redefine the nature of literacy."[2] We tend, on the other hand, to look to the continuities and extensions achieved through the introduction of digital literacy into a print culture, while seeking to understand how these developments encourage what is most admirable about the nature of literacy.[3]

To begin with an important historical continuity between print and digital forms of literacy that is often overlooked, much is made of the democratic qualities of digital literacy, as it affords greater access to knowledge as well as the ability to speak out and make one's views widely available. Yet such was the nineteenth-century democratic rallying cry for mobilizing wider participation in print literacy through the public library and public school movements of the day. Certainly, digital literacy carries with it the potential for a far wider, more global access to knowledge, as will be discussed below. As well, Richard A. Lanham has proven all the more right in the decade and a half since he wrote that the "radical democraticization of art and information offered to us by the computer," would be "rigorously opposed by the concepts of fixed property created by print" (1992, p. 242). Within this new realm of digital literacy, however, we are seeing the emergence of *non-proprietary* and *non-market* forces within the networked information economy, to borrow Yochia Benkler's terms (2006), face considerable opposition from among corporate commercial concerns, in an extension of struggles over intellectual property that were no less a part of print culture, rather than a radical or great transformation.

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[1] See Walter Ong on the line between the spoken and written word, in which "more than any other single invention, writing has transformed human consciousness" (1982, p. 78).

[2] Donald Leu has identified three sorts of transformations that most researchers working on this topic tend to support in their work: These researchers focus on how the computer has transformed literacy (e.g., Labbo and Reinking, 1999); or on how the computer and literacy are transformed in a transactional relation; or on how, in Leu's words (2000), "changing technologies for information and communication and changing envisionments for their use rapidly and continuously redefine the nature of literacy" (e.g., Kinzer & Leu, 1997).

[3] The historical continuities of a digital literacy go back to the Western invention of moveable type, when within decades of their its use, type designers were carefully calculating and artfully configuring the geometry of typeface, which eased reading, while adding to the aesthetic quality of the page (Tufte, 2006, 48).

What follows, then, is a roughly chronological discussion of how digital technologies have over the last few decades extended contemporary notions of literacy. For the purpose of this chapter, we break the emergence of digital literacy into three stages: the public uptake of the computer in the 1980s; the rise of hypermedia and the Internet in the 1990s; and the more recent emergence of a networked information economy. We turn more than once to democratic and educational themes as these themes drive what is most interesting and innovative about digital literacy, whether those themes are realized directly through e-government initiatives to create greater transparency and opportunities for interaction, or more generally with increased access and participation in the literate, informed and knowledgeable quality of our lives through the open access movement and the self-publishing technologies of blogs and wikis (Kolbitsch and Maurer 2006). We recognize in what follows, as well, that the new medium does indeed massage the message in aesthetic, as well as political, ways.

Word Processing

The first hint that computers would give rise to a form of *digital literacy* came with the widespread use of the personal computer for word processing during the 1980s. The term *word processing* may have first found its way into print in 1970, according to the *Oxford English Dictionary*, when it was used in the journal *Administrative Management*, suggesting how word processing was originally a secretarial device for the efficient management of other people's texts. However, it was another decade before those who wrote for a living were drawn to how word processing eased the revision and editing process (Zissner, 1983). Or as James Fallows put it, "each maimed and misconceived passage can be made to vanish instantly, by the word or paragraph, leaving a pristine green field on which to make the next attempt" (1982, p. 84). Given as writers are to reflection, it was not long after word processing had caught on that Michael Heim composed a "philosophical study of word processing," in which he considered how "word processing reclaims something of the direct flow of oral discourse," even as it cannot overcome the loss of immediacy that distinguishes written work (1987, p. 209).

In short order, word processing found its way into the schools, first in business education classes (where it replaced the typewriter, much to the relief of everyone involved) and then with students learning how to write across the subject areas (Smith, 1994). As Marilyn Cochran-Smith (1991) notes in her review of the literature on word processing in education, which goes back to 1982, this form of digital literacy became a natural ally of the process-writing model, with its emphasis on student creativity, consultation, revisions and sharing, and its emulation of how real writers write (Daiute, 1985; Edelsky, 1984). The research at the time certainly demonstrated the integral role that word processing played in classrooms using the writing process (Michaels and Bruce, 1989; Calkins, 1983; Graves 1983). On the other hand, large scale surveys in the U.S.A. made it clear that teachers were as likely, based on their educational beliefs, to use computers for drill and practice exercises as they were to use them for open-ended work such as word processing (Wiske et al. 1987). For those who did have their students write with computers, research showed that the ability of students to readily see and comment on each others' work led to improvements in the quality of writing (Bruce, Michaels, and Watson-Gegeo, 1985). Consistent with that finding was research establishing how word

processing also proved itself more conducive to collaborative work among students, as early as the first grade (Heap, 1989; Levin and Boruta, 1983), as well as collaboration among students and teachers in the primary grades (Cochran-Smith, Paris, Khan, 1991). Still, it is worth noting Haas's finding that word processing led to less conceptual planning in the act of writing among both college students and experienced writers (1989).

As well, in those early days, there were those who sought to temper the enthusiasm for what word processing could do for literacy. In his widely cited piece on the "Computer Delusion" in the *Atlantic Monthly,* Todd Oppenheimer quotes one teacher's concern with students' use of word processors: "They don't link ideas," the teacher says, "They just write one thing, and then they write another one, and they don't seem to see or develop the relationships between them" (1997). Some years earlier, Ronald Sudol, a teacher of composition at the university level, noted how professional writers celebrated the trimming and truing of work afforded by word processing, while for students, word processing was about the "capacity to generate and accumulate" rather than cut (1990, p. 920). In support of this idea, Robert Bangert-Drowns found that the 32 experimental studies conducted during the 1980s comparing students from elementary to college level revealed that word processing does lead to greater length of composition, with slight gains in the quality of writing, especially among weak writers, although there was no indication that it led to a more positive attitude toward writing (1993). The studies Bangert-Drowns analyzed did not produce clear results respecting whether word processing reduces the number of mistakes made by school-age writers or on the value of increased revision. Similarly, Cochran-Smith's review of the literature brought to the fore how the numerous instances in which more extensive but "shallow" or microstructural revising that resulted from word processing did not appear to improve the overall *quality* of the work (1991, pp. 124, 141).

So without knowing for sure what word processing has done to our writing, it has become the standard way we write. It does not appear to be "a transitional tool," as Jay Bolter suggested, marking "the transition between conventional writing for print and fully electronic writing" (1992, p. 19). The "electronic writing"–by which Bolter is referring to writing intended to be read on computers involving various forms of hypertext, with more on this below–has certainly become a daily part of what is read and written. Yet it is still all word processing, whether in preparing documents, sending email, creating a blog, with its expanded ability to type, copy, and paste texts, and its ease of revising, formatting, and distribution. That is, in and of itself, word processing's facilitation of writing may perhaps have led to more letters to public officials, better prepared reports in schools, and more elaborate annual family missives during the 1980s, but what it afforded was greatly amplified by Internet applications, especially with the rapid, global uptake of email in the 1990s and the enormous growth of blogs in the 2000s. In this way, word processing contributes to an increase in the amount of written communication and the global reach of this writing.

Hypermedia

Although the uptake of hypermedia by the public dates to the 1980s, with the marketing of programs for personal computers such as Hypercard, the conceptualization of

networked text environments occurred much earlier. Vannevar Bush's visionary article in the *Atlantic Monthly* is generally proclaimed the first iteration of the hypertext concept (Bush, 1945). Contemplating where scientists might turn their energies in the post-war period, and foreshadowing the birth of the *information literacy* movement, which we will discuss shortly, Bush suggests that the growing mass of the human record and our inability to effectively navigate and distribute that record is one of the most pressing concerns of humanity. To combat this problem, he proposes the development of a personal reading machine designed to facilitate information storage and access, and to enable the user to demonstrate connections between discrete documents through associative linking.[4] Some fifteen years later Douglas Englebart resurrected Bush's ideas in proposing a framework for augmenting or "bootstrapping" intellectual development through a method of computer-based information storage that relies upon associative linking of "concept packets" (Engelbart, 1962, p. 60). The paper constitutes one of the first descriptions of hypermedia in the context of modern computing.[5] Ultimately, however, it was self-styled philosopher Theodore Nelson who coined the term "hypertext" in the early 1960s in the context of exploring a somewhat different question: how might writers use computer technology to compare related texts or different versions of the same text (Nelson, 1965)?[6]

For many years hypermedia remained an obscure concept: even when prototypes emerged, they were available only on high-end workstations such as the Sun and Apollo (Wiggins and Shiffer, 1990). This scenario changed in the mid-1980s with the publication of the first electronic encyclopedia by Grolier (Marchionini, 1989). Shortly thereafter, in 1987, Apple released a software product called Hypercard, which allowed users, typically working on stand-alone machines, to create "cards" (nodes containing text and graphics), and to link those cards to others by clicking buttons displayed on the screen. Evidently it was possible to link the cards sequentially, but it was also possible to link them associatively, creating a network of text and image. Bolter (2001) argues that this affordance—text as network—facilitates a particular form of writing: "Electronic writing . . . is not the writing of a place, but rather a writing with places as spatially realized topics" (p. 36).

One of the earliest examples of the use of hypermedia in an educational setting was Intermedia, an extensive hypertext system developed at Brown University in the mid- to late-1980s with a view to facilitating the teaching of literature courses (Kahn, Launhardt, Lenk and Peters, 1990). The network allowed students to access primary and secondary literary materials, and permitted them to contribute comments, texts, and links

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[4] The concept is reminiscent of seventeenth-century inventor Nicolas Grollier de Serviere's sketch of the "reading wheel," a proposed invention for reading wherein multiple texts are set upon the steps of a large wheel, presumably allowing the reader to consult related documents as necessary without leaving his or her seat (see Figure 1—Grollier de Serviere's Reading Wheel).

[5] The roots of hypermedia and the Internet in military culture are significant in contemplating their socio-cultural implications. Bush wrote "As We May Think" while Chairman of the National Defense Research Committee under Roosevelt. Engelbart's report on the augmentation of intellect (Engelbart, 1962) was prepared for the U.S. Air Force Office of Scientific Research during the post-Sputnik period of educational reform legislated by the U.S. National Defense Education Act (1958).

[6] As Bardini (1997) notes, the enterprise of an individual establishing and displaying connections between well-known texts for the purpose of comparison and "version control" is a substantially different literacy act than following established associative links in a massive body of unknown material. Ultimately, Bardini asserts that there are "two cultures, two world-views, at the origin of hypertext" (n.p.).

to these materials (Landow, 1997). In reflecting on his experience teaching with Intermedia, George Landow proposes that hypermedia revolutionizes education by freeing students from teacher-centred classrooms, promoting critical thinking, empowering students, easing the development and dissemination of instructional materials, facilitating interdisciplinary work and collaboration, breaking down arbitrary and elitist textual barriers by making all text worthy and immediately accessible, and introducing students to new forms of academic writing (Landow 1997, p. 219ff.). He also claims that hypermedia blurs the boundaries between reader and writer and is in this sense a form of what Barthes (1974) refers to as "writerly text."

Whether or not we concede Landow's arguments for hypermedia, we must concede that hypermedia extends in significant ways our notions of textuality and literacy. Writing, for example, has long been deemed a way of making the effervescent word tangible (cf. Ong, 1982). Along these lines, Ignace Gelb (1952), a pioneer in the study of writing systems, advocates that writing developed out of "the need for finding a way to convey thoughts and feeling in a form not limited by time or space," and that writing might be defined as "markings on objects or any solid material" (p. 3). The advent of word processing did not particularly challenge this notion because the technology was widely viewed as a means of facilitating the process of preparing documents for printing on paper. Hypermedia, however, gets at the heart of Gelb's definition, for the essence of highly networked documents with multiple pathways lies as much in their linking structures as it does in their content. Such documents are not necessarily amenable to print—or to replication on any solid surface, for that matter. With hypermedia the McLuhan thesis is undeniable.[7] And clearly text displayed on screen falls outside Gelb's definition of marks on solid material. As Hayles (2003) observes, electronic text exists as a "distributed phenomenon," particularly in a network environment, but even when it resides on a stand-alone machine:

> There are data files, programs that call and process the files, hardware functionalities that interpret or compile the programs, and so on. It takes all of these together to produce the electronic text. Omit any one of them, and the text literally cannot be produced. For this reason it would be more accurate to call an electronic text a process rather than an object. (p. 273)

Thus, in the wake of the advent of hypermedia, and particularly with the public uptake of the Internet in the early 1990s, orthographers such as Albertine Gaur (1992) called for a reassessment of definitions such as Gelb's, suggesting that the digital era is in some respects reminiscent of the pre-literate era, for the storage, preservation and dissemination of knowledge "depends no longer on the actual process of writing. Computers store information in an electronic memory by means of positive and negative impulses--the way information was once (during the age of oral tradition) stored in the human brain" (Gaur, 1992, p. 7).

What, then, are the implications of digital technologies for human engagement with the written word? Considering the luminous character of computer display, there is some question as to whether screen reading might itself pose a literacy challenge.

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[7] "The medium is the message" (McLuhan, 1994, p. 7ff.).

Certainly eyestrain has been linked to reading on computer (e.g., Anshel, 1997),[8] and the exceedingly long line lengths that are common in some online environments can be a challenge for readers (Dyson & Haselgrove, 2001). Beyond these considerations, researchers have pondered the affordances of multimedia for learning. For example, Reinking, McKenna, Labbo and Kieffer (1998) proclaim, *inter alia*, that hypermedia is distinguished from its print predecessors because it is interactive, nonlinear, multimedia, and fluid rather than fixed (p. 1). This sort of understanding of the distinctive features of electronic textuality has become popular, but as some critics have observed (e.g., Aarseth, 1997, p. 46ff.), we should be cautious about applying such notions uncritically. The physical properties of earlier technologies for writing such as the codex, for example, do not in and of themselves presume linearity and lack of interactivity. Indeed, it may be argued that books more successfully enable "random access" than their computer-based counterparts, for readers may commence print texts at any point and establish links therein indefinitely. As well, print allows a range of opportunities for interactivity in the form of the addition of intertext or paratext, not least of which is the footnote that acts as a stepping off point into source texts. Archivists have also argued convincingly against the notion of text "fluidity," preferring to think in terms of version control, in keeping with long-established practices of working with variant texts in the humanities (Burk, Kerr & Pope, 2002).

To return to the question of how readers engage hypermedia spaces, Salmerón, Cañas, Kintsch & Fajardo (2005) report contradictory findings in studies published since 1999, which they review; similar conflicting results are noted in studies published from 1990 to 1999, which are reviewed by two research teams (Dillon & Gabbard, 1998; Unz & Hesse, 1999). Further, it is difficult to synthesize this body of literature because of the range of variables: in the case of the text, there are questions of linking structures (e.g., hierarchical or networked), the presence or absence of advance organizers such as maps or overviews, the presence or absence of cues as to link direction, the extent of multimedia integration, and so on; in the case of participants, we must consider expertise with the medium, content-area expertise, learning styles and preferences, and so on. As well, tasks assigned participants in various studies range widely, from simple recall to complex analytical tasks such as essay writing.

With respect to comprehension comparison across hypermedia and paper, Dillon and Gabbard (1998) report that the majority of experimental findings of controlled, quantitative studies demonstrate no significant difference. Exceptions worth noting are studies by Lehto, Zhu, and Carpenter (1995) and Marchionini and Crane (1994), which reported an advantage for hypermedia in terms of the number of references cited in the context of both search and essay tasks, findings that likely reflect the speed and power of electronic searching. As well, Psotka, Kerst, and Westerman (1993) reported an advantage for hypermedia in a study requiring participants to compare visual objects. The hypermedia tool appeared to facilitate the activity because it enabled a number of modes of visual comparison not supported in the print context. Dillon and Gabbard (1998) conclude that hypermedia appears to be best suited to tasks involving "substantial

[8] The problem is primarily with older CRT (cathode ray tube) screens, which have a high degree of flicker; LCD (liquid crystal display) screens, which are backlit and have no flicker, do not pose the same challenge for readers.

amounts of large document manipulation, searching through large texts for specific details, and comparison of visual details among objects" (p. 331).

A second consideration in relation to literacy and hypermedia concerns the effects of networked (or multidirectional) text environments on readers' abilities to navigate information. In the first wave of literature about how hypertext may modify and extend literacy practices, proponents of the medium invoked the associationist argument, suggesting that hypermedia was destined to improve comprehension and motivation because it mimics the associative processes of the mind (e.g., Delany and Gilbert, 1991). Such claims echo the theories put by Bush (1945) and Engelbart (1962) in conceptualizing the medium. Dillon (1996), however, has pointed out that these notions are seriously flawed: first, there is no definitive evidence supporting the hypothesis that facilitating associative thinking might improve comprehension; second, even if we were to concede this premise, it does not follow that a given hypertext mimics or facilitates associative thinking for anyone save the author of that hypertext. As Dobrin (1994, p. 310) explains, "The author's conception of the connection's relevance is not the reader's, and the reader gets lost."

Along these lines, early empirical studies with hypertexts demonstrated that user disorientation may increase in highly associative networks, particularly for novices in the content area. Mohageg (1992), for example, found that highly networked non-hierarchical environments challenged participants and produced a negative effect on task performance. Hierarchical linking, on the other hand, proved most helpful in enabling readers to complete their tasks, while combined networked-hierarchical linking systems fell somewhere in the middle. Mohageg thus advocates against the use of network linking in isolation from hierarchical linking, a position that is supported by several other researchers (e.g., Dee-Lucas & Larkin, 1992; Simpson & McKnight, 1990; Rouet & Levonen, 1996).

In addition, provision for macro-structures such as maps or "fisheye" overviews has been recommended (e.g., Landow, 1991; Kim & Hirtle, 1995; Gray & Sasha, 1989; Foss, 1989; Rouet & Levonen, 1996; Nilsson and Mayer, 2002; Potelle, & Rouet, 2003). Such advance organizers or literacy supports are advocated because they enable readers to discern, variously, the organization of content, the extent of the text and their own location in the text. However, as Salmerón, Cañas, Kintsch & Fajardo (2005) observe on the basis of their extensive review of recent studies, research does not converge respecting whether hierarchical structures and overviews are beneficial for all readers. They point to findings with readers of print texts demonstrating that while readers with low knowledge of the content area benefit from reading texts with a high coherence order, those with high knowledge may learn a great deal more from a text with low coherence order (McNamara & Kintsch, 1996; McNamara, Kintsch, Songer, & Kintsch, 1996). The work of Rand Spiro and his team with hypermedia readers supports this claim. They have shown that domain experts may find immediate utility in relational linking because they are better able to follow connections in a semantic sense, and that the thematic "crisscrossing" afforded by hypermedia documents may encourage readers to apply their knowledge in a more flexible manner (Spiro, Coulson, Feltovich, & Anderson, 1994; Jacobson and Spiro, 1995).

To get at the question of which literacy processes are facilitated or challenged in hypermedia, Salmerón et al (2005) suggest that it is worth framing the literature on

hypertext literacy from the point of view of the construction-integration model of text comprehension (Kintsch, 1988, 1998; Van Dijk & Kintsch, 1983). This model distinguishes between "two of the mental representations that a reader forms from the text: (a) the textbase, a hierarchical propositional representation of the information within the text, and (b) the situation model, a representation of what the text is about that integrates the information with the readers' prior knowledge" (Salmerón et al., 2005, p. 172). Their experimental work with readers demonstrates that knowledge of the textbase is affected by how many nodes are read in a hypermedia environment, but that the situation model is affected by the order in which those nodes are read. This finding supports studies suggesting that domain experts fair better in highly networked environments because they are able to fill in gaps in the situation model with their prior knowledge. While research on the implications of hypermedia for literacy and learning is inconclusive, recent studies such as this point to the need for a more complex analysis that takes into consideration the affordances of various network structures for readers with a variety of learning needs and styles.

Literary Hypermedia

Notably, most studies with hypermedia—all of those alluded to above, and all studies in the literature reviews discussed—examine the way in which readers engage expository or informational texts. While such texts comprise much of what is available in hypermedia environments, it is arguable that some of the most innovative text experiments in online publishing—ones that truly push the boundaries of established conventions of writing, and that work to explore the particular affordances of digital media—have occurred in creative contexts where the literary and design communities converge with a view to generating alternate, innovative, multimedia forms.

One such form is electronic literature, which is defined as a class of "works with important literary aspects that take advantage of the capabilities and contexts provided by the stand-alone or networked computer" (ELO, 2006, n.p.). E-literature includes genres such as hypertext fiction, reactive poetry, blog novels, and collaborative creative writing projects.[9] Older forms, such as hypertext fiction (e.g., Joyce, 1987; Jackson, 1995), are said to derive from text-based adventure games (Bolter, 2001), while emerging genres such as reactive poetry merge literary arts and multimedia design (e.g., Ankerson and Sapnar, 2001). Often presented through Flash, works in this latter class employ animated image and text accompanied by sound in an effort to produce visually dynamic pieces.

Ryan (2005) observes that when it comes to digital texts generated for the purpose of arts and entertainment, particularly those with a narrative component, digital textuality exists in a sort of "split condition." On the one hand are avant-garde forms, such as hypertext fiction and its increasingly multimedia successors; on the other hand are narrative game worlds such as "first-person shooters" (combat games in which players are provided with a first-person view of the action) and Massively Multiplayer Online Role-Playing Games (MMORPGs), which make use of the network capabilities of computer technology to enable multiple players to interact in a virtual world. The first category—the avant-garde—challenge conventional literary structures and often place a

[9] For examples see *The Electronic Literature Collection, Volume One* (Hayles, Montfort, Rettberg & Strickland, 2006).

high processing demand on readers, resulting in limited appeal for the genre beyond circles of intellectual elite with an interest in the deconstruction of conventional aesthetic forms. The second category holds wide appeal for popular culture audiences. Observes Ryan (2005), there is little between the extremes. Digital texts have yet to reach audiences in the "middle of the spectrum," which she defines as the "educated public" who read for pleasure but who nevertheless pursue challenging literary fiction and nonfiction (Ryan, 2005).

Ryan seems to overlook the possibility of readers who fit into more than one category, but nevertheless, her point is well taken: e-literature does not have a mainstream audience. Further, while literacy scholars such as James Gee have contemplated the implications of gaming for literacy and learning (Gee, 2003), there is a dearth of studies examining how the process of literary reading may be modified or extended in the digital realm (Douglas, 2000). Possibly this is because early examples of electronic literature (e.g., hypertext fiction) met with poor reception by many critics, who suggest that the indeterminate, fragmented, open-ended nature of these texts work against our sense of narrative logic and the aesthetics of literary reading, and that examples of the genre lack the quality of their print counterparts (e.g., Platt, 1994; Birkerts, 1994). Hayles (2003), however, cautions against judging e-literature, which is still in the incunabular phase, against the standard set by print genres developed over half a millennium. A more appropriate course of action would be to develop models of reading and aesthetic response that account for the diversity of contemporary literature, both print and digital. As Dobson (2006) observes, many of the theories of reading that guide the thinking of literacy educators with respect to how people engage literary texts are based on studies of readers working with normal prose or conventional narratives (e.g., Chatman, 1978; Rabinowitz, 1987; Kintcsh, 1988). To develop appropriate models for describing the process of reading complex print or digital narratives, it is necessary to examine how people engage these texts and to revise our perspectives of narrative structure, literary reading processes, and methods of teaching literature. This is work that remains to be done.

Computer-mediated Communication

Roughly concurrent with the public uptake of hypermedia and the Internet was the rise of computer-mediated communication. Baron (1998) identifies five different forms of computer-mediated communication: 1) one-to-one dialogue with an identified interlocutor (e.g., electronic mail); 2) one-to-many dialogue with identified interlocutors (e.g., listservs or bulletin boards); 3) postings to the Internet ("finished" pieces made available for public consumption); 4) joint composition (texts written in collaborative spaces); and 5) anonymous dialogue (real-time chat discussion, often within a fictional context in which interlocutors communicate under assumed identities). Notably, Baron's categories do not take account of more recent developments, such as Instant Messaging and text-based communication with handheld digital devices (e.g., "texting"). Nor do they account for how social software applications such as wikis and weblogs have modified the nature of communicative acts such as "posting," which is certainly less formal and more dialogic in a weblog setting than it is in an html setting. Nevertheless,

these categories serve as a useful starting point in considering the implications for literacy of a broad and growing array of communication technologies.

It is widely acknowledged that computer-mediated communication began with the introduction of electronic mail on ARPANET, the first wide-area computer network, in 1971.[10] Human communication was not the intended use of the network, which was designed for resource sharing among researchers. Nevertheless, the application was received enthusiastically by the ARPANET community. Licklider and Vezza (1978) report that by the mid 1970s the ARPANET was becoming a "human-communication medium" with important advantages over the postal service and the telephone: "one could write tersely and type imperfectly, even to an older person in a superior position and even to a person one did not know very well" (Licklider & Vezza, 1978, p. 1331). Licklider and Vezza attributed this informality to the speed of the network, which encouraged individuals to treat the medium like the telephone. Their assessment was confirmed by early research, which demonstrated that speed, convenience, and asynchronicity were the most appealing features of the medium (Schaefermeyer and Sewell, 1988).[11] Foreshadowing the emergence of a form of shorthand that has come to be known, variously, as "emailese," "chat," and "texting," Licklider and Vezza also remarked on increased informality when two users linked their consoles and "typed back and forth to each other in alphanumeric conversation" (p. 1331).

The uptake of electronic mail by the public in the early 1990s generated pronouncements in the popular media that we are presently witnessing the biggest explosion of writing since the age of Johnson (Tierney, 1993). But critics were quick to point out that this writing resurgence was not likely to result in the revitalization of the letter as an art form associated with Johnson's age (e.g., Solomon, 1998). On the contrary, the emerging orthography associated with electronic mail and its cousins, Instant Messaging (IM) and Short Message Service (SMS), is marked by lack of punctuation and capitalization, the omission of vowels, the frequent use of alphanumeric abbreviations (e.g., "cul8r" in the stead of "see you later"), and the addition of paralinguistic footnotes in order to convey tone.[12] To explain this phenomenon, linguists such as Baron (1998) observe that most forms of computer-mediated communication are "speech by other means," marked by a social impulse for speed characteristic of face-to-face communication, a feature that is also noted in the psychology literature (e.g., Gackenback, 1998). As such, these communicative modes employ a cross-modality model, which differs from the dichotomous relationship between speech and writing that is widely assumed (e.g., speech is deemed informal, interpersonal, ephemeral, dialogic, and so on, while writing is deemed formal, personal, durable, monologic and so on). Baron (1998, 2005a) reminds us that this sort of cross-modality model is not unusual: throughout history we can find many examples of texts written for oral performance and

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[10] The Advanced Research Projects Agency Network (ARPANET) was developed by the ARPA of the United States Department of Defense. It was the first operational "packet switching" network, originally designed for resource sharing among researchers. The ARPANET is the forerunner of the Internet (Hafner and Lyon, 1996).

[11] Synchronous communication is distinguished from asynchronous communication: the former requires both communicators to be present at the time of communication (e.g., telephone conversation or chat rooms); the second allows a written or oral message to be delivered to a mailbox, where it awaits receipt.

[12] "Emoticons" (emotion icons) are a form of iconography employing combinations of keyboard symbols to mimic facial expression and gesture.

of oral texts that have been put to the written record. We can also find many examples of primarily oral societies that have produced sophisticated written works. It is not inconceivable, therefore, that increasing reliance on digital modes of communication and the linguistic shifts that such reliance promotes might eventually result in “print culture sans print” or even “print sans print culture” (Baron, 2005a, pp. 28, 29).

Not surprisingly, any contemplation of the implications of computer-mediated communication practices for literacy inevitably leads to a consideration of whether extensive writing in such environments might erode print-based literacy. As Carrington (2005) observes in speaking of instant messaging, discussions in the popular media exhibit a discursive chain linking “txting to youth to declining standards to poor academic achievement to social breakdown” (p. 163). But research does not necessarily support this position. In a review of the literature on computer-mediated communication, Cassell and Tversky (2005) observe that there are conflicting results and a number of significant lacunae. For example, networked computer-based communication is known to facilitate global dialogue, and yet research is sparse with respect to how language functions in cross-cultural online communities. Among the studies to which they allude, Palfreyman & Khalil (2003) have discussed the modification of particular alphabets for the purpose of instant messaging, and Herring (1996) observes a difference in the way men and women communicate, suggesting that the minority gender on a given listserv will conform to the style of the majority. Extending this work, Panyametheekul and Herring (2003) suggest that a similar process occurs in cross-cultural forums. This latter study is "often cited as evidence for the 're-construction' of physical categories such as gender in the apparently disembodied space of the Internet" (Cassell and Tversky (2005, n.p.). Finally, Cassel and Tversky note that although debates continue in the popular media regarding the implications of extensive Internet use for the social and psychological wellbeing of children, studies to date on the matter are inconclusive or contradictory.

Ultimately, Luke and Luke (2001) observe that competence with new technologies—particularly adolescents’ competence with new technologies—is often inappropriately reconstrued as incompetence with print-based literacies. They argue against what they see as the representation of a crisis in print literacy as a means to “delay and sublimate the emergence of new educational paradigms around multiliteracies, around new blended forms of textual and symbolic practice and affiliated modes of identity and social relations” (p. 96). To be sure, language and language use have always been fluid and variable, changing over time and in different socio-cultural contexts. As Hayles (2003) notes, the advent of electronic textuality reminds us of this, inviting us to reconsider our presuppositions about reading and writing, which are infused with assumptions specific to print, to “re-formulate fundamental ideas about texts and, in the process, to see print as well as electronic texts with fresh eyes” (p. 263).

Digital Divide

As the computer became part of a global business and educational culture during the 1980s and early 1990s, discrepancies in who had access to this technology became strikingly apparent. What became widely known as the *digital divide* has been described by Pippa Norris “as shorthand for any and every disparity within the online community,”

including differences in access between developed and developing nations, the rich and poor, as well as men and women within those nations, and even a democratic divide between "those who do, and do not, use the panoply of digital resources to engage, mobilize and participate in public life" (2001, p. 4). This last point has a special poignancy, as digital literacy is so closely connected to the traditional association of literacy and democratic rights, as well as to more specific notions of e-government.

With regard to the gendered dimensions of this divide, Joel Cooper's overview of research published from Australia, Canada, Egypt, Great Britain, Italy, Romania, Spain, and the United States over the last twenty years demonstrates that females have been disadvantaged relative to men in both learning about computers and in computer-assisted learning (2006). If the occasional study found no gender difference (e.g., Solvberg 2002), Cooper still concludes "the weight of the evidence strongly suggests a digital divide that has persisted across time and international boundaries" (Cooper, 2006, p. 321). The research demonstrates that males were faster in taking up computers in the first instance (Maurer, 1994) and then the Internet, leading to a shaping of the medium around their interests (Liff & Shepherd, 2004). Reported reasons for the comparative reluctance of women to take up computers and computer applications range from computer anxiety to negative perceptions of self-efficacy (Brosnan, 1998; Colley, Gale & Harris, 1994; Colley and Comber, 2003; Dundell & Haag, 2002; Farina, Arce, Sobral & Carames, 1991; Temple & Lips, 1989; Todman & Dick, 1993; Whitley, 1997).

Recent international surveys of the digital divide, such as the UCLA World Internet Project, suggest that a gender gap still persists in many parts of the world, being wider in some countries (e.g., Italy, where 20% more men are reported as being online) than in others (e.g., Taiwan, where less than 2% more men are reported as being online) (Lebo & Wolpert, 2004). And yet, a 2003 survey from the US Census Bureau claims that the gender gap is now reversed in that country, both in terms of computer and Internet use. While in 1984 "men's home computer use was 20 percentage points higher than that of women," statistics in 2003 favoured women by 2 percentage points (US Census Bureau, 2003, p. 11). The survey also reports that more women than men use computers and the Internet at work, although this may merely reflect women's prevalence in clerical support jobs.

The gradual closing of the gender gap in many nations has lead some researchers to argue that initial concerns over a digital divide along gender lines were premature and that equity initiatives to promote technology use among women and other so-called disenfranchised groups may not be necessary (Compaine, 2001; Fink and Kenny, 2003); however, simple measures of computer and Internet use, which are often cited to support such claims, do not give an accurate sense of the complexity of the situation. A Canadian examination of computer use in school settings, for example, revealed that although "males and females report relatively similar levels of use, males tend to use computers in more diverse ways, such as programming, using graphics and spreadsheet programs, and desktop publishing" (Looker & Thiessen, 2003). Similarly, Bryson, Petrina, Braundy and de Castell (2003) found that enrolments of males and females in secondary school courses requiring sophisticated use of computers (that is, those uses more likely to lead to careers and positions of leadership in computer technology, such as programming) is severely skewed, with males comprising between 79% and 90% of the student population in senior-level technology courses. Significantly, these numbers are nearly identical to

enrolment patterns observed in such courses in the late 1980s, suggesting that in certain respects there has been very little movement in the gender gap in the last two decades. Ultimately, we suspect that an analysis of who is in the business of maintaining web servers, publishing web materials, designing interfaces, and so on, would likely reveal that a significant digital divide in regards to gender remains. As has been the case with the rise of most communication technologies, from print through television, males are the primary adopters and tend to control the content and format of information diffused through various media irrespective of how audiences change through time (Faulkner, 2001; Graff, 1995).

In economic terms, the digital divide has been measured on an international scale in many forms, with, for example, the likelihood of someone in a high-income country being a regular Internet user being 22 times greater than in a low-income country (*The Digital Divide Report*, 2006). While this divide reflects disparities among nations that have become endemic to the current world economic system, ambitious efforts are underway in developing countries to increase participation in digital literacy through the Internet. In India, the government has recently given $23 million to Mission 2007: Every Village a Knowledge Centre, which will enable, with "training and technical help, local women and men…to add value to information and mobilize both dynamic and generic information on a demand-driven principle" (Swaminathan, 2006). Brazil has a PC Connectado campaign underway that is intended to make computers affordable to low-income families in part by using open source software (Benson, 2005). MIT's Nicholas Negroponte has developed a hundred-dollar laptop, as part of the One Laptop per Child initiative that is intended to help millions of children acquire basic computing power (Varian, 2006a).

Among universities in the developing world, the online availability of journals has proven something of a boon, enabling them to narrow what had become a growing print divide. The modest growth achieved in research library collections during the 1970s was almost entirely lost to currency fluctuations, loss of government support for universities, and well-above-inflation increases in subscription prices in the 1980s and into the 1990s. As journals moved online throughout the 1990s, it was possible for a number of organizations to convince publishers to make their online editions available at no or very little cost to developing countries.[13] By the same turn, programs such as African Journals Online have been able to take advantage of the Internet and open source publishing systems to give an increasingly global presence to journals published in developing countries, with similar programs opening up in South East Asia (Cumming, 2005). It is not that the divide between countries has been overcome or even significantly reduced; rather, the recognition of the problem as fundamental to basic rights around literacy is being addressed by a number of initiatives that are taking direct advantage of digital technologies.

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[13] The World Health Organization worked with publishers to provide free access to, in the first instance, their medical journals (HINARI http://www.who.int/hinari/en/); this was followed by arrangements to secure access to agricultural journals (AGORA http://www.oaresciences.org/en/) and environmental journals (OARE http://www.oaresciences.org/en/). In addition, the International Network for the Availability of Scientific Publications (INASP http://www.inasp.org) has negotiated agreements with publishers to provide access to close to twenty thousand titles across the disciplines to impoverished nations at extremely reduced prices.

Yet more than basic economic issues are at stake when it comes to literate participation online, as the pervasiveness of English on the Internet can form a further point of exclusion. In a good example of how biases and divides are built into the system on a historic basis, the Internet adopted ASCII (American Standard Code for Information Interchange) as its language standard in 1992, which was a code designed to handle North American English alone. It was only gradually superseded by the Unicode standard, which is capable of handling the full extent of the world's writing systems. By 2001, English prevailed with 230 million Internet users, compared to Chinese, the next most frequently used language online, which was deployed by 60 million users (Paolillo, Pimienta, Prado, Mikami, & Fantognon, 2005, p. 60). The interest in creating a more multilingual online environment has found eloquent expression in *Wikipedia*, which represents a publicly constructed encyclopedia with entries in over two hundred languages (discussed further below).

Within the United States, President Bill Clinton spoke in 1996 of the digital divide within the country in his State of the Union message, calling for every library and classroom to be connected to the Internet (1996). And indeed, while the distribution of computers in the nation's homes continues to reflect an economic divide that hampers participation in forms of digital literacy, the schools and libraries of the U.S.A. have become beacons of equitable public access to the Internet (*Public Libraries and the Internet*, 2005). Libraries, especially, have become important access points for more equitable utilization of e-government, especially in times of crisis (Bertot, Jaeger, Langa, & McClure, 2006).

In considering the scope of the divide, we would do well to heed Mark Warschauer's caution that current concerns parallel an earlier interest in the "great literacy divide" between oral and literate cultures, which was the object of anthropological research a few decades ago (2002; see Goody and Watt,1963). Warschauer points out that those who analyze communities' differential access to computers can treat the differences–in a similar pattern to the way that oral and literate cultures were once distinguished–as a matter of "intellectual differences between simple and complex societies," rather than simply as a concentration of specific material resources. Warschauer points to the landmark study by Sylvia Scribner and Michael Cole of the Vai tribe in Liberia, which made it clear that *literacy*, per se, did not have generalizable cognitive benefits (Scribner & Cole, 1981). Yet, Warschauer also sees what he terms *electronic literacies as* a "democratic medium," with that democratic element existing in tension with the Internet's top-down economics, as well as its privileging of English-language and masculine cultures (1999). The growing global dimensions of people's participation in digital literacy, with its economic as well as political implications, suggest that efforts to increase opportunities for access remain a worthwhile human rights goal, much as access to literacy itself has always represented.

New Literacy Studies

Warschauer is hardly alone in drawing attention to how the new uses to which literacy is being put is situated in socio-cultural contexts. Graff (1979), for example, argues that it is not appropriate to characterize literacy as a discrete property that individuals possess or lack in varying degrees; literacy should be viewed, rather, as a set of complex

characteristics and processes that influence and are influenced by social context and personal circumstance. Street (1984) has likewise advocated for viewing literacy as a social practice rather than as acquisition and employment of a particular skill set, an approach that has come to be known as the *New Literacy Studies* (Gee, 1991; Street, 1995). In summarizing his own work on the subject, Street (2003, p. 77) observes that the New Literacy Studies recognizes the existence of "multiple literacies" and the social practices with which those literacies become associated. It is a movement that seeks to problematize what counts as literacy. This paradigm shift in literacy studies through the last half-century is referred to by Gee (1999) as the "social turn," and may be equated with the work of, among others, Graff (1979), Heath (1983), Street (1984), Willinsky (1990), Gee (1991), and Barton (1994).

Drawing on and expanding this tradition, The New London Group (1996) has introduced the term "multiliteracies" with a view to accounting not only for the cultural and linguistic diversity of increasingly globalized societies and the plurality of texts that are exchanged in this context, but for the "burgeoning variety of text forms associated with information and multimedia technologies" (p. 60). Distinguishing multiliteracies from what they term "mere literacy" (a focus on letters), the group calls for attendance to broad forms of representation, as well as to the value of these forms of representation in different cultural contexts. They also call for attendance to the dynamic nature of "language and other modes of meaning," which are "constantly being remade by their users as they work to achieve their various cultural purposes" (Cope & Kalantzis, 2000, p. 5)

Digital technologies are associated with this movement both in terms of their facilitation of global, intercultural exchange, which leads to the convergence of peoples and languages in online communities, and in terms of the way in which they allow for the convergence of a range of media, thereby affording multiple modes of representation. Along these lines, Lankshear has proposed that "technological literacies" (what we term digital literacy) may be defined as "social practices in which texts (i.e., meaningful stretches of language) are constructed, transmitted, received, modified, shared (and otherwise engaged), with processes employing codes which are digitized electronically" (Lankshear, 1997, p. 141). These social practices are undertaken through the means of computers and a range of hand-held devices. Engaging in meaning-making and communication in the digital age therefore entails becoming well-versed in different semiotic modes, visual, textual, and verbal (Kress & van Leeuwen, 1996; 2001).

For Kress (2000), one outcome of this convergence of media is a dominance of the screen. He evokes the image of the twelve-year-old child who "lives in a communicational web structured by a variety of media of communication and of modes of communication" (p. 143). In this scenario, remarks Kress, "the 'screen' may be becoming dominant" and the "visual mode may be coming to have priority over the written, while language-as-speech has new functions in relation to all of these" (p. 143). Bolter (2001, pp. 47ff) has likewise identified a "breakout of the visual" in digital culture, viewing this as the continuation of a trend favoring icon over alphabet already evolving in print, television and cinema—one that has been documented by previous scholars (Gombrich, 1982; Mitchell, 1994; Jameson, 1991). Moreover, Manovich (2001) has observed that visual objects in the digital realm have an unusual quality, often having been achieved through "compositing," a process by which the whole is attained through

combining a number of disparate elements. Thus, what appears to the user as a single Web "page," or even a single image on a web page, may in fact be comprised of many files that are stored as separate units in the file structure and displayed by the browser according to an arrangement specified in the page code. In considering this feature of digital media, Walton (2004) contemplates the significance of the difference between the designer's and user's interface with the Web. While users generally encounter Web pages as seamless visual artifacts, she observes, "Designers see the Web in its raw, uncomposited state, and work with separate components which they must construct into a whole. They can see the seams of the design and its component pieces: their view reveals the artifact as constructed and composite" (p. 167). Digital literacy, therefore, assumes visual literacy and entails both the ability to comprehend what is represented and the ability to comprehend the internal logics and encoding schemes of that representation (cf. Dobson, 2005).[14]

Digital Archives

One of the great dreams surrounding Western literacy was born in the third century BCE, when Ptolemy II, King of Egypt, came to support the wildly ambitious idea of gathering a copy of all the world's texts in the *Musaion* or temple that his father built in Alexandria. Here was the idea of a complete and universal library, which has haunted the committed reader's imagination ever since.[15] This dream has taken on new force with digital literacy, beginning with Michael S. Hart's typing of the *United States Declaration of Independence* into a networked computer at the University of Illinois in 1971, and then making it available to the entire network, thereby initiating what has since grown into Project Gutenburg, which currently offers readers free online editions of 18,000 books that have been entered and checked by volunteers (Hart 1992). Project Gutenberg was inspired by "dreams of increased world literacy and education," as its website describes, and it was but the first of many expressions of this urge to turn the Internet into a universal library. Google announced its Google Print Library Project in 2004, with the goal of placing the contents online of the libraries at the University of Michigan, Harvard University, Stanford University, Oxford University, and the New York Public Library, for a total of 25-30 million books. For the roughly 15 percent of books in these libraries that are in the public domain, readers would have complete access, while for books still subject to copyright restrictions, readers would be able to see only excerpts and a few lines around keywords for which they search (Varian 2006b).[16] Other book digitization

[14] Wileman (1993) defines visual literacy as "the ability to 'read,' interpret, and understand information presented in pictorial or graphic images" (p. 114). He associates this form of literacy with visual thinking: "the ability to turn information of all types into pictures, graphics, or forms that help communicate the information" (p. 114).

[15] The idea of a universal library was introduced earlier in this chapter with Vannevar Bush's sketch of the "memex," a machine that would take advantage of new technologies through which "a library of a million volumes could be compressed into one end of a desk," even as "Wholly new forms of encyclopedias will appear, ready made with a mesh of associative trails running through them, ready to be dropped into the memex and there amplified" (1945). It is also vividly realized in fiction by Jorge Luis Borges (1962).

[16] At this point, Google is being sued by the Authors Guild of America and the Association of American Publishers, in a dispute over *fair use*, a concept which has played such a vital part in the development of print literacy (Ganley, 2006). Fair use is what enables writers to copy, cite, and thus engage another's copyrighted work without having to compensate the cited author. Insofar as writing is so often about what

projects, such as Project Gutenberg, the Open Content Alliance and the Million Book Project (which is also distinguished because the vast majority of books are in languages other than English, with India and China playing leading roles), have taken the more cautious approach of digitizing only material for which copyright is no longer an issue. Today, the sheer quantity and range of texts that are now available online has become a defining aspect of digital literacy.

Against these rising expectations of access to knowledge, a struggle has emerged within the scholarly literature between traditional economic models of relatively expensive access to journals and an *open access* model that seeks to add this body of work to the universal library open to all readers, which is developing online. In 1991, Paul Ginsparg, a physicist at the Los Alomos National Laboratory, established what is now known as arXiv.org ASD, a freely accessible database for posting high-energy physics "preprints" that were going to be or had been published in the field's traditional journals. The database grew over the decade from a small collection of documents accessed by a community of 200 users to an archive that was receiving 40,000 papers a month in the areas of physics, mathematics, computer science and quantitative biology (Pinfield, 2001). As a result, as Ginsparg put it, "the communication of research results occurs on a dramatically accelerated timescale and much of the waste of the hardcopy distribution scheme is eliminated" (1996).

Of course, the "hardcopy distribution scheme" that Ginsparg refers to has since been transformed into an online distribution scheme of journals, so that the same published and peer-reviewed paper may be available through a subscription journal in a research library's online collection and through an open access database like arXiv.org or on the author's website. The majority of journal publishers now permit their authors to post copies of their published work in such archives or on their websites, and many journals offer authors a right to purchase open access for their article within the online edition of the journal. Still other journals make their contents open access without charge to authors or readers, either immediately on publication or some time after first making the articles available to subscribers.[17]

The resulting increase in open access to this research has meant that it is read and cited earlier and more often (Harnad and Brody, 2004; Eysenbach, 2006). The new economics of open access to this archived body of research is having a profound impact on scholars in developing countries, as discussed above. It is also leading to a greater uptake of this work by the public, professionals, and policymakers (Willinsky, 2006). This is especially the case in the area of health and life science research, where greater access to knowledge is changing the practice of medicine (Murray, Lo, Pollack, Donelan, Catania, White, Zapert, & Turner, 2003; Diaz, Griffith, Ng, Reinert, Friedmann, & Moulton, 2002; Fox & Rainee, 2000).

Still, the proportion of the scholarly literature that is open access is still less than 25 percent, by most estimates (e.g., Harnad, 2005). The vast majority of this work is only

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others have written, a well-defined and not overly parsimonious sense of fair use is necessary to a literary economy.

[17] On institutional repositories, see Harnad (2005), and on the publisher's policies permitting authors to post work published in their journals in open access institutional repositories or on their websites, see SHERPA (http://www.sherpa.ac.uk/). In addition, see Morrison & Waller (2006) and Byrd, Bader & Mazzaschi (2005) on scholarly journals that make their contents freely available to readers, either immediately or after a period of time.

available through well-endowed research libraries, with no one library providing access to it all. Most faculty members have yet to take advantage of publishers' self-archiving policies to post copies of their published work in their library's open access archive or on their own website. That is, the scholarly wing of the universal library is still a long way from being fully open, but it has, at least, demonstrated that digital literacy holds for readers vast new realms of knowledge and a general right to that knowledge. At the same time that the open access movement has gained a hold on the scholarly literature, there are similar movements afoot in Benkler's realm of the non-market and non-proprietary approaches to the networked information economy (2006). These include the emergence of open source biology (Maurer, 2003) and open data release policies (Rowen, Wong, Lane & Hood, 2000), as well as Creative Commons and Wikipedia, discussed below, all of which speak to the development of a knowledge commons that is at once an integral feature of the democratic and educational qualities of digital literacy.

Information Literacy

As digital literacy is leading to significant increases in the quantity and range of information that can be readily accessed, new technologies are adding to the convenience, speed, and accuracy with which readers can work with this wide variety of information sources. Not only is there an ability to locate a single word or phrase in a mountain of digital documents, but electronic indexes and databases enable readers to readily sort through centuries worth of publications, finding relevant materials on a given theme. That is, digital literacy can be cast, to a considerable extent, as a form of *information literacy* that demands skilled navigating through, searching for, and making sense of relevant and reliable information. Or, as Richard A. Lanham noted in *Scientific American*, "the word 'literacy,' meaning the ability to read and write, has gradually extended its grasp in the digital age until it has come to mean the ability to understand information, however presented" (1995, p. 198).

Much as with the concept of word processing, the idea of an *information literacy* was first proposed by those industries that made the sale of information their business in the 1970s (Webber and Johnson, 2000, p. 382). However, it was not long before the idea was to find its larger home within the library community, as a way of making sense of what was required to operate within the new information systems. In 1989, the American Library Association offered a definition of *information literacy* that, while it was technology-free, had an obvious bearing on the growing digitization of information resources: "To be information literate, a person must be able to recognize when information is needed, and have the ability to locate, evaluate, and use effectively the needed information" (ALA, 1989). Such abilities are no less pertinent within print culture, but what has changed over the last two decades, particularly with the development of user-friendly Internet search engines in the early 1990s, is the enormous growth in the digital information resources that are suddenly at far more people's fingertips.[18]

Now, some within the information science community have suggested that the library community's focus on information literacy represents an effort to consolidate, if not extend, the work that they had been doing for years with programs in library skills

[18] A review of Internet search engine development is provided by Schwartz (1998).

and bibliographic studies (Foster 1993; Miller, 1992). Certainly, information literacy, no less than digital literacy, is an instance of the general proliferation of literacies.[19] It can seem to be based, as Macrum charges (2002), on too simple of a model for information in which the literate move from data through information to knowledge (for an example see Bruce, 1997), and it is perhaps too much to ask of a literacy that it include, as Marcum also points out, a "competency with tools, resources, the research process, emerging technologies, critical thinking and an understanding of the publishing industry and social structures that produce information products" (2002, p. 20).

Yet the library community has brought to the fore an awareness of *information literacy* that speaks to increasing opportunities, and needs, for readers to now find their own way across a plethora of information resources and to be able to do so outside of the traditionally supportive bounds of libraries, publishers, and educational institutions. It is a further instance, in that sense, of literacy as a skill not just for decoding text, but for locating texts and establishing the relationship among them. There is something to this approach that parallels the Protestant advocacy of literacy education focused around reading the Bible on one's own (Luke, 1989). Jay Lemeke provides a similar emphasis on the independence at issue with information literacy when he encourages teachers to pursue a "metamedia literacy" with students, which places the emphasis on "access to information, rather than the imposition of learning" (1989, p, 293).[20] This digital form of information literacy would further equip readers in their independent pursuit of a greater understanding, providing them with search and reading strategies for navigating among sources and for dealing with related issues of source reliability, intellectual property, and access rights.[21]

Collaborative Knowledge

A further aspect of the Internet's enormous capacity for the distributed accumulation of knowledge has come with the introduction of software designed to facilitate collaborating on and sharing of information online (O'Reilly, 2005; Alexander, 2006; Bleicher, 2006). Bryan Alexander (2006) provides a comprehensive review of Internet-based projects and collaborative services that are associated with what has come to be known as the "Web 2.0" movement.[22] Alexander notes that from the start many Internet technologies, such as listservs, discussion software, chat spaces and so forth, have been profoundly social, linking communities and individuals around the world. Extending this trend, a group of Internet-based services and projects that is deemed particularly connective has emerged

[19] Snavely and Cooper, for example, identify 35 current types of literacy, from agricultural literacy to world literacy (1997, p. 12). See, as well, the discussion of multiliteracies above.

[20] Lemeke opposes metamedia literacy to what he identifies as the "curricular paradigm," which "assumes that someone else will decide what you need to know, and will arrange for you to learn it in a fixed order and on a fixed timetable"; the interactive paradigm, he is advocating, is "how people with power and resources choose to learn" with results that are "usually useful for business or scholarship" (1998, p. 293).

[21] See Baldwin, for example, on the standards of scientific and technical information literacy: "Understands the flow of scientific information and the scientific information life cycle" (2005, p. 120).

[22] O'Reilly (2005) observes that the concept of "Web 2.0" began with a brainstorming session between O'Reilly and MediaLive International respecting the bursting of the dot.com bubble: "Dale Dougherty, web pioneer and O'Reilly VP, noted that far from having "crashed", the web was more important than ever, with exciting new applications and sites popping up with surprising regularity" (n.p.). Many of the sites and services that survived the dot.com collapse come within the rubric of social software.

in the last five years. These services, collectively termed “social software,” include “weblogs, wikis, trackback, podcasting, videoblogs, and enough social networking tools like MySpace and Facebook to give rise to an abbreviation mocking their prevalence: YASN (Yet Another Social Network)” (Alexander, 2006, p. 33).

Alexander observes that much social software is “predicated on microcontent”; in the case of weblogs, for example, the unit of import is the “post” not the “page.” This altered rhetoric, he suggests, has “helped shape a different audience, the blogging public, with its emergent social practices of blogrolling, extensive hyperlinking, and discussion threads attached not to pages but to content chunks within them” (2006, p. 33). Similarly, wiki software allows for the creation of collaborative, networked, online writing spaces that are remarkably easy for communities of users to edit on an ongoing basis. The trend in online knowledge creation appears to be toward “mass amateurization” (Shirky, 2002; Coates, 2003), a scenario wherein activities once reserved for professional publishers and writers (e.g., journalists, essayists, columnists, critics, pundits, and so on) are taken up by the public *en masse*.

While it is by no means clear what the online literacy economy will look like as it emerges from this formative period in the coming years, it is apparent that there are forces arrayed for increasing public access to and participation in the production of digital texts of every sort, which remains a critical democratic element behind this form of literacy. This increased access is bound to have an effect on how people read and write. One of the strongest, if not strangest, examples of how this digital medium is altering people’s relationship to knowledge generally is what can be described as the *Wikipedia* phenomenon.

Wikipedia represents what is perhaps most new about digital literacy. It ranks among the *impossible public goods* that this new age has created, with open source software, such as Apache and Linux, foremost among those goods, as this software is made freely available with countless people contributing to its development and improvement. In the case of *Wikipedia*, thousands of people all over the world are freely collaborating in creating the world’s largest encyclopedia, and doing so with minimal governance, a policy of maintaining a neutral point of view, and a growing multilingual reach (as noted above). In the process, it is challenging our basic literacy notions of authorship and intellectual property. Historian Roy Rosenzweig points out how the “Roosevelt entry, for example, emerged over four years as five hundred authors made about one thousand edits” (2006). Although rules and policies exist for creating entries, as well as rarely invoked policies for locking down articles and banning authors, the project is run, as Rosenzweig notes, “somewhat in the style of 1960s participatory democracy.” And if the quality of the writing is uneven as a result of so many hands, *Wikipedia*’s accuracy has been pronounced “surprisingly good” by the editors of *Nature* magazine who conducted a study of it, and ultimately advised that “researchers should read Wikipedia cautiously and amend it enthusiastically” (Wiki’s Wild World, 2005).

In another notable feature for students of digital literacy, *Wikipedia* entries are accompanied by a “discussion” page for contributors and readers to make suggestions and debate issues (whether, for example, Copernicus is rightly considered Polish, German or Prussian), as well as a “history” page that records all of the changes that have been made to the entry. These meta-pages make up about a quarter of the site’s content and speak to yet another educational aspect of this collaborative digital literacy (Schiff, 2006,

p. 41). This sense of public contribution to the representation of knowledge has been taken up, as well, through another Web 2.0 phenomenon known as "folksonomy" (as opposed to taxonomy). Here, people are coming together to share their own classification and indexing of online materials (Alexander, 2006). While traditional metadata classifications are typically hierarchical, structured, and predetermined by content authorities, folksonomic metadata is generated on the fly by users. For example, "social bookmarking" tools such as Furl and del.icio.us allow individuals to create collections of bookmarks, each of which may be "tagged" or categorized with keywords in accordance with the user's interests. When individuals add bookmarks to their lists, the entries are automatically linked to other lists sharing the entry or tag in common, and those collections, in turn, are searched for related sites. Services like del.icio.us thereby allow individuals to learn from and respond to one another's indexing tags, facilitating an inherently social form of information management and exchange.

Social software constitutes a fairly substantial answer to the question of how digital literacy differs from and extends the work of print literacy. It speaks to how people's *literacy* combines the taking in and giving back of words. The contributions that people are making to various collective commons sites extend the connection well beyond what was afforded by print culture, even with its more radically democratic and accessible forms of expression through pamphlets, broadsides, graffiti, mimeographing and photocopying. This writing back to what had been read, and this writing outside of the principal and official media forms has always been a part of literacy's public side. *Wikipedia* in particular provides a constant localization, in languages, places, events, and works, within this otherwise global phenomenon.[23] The very scale of participation in *Wikipedia*–with a 100,000 edits a day at this point–and the resulting quality of work signal a milestone in the long history of the public's literate engagement with knowledge.

Conclusion

We are aware of having painted a fairly Whiggish picture of digital literacy's emergence over the last three decades, having tended to treat it as another step forward in the long road of literate development. Digital literacy does appear to be leading to greater literate participation in a wide range of activities, brought on by the ease of writing, greater linking of ideas and texts, and at least the promise of universal access to knowledge. Caught up in the emergence of this medium, we understandably want to highlight and encourage what we find most valuable about this new form. Certainly, serious challenges persist in realizing the benefits of digital literacy across this increasingly global society.

The digital divide may have narrowed over the last two decades as online access has improved through public libraries and Internet cafés, but the opportunity to use this technology remains very much part of a larger landscape of economic disparities and gender biases. There are also dangers of government and employer surveillance and tracking, which have long marked literacy's progress across the ages (Stone, 2007). And there are a number of groups with criminal intent (e.g., fraud, child pornography, terrorism, and so on) that advance their cause with the help of digital forms of literacy

[23] See Josef Kolbitsch and Herman Maurer who write that the "[*Wikipedia*] distorts reality and creates an imbalance in that it emphasizes 'local heroes'" (2006, 196).

(Wall, 2001). Further, it is not yet clear that the open access movement and other open content initiatives, which have begun to increase access to scholarly and other work for scholars and the wider public, will prevail against commercial concerns, including the growing corporate concentration in the publishing of academic journals, which is driving up the cost of access to this knowledge. And there are very real issues around too much information, in the form of inundated mailboxes clogged with spam and a World Wide Web that can seem at times overwhelmingly wide, if less than very deep.

Against all of that, however, we are still not inclined to temper our enthusiasm for identifying and supporting what is most promising in the emergence of digital literacy. In the past ten years, the image of the Internet as a "Wild West" publishing zone, where anything goes (and goes all too quickly), has faded. To be sure, the Internet has lowered cost and distribution barriers to publishing, so that works can gain wide access without going through the traditional apparatuses of scrutiny, such as editors and publishers. But one has only to think of the hand-printed pamphlet and broadside to realize that the urge for unfettered expression had its homology in print culture, if without the element of global access. At the same time, the most respectable pillars of periodical culture, whether the newspapers of record or the academy's peer-reviewed journals, now have online editions. To publish an article or essay today in a respectable periodical is to publish electronically. Moreover, digitization projects such as Project Gutenberg, the Million Book Project, JSTOR, the Blake Archive, and the Perseus Digital Library, to name but a few, are placing a substantial portion of the human record in print online on a permanent and well-supported basis.

For these and other reasons, setting digital literacy's anarchy and ephemeral nature against print literacy's orthodoxy and authority has become a late-twentieth century perspective. It is now clear that in respect to the range of genres – from tabloids to scholarly treatises – the digital realm is similar to print, and is similarly engaged in all of the craft and care that has long gone into the production of knowledge (see, for example, Johns, 1989). Vigilance is called for, certainly, in recognizing that we are all part of what is giving historical shape to this new medium of expression, especially as it breadth of participation is that much greater than with print. We must attend to where exactly and by what means digital literacy can be said to be furthering, or impeding, educational and democratic, as well as creative and literary, ends. There can be no guessing in advance exactly what such contributions to the public good will look like. For that reason, the nature and value of digital literacy should continue to be the subject of public interest and scholarly inquiry.

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