Digital Wave[1]

Introduction

In Stanley Kubrick's' renowned 1968 science fiction film, *2001: A Space Odyssey*, a computer named HAL (Heuristically Programmed Algorithmic Computer) controls operations on a group of scientists' extraordinary venture into space. Demonstrating his artificial intelligence capabilities—which include natural language processing, voice and face recognition, and an ability to reason as well as make judgements—HAL introduces himself to the crew: "I am a HAL 9000 computer. I became operational at the H-A-L plant in Urbana, Illinois on the 12th of January, 1992." The film's plot hinges on the crucial moment when the crew's judgement is perceived as conflicting with HAL's logic, at which point HAL proceeds to override them—in some cases by cutting off their life support. While the movie is set in the future, it is noteworthy that the technology as well as the human-interface tensions had already emerged at the time of its release. In conjunction with its imagined journey into deep space, the film was thus adept at envisioning developments with computers that now seem commonplace—anticipating the shifts in our digital worlds and the more pervasive and encompassing role of computers and the media in our lives.

It is interesting that the film situated HAL's origins in Urbana—the home of the University of Illinois, where Rob and David spent several years involved in interdisciplinary pursuits with scientists engaged in advancing digital developments. The University of Illinois was a hub of some major developments in the use of computers as learning tools, and many of these pursuits drew upon work in reading comprehension and digital teaching approaches to explore natural language processing in particular. Indeed, 1968—the year of the film's release—represents a historic marker in terms of one of the university's more noted developments, PLATO (Programmed Logic for Automated Teaching Operations). Developed in the 1960s by a team at the Computer-based Educational Research Laboratory (CERL), PLATO offered a multiuser platform with random access capability, including precursors to what are now

[1] This chapter befits a moment in time, given what appears to be the everchanging, deictic nature of our digital literacies (Leu, 2000).

recognized as chat rooms, touch screens, visual and audio interfaces, and various gaming functions (i.e., role playing avatars and precursors to Dungeons and Dragons, Warcraft, and others). Not surprisingly, PLATO spurred a large and formidable digital community of users, akin to affinity groups, throughout the period of its use until 2006.

Like the other developments in this book, the digital advances we see today have their origins in waves that began to take form over 100 years ago. The realization of their power and influence upon our literacy lives, however, only took a recognizable shape in the last 40 years with technological improvements, software developments and breakthroughs in design—most notably with the introduction of Hypertext and its multimodal capabilities (as can be instantiated on the internet, games etc.). We begin with a discussion of some of the more significant early waves of technology and software development before shifting to the superwave that changed the path of digital literacy: Hypermedia, which changed our literacies forever. It changed how we make meaning, how we engage with one another, how we develop our personal and cultural identities. and how we as humans interact with machines.

Introduction to Digital Technologies

Prior to what we have designated as the Digital Advance, digital technology was seen as a complement to learning rather than an integrated component of it. Educational technology therefore focused upon how programmable technologies could be used as aids to learning. Broadly speaking, these included programmed learning-based analyses of the sequence of learning; technological adjuncts to learning (e.g., clicker responses, when teaching is interrupted by a polling of students); and an emphasis in schools on teaching coding (sometimes coupled with instruction on robotics and simulations). In terms of literacy, programs focused on designing aids for reading and writing development. For example, we saw a range of software developments to support writing (e.g., Quill, initially developed by Andee Rubin and Bertram Bruce) and reading development (e.g., speech recognition by Don Nix and his colleagues).

However, these appeared to operate as adjuncts to classroom learning, with the goal of increasing reading or writing fluency (Nix, Fairweather, & Adams, 1998; Rubin & Bruce, 1984; 1985). At the same time, studies of the computer-based reading have perseverated on comparisons between on-screen and off-screen reading of the text equivalent of reading PDF

documents. Even nowadays there is a tendency to do such comparisons while ignoring the various forms that digital texts can assume (e.g., Delgado, Vargas, Ackerman, & Salmerón, 2018; Singer & Alexander, 2017). Furthermore—and, perhaps, ironically—most of the measures enlisted to assess students' reading and writing progress alongside these aids and forms were and sometimes still are paper and pencil. It is only quite recently that tests reflected and integrated digital forms.

In the latter half of the twentieth century, developments in hardware and software spurred shifts related to data analysis and word processing. Earlier breakthrough inventions of transistors, chip technology, connectivity, portability and computer programming language initially set the stage for the digital spaces that are nowadays pervasive in our everyday lives. A sampling of some key developments in hardware and software is shown in Table 9b.1.

Table 9b.1

Hardware Developments

1820s-1830s: Charles Babbage creates designs for the first mechanical computers with memory, operational procedures, conditional jumps, etc. Although left undeveloped, the designs were foundational to later developments.

1936: Alan Turing introduces the notion of a universal machine, the Turing machine, for computing anything. Some suggest this was the basis for the modern computer.

1937: J.V. Atanasoff, a professor of physics and mathematics at Iowa State University, attempts to build the first computer without gears, cams, belts or shafts.

1939: Hewlett-Packard is founded by David Packard and Bill Hewlett in a garage in Palo Alto, California.

1947: William Shockley, John Bardeen and Walter Brattain of Bell Laboratories invent the transistor, an electronic switch with solid materials and no need for a vacuum.

1947-49: The first functional computers are developed—e.g., the Harvard Mark 1 and the Manchester Mark 1 (nicknamed "The Baby").

1958: Jack Kilby and Robert Noyce unveil the integrated circuit, known as the computer chip.

Software: Computer Language Developments, Connectivity and Advent of Personal Computers

1953: Grace Hopper develops the first computer language, COBOL (Common-Business-Oriented Language).

1954: The FORTRAN computer language (FORmula TRANslation) is introduced, beginning its wide use for statistical analyses.

1956: Informational processing language is developed by Newell, Shaw and Simon at Carnegie Mellon Institute of Technology and the Rand Corporation.

1958: The programming language LISP is developed and used by a number of artificial intelligence scholars as a better fit for language representation, making links, and offering connective links with recursive functions.

1964: Douglas Engelbart shows a prototype of the modern computer that is more accessible to a wider public, with a mouse and a graphical user interface (GUI**)**.

1967: LOGO is developed at the research firm Bolt, Beranek and Newman, and Seymour Papert advocates for its use in schools. In his 1980 book *Mindstorms: Children, Computers and Powerful Ideas*, Papert discusses using computers in conjunction with constructivist ideas.

1969: C Programming Language is used by a group of developers at Bell Labs to produce the Unix operating system, addressing compatibility issues across multiple platforms. Unix became operating system of choice among mainframes at large companies and government entities.

1971: Alan Shugart from IBM invents the floppy disk, allowing data to be shared among computers.

1973: Robert Metcalfe at Xerox develops Ethernet for connecting multiple computers and other hardware.

1974-1977: A number of personal computers are introduced and made available to the public (e.g., Altair, IBM 5100, Radio Shack's TRS-80).

1975: Following a *Popular Electronics* feature on the Altair 8080, Paul Allen and Bill Gates write software for the Altair, using the new BASIC language. On April 4, Gates and Allen form their own software company, Microsoft.

1976: Steve Jobs and Steve Wozniak roll out the Apple I, the first computer with a single-circuit board—thus starting Apple Computer.

1978: VisiCalc, the first computerized spreadsheet program, is introduced.

1979: Bob Barnaby, with MicroPro International, releases WordStar—the first word processing program.

1981: The first IBM personal computer, code-named "Acorn," is introduced.

1983: Apple's Lisa is the first personal computer with drop-down menu and icons.

1986: Compaq brings the Deskpro 386 to market. Its 32-bit architecture provides personal computer users with speeds comparable to mainframes.

1990s: Mobile devices (laptops and smart phones) become possible as transistor technologies, lithium batteries, etc. improve—following developments by Microsoft, Research in Motion, Nokia, Apple, and others.

Digital Literacies: Hypermedia, Worldwide Web and New Literacies

Digital literacies arose in tandem with the advent of and access to hypermedia and these aforementioned developments. These new technologies and forms of architecture for digital spaces afforded multimodal possibilities that, over the last 30 years, have intertwined with shifts in our literacies and our personal, social, economic, and political lives. They have provided the foundational structures for what became known as the world wide web and internet, the basis for social media platforms (from Facebook to Instagram), and the hub for online gaming communities. And, as technology itself has shifted—replacing the mainstay of static print with such multimodal, multilayered interconnections—we in turn have become increasingly tethered to new digital tools that have redesigned how ideas are represented and accessed. In particular, the development of HyperCard and Hypertext had a monumental influence on the nature and shape of literacy today by providing the means for the multimodal and multilayered architecture of text. Such shifts were harbingers of what has been deemed a "post-typographic world," wherein type and visuals co-communicate ideas and information (e.g., Reinking, McKenna, Labbo, & Kieffer, 1998). As Reinking (1998) noted in his introduction to the landmark edited

volume, *Handbook of Literacy and Technology: Transformations in a Post-Typographic World*, there were four significant shifts:

1. "Electronic and printed texts are qualitatively different" (p. xxiv).
2. "There is an important sociocultural and historical dimension to considering the relation between technology and literacy" (p. xxv).
3. "The new technologies of electronic reading and writing are slowly but steadily transforming classrooms, schools, and instruction" (p. (xxv).
4. "There is a dearth of research and scholarship available to understand and guide technological transformations of literacy" (p. xxvii).

These developments also occurred in tandem with an emerging interdisciplinary interest in how readers make meaning of extended text, how they navigate multilayered multimodal presentations of information, and how they produce, consume, and communicate ideas. From its early days, the digital advance involved scholars engaged in literacy research to explore language and text processing and programming language (i.e., to process how text and the architecture of complex ideas is navigated by learners and experts). This overlapped with what we have outlined as the cognitive turn, bringing together scholars such as linguists, cognitive scientists, text analysts and a number of the first and second generations of artificial intelligence researchers. By developing the construct of the oral and written language scripts and plans that humans use to organize experience and ideas, researchers in artificial intelligence (e.g., Roger Schank and Robert Abelson) were able to develop approaches to language processing—relying upon research emanating from cognitive science.[2]

[2] Many of the major computer laboratories that focused upon teaching and learning with digital resources were developed by early cognitivists—specifically those with an interest in informational processing and reading and writing research. Stanford University and Xerox Research Laboratory in Palo Alto were two such think-tanks for some of these developments. At Stanford, for instance, Terry Winograd's (Winograd, 1980; Winograd & Flores, 1987) study of knowledge access and use proved foundational to two of his students who later founded Google. John Seely Brown, along with scholars like David Rumelhart, helped Roy Pea establish the Stanford Human Sciences and Technologies Advanced Research Institute. Elsewhere, John Bransford advanced the Learning Technology Centre and the Cognition and Technology Group at Vanderbilt University and later at the University of Washington. Other notable units were established at Bank Street College, Northwestern University and the University of Connecticut, alongside a host of collaborative initiatives with the major computer companies (e.g., Microsoft, Apple, IBM) and selected foundations (e.g., Macarthur Foundation, George Lucas Foundation, and the Gates Foundation). These engagements spurred interest in educational matters, but also contributed to immensely fertile discussions of and developments related to digital spaces that encompassed multimodal, multimedia-based, multilayered and networking of ideas and people.

Hypermedia. It is notable that these developments undergirded what some consider to be the advent of digital literacies: Hypermedia. The development of Hypertext and its influence on literacy was profound. As David Reinking (1997) demonstrated Hypertext provides a means to express ourselves in ways that reflect more directly the complexity of our thinking and the interrelatedness of ideas. Hypertext allows authors and groups of authors to link information together, create paths through a corpus of related material, annotate existing texts, and create notes that point readers either to bibliographic data or to the body of reference material. At the same time, hypertext blurs the distinction between author and reader by inviting readers to navigate their way via links including perhaps their own additions. As Yankelovich, Meyrowitz, and van Dam (1985) note, "Hypertext can allow the creation of an automated encyclopedia of sorts: readers can browse through linked, cross-referenced, annotated text in an orderly but sequential manner" (p. 18). Additionally, as users create texts, they develop spaces for themselves and others—befitting Vygotsky's (1978) notion that tools such as language or other sign symbols mediate our interactions with the world. In particular, with the advent of Hypertext, users have access to an authoring tool that allows for the following:

- Unfolding ideas through buttons, scrolling, and other means by which authors can stage when and where ideas are displayed;
- Creating links between ideas (for example, embeddings) that allow for various forms of relationships (i.e., definitional, illustrative, or critical), such that compositions or textual spaces are, as Bolter (2001) has argued, "pulsing networks of ideas;"
- Providing multimodality—the dynamic and graphic presentation of ideas by interfacing alphabetic texts with nonlogocentric media, such as graphics, animation, or video;

In turn, a number of scholars at the Center for the Study of Reading (e.g., Andrew Ortony, Phil Cohen, Allan Collins, Bertram Bruce) were also members of what was emerging as a field focused on artificial intelligence. They brought to the Center cutting-edge thinking regarding computer-based reasoning and communication. Mostly, these scholars were interested in whether we might be able to define how we make meaning. In this pursuit, they asked whether our understandings might be formulated in ways that might be replicated on computers. To develop these scripts and delve into these issues in preliminary ways, they drew upon a mix of schema-based determinations of background knowledge along with knowledge of pragmatics, semantics, and syntactical structures. (Similarly, Noam Chomsky was initially hired by the Massachusetts Institute of Technology in the hopes that he might apply his theories of language development and use to computers.) To program a computer to understand natural language, researchers and institutions sought to draw upon cognitive studies of reading comprehension of extended text.

- Supporting access to resources and their incorporation in ways that are both malleable and complex;
- Furthering a relationship with readers that is collaborative and portfolio-esque, as stacks offer multiple layers and multiple explorations and engagements;
- Affording asynchronized access to ideas and communications.

In terms of literacy, as Hull and Nelson (2005) advanced:

> All about us, there are unmistakable signs that what counts as a text…have already changed and radically so—in this our age of digitally-afforded multimodality. … it's possible now to easily integrate words with images and sound and music and movement in order to create digital artifacts that do not necessarily privilege linguistic forms of signification, but rather that draw upon a variety of modalities—speech, writing, image, gesture, sound—to create different forms of meaning.… through a process of braiding (Mitchell, 2004) or orchestration (Kress & van Leeuwen, 2001), a multimodal text can create a different system of signification, one that transcends the collective contribution of its constituent parts. More simply put, multimodality can afford not just a new way to make meaning, but a different kind of meaning. (pp. 224-225)

As Siegel (1995) likewise suggested, these multimedia explorations have "a generative power that comes from juxtaposing different ways of knowing … as a way of positioning students as knowledge makers and reflective inquirers" (p. 473). Or, as Witte (1992) notes, "the influence of alternative intertexts on the constructive processes increases dramatically as the multiple voices of distinct constructive semioses mix on what might be called the battleground of the 'trace.' It is for this reason that … all discourse … is fundamentally dialogical" (pp. 287–288). The dynamic afforded by Hypertext befits what Forman (1998) has described as "the type of constructive conflict we deem to be the power of this multisymbolic approach to education" (p. 187). It corresponds to a kind of semiotic engagement that provides students access to multiple symbol systems, which allow for ongoing learning through analogies or metaphor. As Lemke (2015) contends, when students interact with multimedia text, there is "an amplifying effect."

With the multilayering and intermingling of text forms with images, Hypertext prompted a shift that carried with it new requirements for meaning making. It was as if meaning makers

were confronted with an expanding set of new genres to navigate. Further, as meaning makers shifted from working with a single text to those of connected multiple texts, involving new forms of syntheses or remixing, their active roles become more apparent. For example, based upon her work and that of her colleagues across a number of studies examining synthesizing from multiple print sources, Spivey (1997) suggests that with HyperCard and Hypertext the following applies:

> People make across-text linkages and topical jumps, and they generate relations from one text to another as they do their transformation. The kind of intertextual connections that are so visible when people work in Hypertext environments are the kinds of transformations that we have been considering… (pp. 209–210).

Essentially, with the introduction of Hypertext, technology expanded beyond being a tool that expedited data analysis and word processing to a platform that supported different forms of representation, communication, and meaning making.[3] In many ways, Hypertext was the architecture for ways of knowing and interacting with new norms and conventions befitting multimodal forms mixing image and text. Despite its initial clunkiness, it garnered momentum in the 1980s before proliferating in early 90s, as the advent of the World Wide Web (made possible through Hypertext) gave everyday users the opportunity to engage with the technology.[4]

[3] The first Hypermedia application is generally considered to be the Aspen Movie Map, implemented in 1978. The Movie Map allowed users to arbitrarily choose which way they wished to drive in a virtual cityscape (in two seasons, derived from actual photographs) and 3D polygons.

[4] Key developments in the digital advance included the advent of Hypermedia (Hypertext and HyperCard) and the widespread access to this software with the release of the Macintosh computer. A sampling of these developments include:

1963: Ted Nelson coins the terms Hypertext and Hypermedia to represent linked content and developed a text editing system.

1960s and 1970s: Various incarnations of IN emerge as tools for linking documents and communities with shared interests (e.g., Abdrie van Damm at Brown University and Tom Englebart at Stanford Research Institute).

1980: Tim Berners-Lee creates ENQUIRE, an early Hypertext database system, somewhat like a wiki but without Hypertext punctuation. Wiki is not invented until 1987.

1980s: A number of experimental "hyperediting" functions in word processors and hypermedia programs emerge, with many features similar to what became the World Wide Web.

1982: Peter J. Brown of the University of Kent develops the first significant Hypertext system for personal computers.

1980: Robert Busso, an Italian Jesuit Priest, with support from the founder of IBM, develops a tool for pursuing massive searches on Thomas Aquinas work and publishes the *Index Thomisticus*,

1983: Ben Shneideman (University of Maryland) and his colleagues develop the HyperTies system, which is commercialized and used to create the first commercial electronic book, *Hypertext Hands-On!*

With the emergence of the web browser—and its explosion from only 500 known web servers in 1993 to over 10,000 in 1994—Hypertext became the basis for what became our web based digital engagements. These engagements, as John Callow (2010) suggested in his comparison of screen and page-based texts, entailed the following:

> The web page has multiple hyperlinks—we seen them both on the top and side menu bars and in more content-specific subheadings or tabs placed about the main body of text. There has been much research done on online comprehension skills and the choices made by students when navigating the Internet for information. Locating relevant information and critically evaluating hyperlinks are key skills in an online environment. If we compare the print page to the web page, in some ways the use of the smaller call-out boxes on the bottom right of the double page does a similar job to the hyperlinked tabs on the web page. Each takes the reader to more specific information. From a reader's point of view, how are either the call-out boxes or the hyperlinks supporting a clear understanding of information about the topic? Do they elaborate on the information or extend and present more depth? They may be purely decorative, tangential or, at worst, irrelevant to the main topic. (p. 109).[5]

Table 9b.2 provides an overview of these developments.

1986: Bill Atkinson creates HyperCard, released by Apple in August.
1987: With the understanding that it would be given for free on all Macs, Apple releases HyperCard with Macintosh computers. Apple also provides high school students in Apple Classrooms of Tomorrow with beta versions of HyperCard for purposes of pursuing multimedia projects, enabling them to enlist random accessible laser disks as complements to the Macintosh computers.
1989: Tim Berners-Lee, a scientist at CERN (Conseil européen pour la recherche nucléaire), proposes and later prototypes a new Hypertext project in response to a request for a simple, immediate, information-sharing facility to be used among physicists working at CERN and other academic institutions. He calls the project "WorldWideWeb."
Late 1990s: HyperCard of Hypertext more broadly becomes a key influence in the design of the Web.

[5] Burbules and Callister (1996) warn:

> …. many readers of Hypertext end up browsing or performing the textual equivalent of "channel surfing": quickly scanning or surveying randomly accessed information, in very short snippets, with no overall sense of coherence or meaning for what they are exposed to. A novice encountering a complex Hypertext system for the first time cannot possibly know what information the system contains, without happening to come across it through searching or guesswork. (pp. 24–25)

Similarly, Oras Snyder (1998) argued that with Hypertext, meaning makers may be constrained by a kind of labyrinth and proceed from one text to the next and one link to the next gingerly—lest they become lost, at a dead end, or miss what they perceive to be a key item.

Table 9b.2

Web Development, Multimedia, and Gaming

1985: The first dot-com domain name is registered on March 15, years before the World Wide Web would mark the formal beginning of Internet history. The Symbolics Computer Company, a small Massachusetts computer manufacturer, registers Symbolics.com. More than two years later, only 100 dot-coms had been registered.

1990: Tim Berners-Lee, a researcher at CERN, the high-energy physics laboratory in Geneva, develops Hypertext Markup Language (HTML), giving rise to the World Wide Web.

1993: The Pentium microprocessor advances the use of graphics and music on PCs.

1994: PCs become gaming machines as "Command & Conquer," "Alone in the Dark 2," "Theme Park," "Magic Carpet," "Descent" and "Little Big Adventure" are among the games to hit the market.

1996: Sergey Brin and Larry Page develop the Google search engine at Stanford University.

1999: The term Wi-Fi becomes part of the computing language and users begin connecting to the Internet without wires.

2001: Apple unveils the Mac OS X operating system, which provides protected memory architecture and pre-emptive multi-tasking, among other benefits. Not to be outdone, Microsoft rolls out Windows XP, which has a significantly redesigned GUI.

2004: Mozilla's Firefox 1.0 challenges Microsoft's Internet Explorer, the dominant Web browser. Facebook, a social networking site, launches.

2005: YouTube, a video sharing service, is founded. Google acquires Android, a Linux-based mobile phone operating system.

2006: Apple introduces the MacBook Pro, its first Intel-based, dual-core mobile computer, as well as an Intel-based iMac. Nintendo's Wii game console hits the market.

2007: The Blackberry, iPhone and other companies bring many computer functions to the smartphone.

Web Based Explorations. Befitting the proliferation of the web and its use for meaning making in the digital realm, we saw the emergence of studies that examined these hypermedia environments. For example, a study by Coiro and Dobler (2007) examined the online comprehension strategies (via think-alouds, responses to semi-structured interview tasks and other responses) of successful sixth-grade comprehenders. Students engaged with a preset Internet site dealing with the topic of tigers as an assignment prompting search engine usage. The architecture of the online material, especially with hyperlinks and the use of thumbnails and annotations, seemed to prompt the use of such features to assist with the navigation of the texts. Based upon their findings, Coiro and Dobler (2007) suggested that one of the key distinctions between online and offline comprehension is tied to the more frequent use of forward inferencing (versus backward inferencing)—prompted at the point of a Hypertext link. They link this usage to a more multilayered inferential engagement among online meaning makers. As they stated:

> The skilled readers in our study engaged in a multi-layered inferential reading process that occurred across the three-dimensional spaces of Internet text … combining traditionally conceived inferential reasoning strategies with a new understanding that the relevant information may be "hidden' beneath several layers of links on a website as opposed to one visible layer of information in a printed book. (p. 234)

They also suggested that "… internet reading seems to demand more attempts to infer, predict and evaluate reading choices … to require readers to orient themselves in a new and dynamic three-dimensional space … to figure out how to get back to where they were" (Coiro & Dobler, 2007, p. 234). Thus, they concluded, the self-regulation of online comprehension seems tied to a similar set of recursive strategies of past models of composing (e.g., Tierney & Pearson, 1983). Online comprehension involves planning within and across websites, predicting and following leads, monitoring how and where to proceed and evaluating relevance and judging merits. They noted that there were physical dimensions associated with these activities (e.g., scrolling, clicking) and speculated that the online environment might be more demanding and complex than offline. In some ways, these results support the characterization of online comprehension as more likely to be aligned within the author(s) frame(s) or labyrinth(s) at the

same time as it entails agility with being able to navigate, search, select and integrate across sources. As Coiro and Dobler (2007) noted:

> Our findings suggest that the greater complexities in online reading comprehension may result largely from a process of self-directed text construction; that is, the process online readers use to comprehend what they read as they search for the Internet text(s) most relevant to their reading needs.
>
> On one level, we observed skilled readers engaged in an ongoing "self-directed" planning process involving a series of inferences about what would best fit with their internal representation of the text's meaning. Simultaneously, on a second level, these readers constructed their own external texts. Each decision about which link was most relevant involved constructing the next element in the text they built. We observed readers actively anticipating and monitoring the relevancy of each new text unit, while quickly deciding whether to continue to add that text to their own external text by following deeper links within a page or to exclude that text and search elsewhere by clicking the back button as a fix-up strategy, for example. At the end of the reading session, it became clear that each reader had constructed not only his or her internal understanding of a certain text but had also constructed a unique external representation of the Internet texts most applicable to their needs. (p. 241)

They contrasted this observation with:

> Readers who do not strategically plan and anticipate where they are headed within open Internet spaces may end up constructing a disjointed collection of random texts as opposed to a systematic compilation of carefully chosen texts from which to sift out a relevant point. Thus, an increased need to make forward inferences about text appeared to compound an already complex process of making bridging inferences about content in a manner that may prompt additional complexities to the process of reading online. (p. 241)

In Coiro and Dobler's study, the online demands of meaning making appeared to prompt what they labeled forward inferencing, or a form of making predictions, as meaning makers attempted to navigate the layers of text or information that the text template and online

navigational tools might suggest. Forward inferencing seems to arise in conjunction with an interest in determining where links might lead and in assessing the possible saliency of what may be uncovered, especially by a hyperlink. When using search engines, the students often relied on annotations offered with hyperlinks derived from the search as a means of assessing degree of relevance or the likelihood that an identified site would yield more or less relevant results.

Coiro and Dobler (2007) further conjectured that online comprehension could be differentiated from offline comprehension in a number of ways. First, as meaning making proceeded online, meaning making involved knowledge of topic and knowledge of print informational text structures akin to offline comprehension; in contrast, it involved knowledge of informational Web site structures as well as search engines. Such influenced how they navigated the text including the physical nature of their approach (e.g., returns to the home page). Second, online comprehension involved—to a degree—similar and different inferential strategies. In response to questions that were set, the meaning makers use of context and other text cues was akin to that of offline comprehenders when exploring texts. But, as suggested, there was more forward inferencing involved as one chose what path to follow.

Teresa Dobson's research on reading Hypertext novels exhibited similar findings—especially with regard to the nature of the influence of Hypertext architecture upon the approach and strategies of the meaning maker. She has done extensive probing of adolescents' responses to selected Hypertext novels which are literary in nature (e.g., Dobson & Luce-Kapler, 2005; Luce-Kapler, Dobson, Sumara, & Davis, 2006; Dobson, 2007). Her observations of and comments by her students indicated that Hypertext novels provoked more self-consciousness of the reader's role in meaning making and a great deal of emphasis upon reading in a fashion which might be considered text dependent or author-centric. She suggested, in her subsequent work with wikis, that meaning makers engage in their own development of these structures seem to shift in their attitude (Dobson, 2004). As she stated:

> … in my current work with students reading Hypertexts and writing collaboratively and individually) in malleable "wiki" writing spaces, I often find those who are exceedingly critical of Hypertext structures as readers become wholly engaged as writers, often delighting in engaging the rhetorical ploys they previously eschewed. (pp. 17–18)

Observations of high schoolers from the Apple Classroom of Tomorrow who were engaged in Hypertext projects suggested similar tendencies (Galindo, Tierney, & Stowell, 1989; Tierney, Kieffer, Whalin, Desai, Moss, Harris, & Hopper, 1997). Students displayed a similar preoccupation with form and the possibility of engaging the use of special effects drawn from their exposure to pop culture. The students appeared to approach Hypertext with more questions and more interest and more concern over form (e.g., the layering of material with links and interface with video) than the regular print-based projects. They viewed the advantages of the Hypertext as allowing them to design a space that affords different forms of engagement for others (e.g., especially with a kind of edginess). Perhaps more profound were the lasting effect upon the students. When interviewed several years later, it was obvious that for these early users, these projects constituted far more than an engagement with a new genre or access to enlivened integration of image and text. The technology was a springboard into a life that was shaped by new affordances with new forms of literacy. This shift went beyond performing meaning making drawn from the web—it affected how they integrate its uses personally, in their studies, and professionally (Tierney, Bond & Bresler, 2006).

In recent years, studies of digital reading have expanded to address a range of other dimensions, including the ability of students to make critical judgments of the material that they might access—for example, judgments related to its credibility. In a study of a large pool of students from a range of schools, Turner, Hicks and Zucker (2020) explored the approach—especially the means of evaluation—that students enlisted for judging web-based resources en route to suggesting how educators might better prepare them to do so.

Living in the Media: Embodiment.[6] For many of us nowadays, digital technologies permeate our lives. As Rob and Richard Beach (2018) suggested:

> Our daily lives are inseparable from the events and affordances of our handheld devices, Web-based interactions, and participation in various virtual spaces. We are in the media age; our existence as individuals, groups, and societies occurs in various media rather than with media (p.136.)

[6] Embodiment here denotes Csordas' (1999) use of the term—"an existential condition" (p. 143) that grows out of subjectivities, alliances, and choices and influences one's engagement with ideas, the strategies one employs, and how one connects with others.

We enlist digital tools 24/7 as information retrieval devices, vehicles for communications and transactions, portals for entertainment and culture, platforms for building social and identity relationships, and launchpads for how we position and identify ourselves and engage with our virtual experiences on screen (especially in conjunction with virtual associations, such as role playing in games like Second Life and other settings. See also: Thomas, 2007; Kim, 2016; Schallert et al., 2016). We also pay for goods and services online; and our work life often has the feel of being in a digital studio with an array of tools—akin to having a palate on our computers. We have moved from fixed usage of uni-dimensional software that constrain our responses to sites that involve critical and creative responses, including forms of vicarious participation, reaction or networking—synchronized and asynchronized. As Hepp and Krotz (2014) aptly summarized, we operate in "mediatized worlds" … "structured fragments of social lifeworlds with a certain binding intersubjective knowledge inventory, with specific social practices and cultural thickenings. Mediatized worlds are the everyday concretization of media cultures and media societies" (p. 8).

Perhaps more significant, our digitally-based social lives are not just extended by digital exchanges. They are integral to our identity formations and our experiences as social beings at various levels (both local and global, intimate and afar). Our digitally-based social engagements—emails, text messaging, direct and indirect communications by web chats, social media, or professional networks, and collaborative projects or exchanges within local or global communities—have contributed to a heightening of collaboration and forms of shared, "spreadable" (see Jenkins, Ford, & Green, 2013), and collective meaning making. Our digital engagements may involve transactions with fellow meaning makers, or collaborators, and with digital authors—virtually and face-to-face, synchronized and a-synchronized. For instance, Henry Jenkins and his colleagues (Jenkins et al., 2008) introduced the notion of participatory culture to describe the social meaning making emerging across digital environments As Jenkins et al. (2008) noted, "participatory culture shifts the focus of literacy from individual expression to community involvement. The new literacies almost all involve social skills developed through collaboration and networking" (p. xiii). Adding to this, platforms for online learning have often provided avatars and other forms of scaffolding to support different forms of collaborations.

More intimately, the social spill over to identity and personae play extends to text messages and avatars, the formation of affinity groups, and the collaborative nature and possibilities of internet projects. For example, Lewis and Fabos (2005) found that when adolescents instant message, they may shift their personae and identity to match a perceived relationship or exhibit a desire to attempt such a shift (e.g., from confidante to advisor, cynic, or empathetic supporter, depending on the participants). As Lewis and Fabos (2005) stated, "…they enact identities that depend upon a running analysis of the online and offline contexts" (p. 494). Wade and Fauske (2004), from their observations of online discussions, suggest individuals are "not passive reproducers in creating their identities their use of language and other social choices … language choices can be thought of as strategies designed to achieve particular goals in a particular context" (p. 140).

In a related vein, as Sefton-Green (2013) found, youth compose by appropriating different elements from various sources for their own creative and sometimes critical use via "snatching" and then adapting—"remixing" content for their own signature compositions to be shared with others. A number of researchers studying youth responses to and uses of media (e.g., Beach, Castek, & Scott, 2017; Napoli & Sychterz, 2015; Phelan, 2014; Unsworth, 2008; Wiesner, 2006) have noted similar forms of appropriation and adaption in conjunction with students' enlistment and adaptation of digital modes, as well as their instantiations of responses—from aesthetic and other forms of engagement—with a range of multimodal texts.

In the digital realm, meaning-making spaces for expressing ideas have proliferated (e.g., text messaging, tweets, blogs, chatrooms, listservs, and affinity groups, and in combinations of online and offline spaces that can extend one's community, collaborators, or audience. These spaces are not all the same; some can serve simply as a means of checking on schedules, locations or facts or for exchanging information or sharing or uniting with people with similar interests (akin to fan clubs or groups of fellow gamers). As such, these engagements can be incidental or more substantial. For example, Ito et al. (2013) explored digital media and its role in shaping identity and affinity (e.g., through connections made via fan culture). But these engagements can also be supportive, subversive, or even perverse—seeking allegiance to certain causes or used to bully, shame, or exclude.

Indeed, the issue of audience or fellow meaning makers can become especially pronounced if they extend beyond an intended audience or consumer or user. Participation and

postings may be less restricted than intended and less sacrosanct as presupposed. If exchanges are across cultures, they are apt to involve a myriad of negotiations, attempts, and transactions—especially when image and text and a host of semiotic meaning offerings may not fall outside of the possibly ego-centric indulgences of digital correspondents. Glynda Hull and Amy Stornaiuolo (2014), in an article on cosmopolitan literacies, offered a powerful demonstration of these dimensions through the digital video and text exchanges they recorded between Indian and New York high schoolers as the students explored each other's worlds.

Alternatively, several scholars (Rogers & Winters, 2006; Alvermann, Hagood, & Williams, 2001; and Hull & Nelson, 2005) have argued that providing access to these multimedia environments may open up new and transformative spaces and identities. Students are afforded the possibility of having their literacy practices travel across spaces, in and out of schools—to "juxtapose and transform genre practices for critical purposes, engage in the playful instability of genres, selves, and messages, and re-narrate their stories and identities in the process" (Rogers & Winters, 2006, p. 29). In some ways, these multiple engagements befit the view of meaning makers as a kind of multivocal and multiperspectival pursuer of understandings, akin to what was suggested by Barthes, or other views of the social construction of multiple meanings. That is, the meaning maker is engaged in constructing selves or multiple personas in the company of others—as a form of embodiment. Quoting Lorri Neilsen, Alvermann, Moon, and Hagood (1999) contend that these "symbolic resources not only help adolescents to make sense of their experiences, but they also offer opportunities for trying on or taking up often multiple and conflicting roles or identities. In this way, a text is both a window and a door" (p. 13).

In their study of primary students' engagements in a virtual world, Burnett and Merchant (2014) illustrated in detail how students can navigate various spaces in such a multiplicative fashion.[7] As they describe:

> The virtual world in this case was 'Barnsborough', a secure virtual world built by virtuallylearning.co.uk in the Active Worlds Educational Universe (www.activeworlds.com). Developed by a group of educators, researchers and

[7] Drawing on Massey's (2005) theory of space and the work of Leander and Sheehy (2004), Cathy Burnett and colleagues (Burnett, 2014; Burnett and Merchant, 2014) have similarly highlighted the power of online interactions across borders, including those involving virtual worlds.

> consultants, it was designed to provide opportunities for children to engage in literacy activities within a meaningful and motivating context (Merchant, 2009, 2010). 'Barnsborough' itself is a three-dimensional simulation of a deserted town, which children can explore, visiting interconnected locations such as sewers, a park, the town hall, an Internet cafe, military headquarters and an old castle. As they move around the world, they encounter clues hinting at why the town is deserted in the form of dropped notes, Internet sites, graffiti, posters and so on. Children are represented as avatars on-screen and have access to an online chat function through which they can communicate with others. Chat items appear not only above avatars' heads but also on an ongoing scrolling chatlog at the bottom of the screen. They can access other functions, such as teleporting or flying between different locations. (p.38)

They note in particular how "...incidents, individuals, objects or places are not completely in either the material or virtual world, and nor do they jump between. Instead, the virtual seems to inflect the material and vice versa" (p. 38). As they demonstrate in their example of one student:

> John could be seen as in a 'world of his own' but not in the sense that his exploration of the virtual world sets him apart from the rest. He moves both in the classroom and in Barnsborough; his laptop is both a physical object in the classroom and the portal to the virtual world; he interacts with others both in and out of world. At the same time, the class- room frames not only what he does in physical space but also what he does online. The 'world of his own' is perhaps the one he helps construct as he operates across both environments and helps sustain a space that allows both movement and stillness, both autonomy and compliance, both material and virtual actions. Importantly then, these are not parallel plural places inhabited by parallel plural identities. Instead, as Law writes, we can understand this in terms of a multiplicity that 'implies that different realities overlap and interface with one another. Their relations, partially coordinated, are complex and messy' (Law, 2004, p. 61). (p.43)

Burnett and Merchant (2014) detail how offline and online engagements can seem inseparable. As they suggest, there is a mobility to ideas, rather than a boundedness; the students' engagements seemed changing and fluid due to the interactions, relationships, and

trajectories created through the meshing of online and offline spaces; and students drew from both offline and online experiences to layer their virtual experiences. As they explain, John's online and offline engagements support each other:

> John reads and responds to the chatlog in the light of his particular journey through Barnsborough or talks to his friends, he fuses together action and interaction both in-world and in the classroom. We see this as he switches between 'doing as he is told' in class and continuing, surreptitiously, with his investigation of Barnsborough. An analysis of his online/offline activity as binary or separate events is insufficient. Instead, we suggest it is helpful to see him as enacting a kind of 'layered presence' (Martin et al., 2012), in space that is both online and offline, both schooled and not-schooled.
>
> In unpacking this, we can begin to identify some of the things that are latent within the experience of John, which we could see as 'folded' (Deleuze, 2001) into what he does as he interacts with the text. For example, folded into his interactions in and around Barnsborough is his prior experience of different kinds of texts, his experience of using virtual worlds or online texts, the way he has positioned himself, or has been positioned, in relation to literacy in the classroom and also of course, his understandings of classrooms, military headquarters, castles and so on, as well as his relationships with other children and adults. (p. 44)

This intersection between online and offline spaces is consistent with studies of cross-cultural understandings that have been observed in chat rooms, Twitter exchanges, and other forms of media. As Beach and Myer (2001) have argued and as various studies by Myer and his colleagues (Myer & Beach, 2001; Myer, Hammond, & McKillop, 1998; 2000) have demonstrated, these literacies give meaning makers the tools for representing themselves and their communities as well as those to engage with others and their communities. In so doing, meaning makers have the potential to enhance their understandings of self, other, and a diverse range of communities, in accordance with the portrayals and the frames undergirding the participations. As Levin (1996) and Turkle (1995) have noted, however, this also risks sustaining forums and practices that befit the norms of some but not others. Indeed, some online discussions may verge on or cross into unethical territory, colonizing or perpetuating certain

views over others and resulting in the rallying, silencing, alienating or marginalizing of individuals and groups.

Indeed, the complex nature of these spaces and how individuals and groups are located in and displaced by them is apparent in studies of how historically marginalized groups form communities. For example, studies of a sense of community achieved among lesbians via e-mail listserves, blogs and other spaces have demonstrated how individual members may become dislodged or marginalized within the community, depending upon their performances as members of the group and the norms that are applied or develop across time (e.g., Bryson, MacIntosh, Jordan & Un, 2006; Wincapaw, 2000). Bryson et al. (2006) suggest that one might find a haven or prison, a sense of belonging or a sense of dislodgement in such spaces.

In other studies of digital communities that explore digital users' portrayals of certain personae, some users have been observed constructing a "discoursal self" to convey a certain identity related to the values, beliefs and power relations of that space. This is distinct from an "authorial self," constructed through uses of certain writing techniques or content, or an "autobiographical self," evoked through sharing autobiographical events through writing, which result in their identities to others as "perceived writers" (Burgess & Ivanič, 2010, p. 237-241). Users construct such identities in a fashion that is ongoing or tied to events or practices mediated by the social networking platform (e.g., the use of the hash-tags). For instance, as the sociological papers of Damarin (1995) and Grint and Gill (1995) indicate, certain ways of interacting with technologies define particular types of gender identity. Michael Tierney (1995) (working with systems) and Hapnes and Sorenson (1995) (in studies of hacking) similarly suggest that the behavior associated with computer usage and naming may be aligned with ways of defining masculinities. As we describe, Jenson and de Castell (2018) and others have brought to the fore how this occurs in the digital gaming industry.

Gaming. Even more overtly, embodiment occurs in gaming and digital animations such as anime, manga and their followings or fans. With the advent of interactive media, especially in the form of simulations and hands-on virtual engagements, especially games, etc., Squire (2006), Gee (2003), Black (2008), Steinkuehler (2008) and others describe how students' exploration of others and their worlds assume forms of embodiment with customized identities and new hybrid forms of text. They can be looked at, as suggested by the New London Group (1996), in terms of

hybridity or as "articulating in new ways, established practices and conventions within and between different modes of meaning ... (of discourses and genres), … cutting across boundaries of convention and creating new conventions" (p. 29).They may thereby serve as powerful means to explore new ideas and worlds. As Squire (2006) and Gee (2003, 2005) suggest, in the context of these digital spaces, gamers can experience new environments and situations with tools, identities, and ideologies to explore problem-solving. Squire (2006), for example, argues that "… games focus our attention and mold our experience of what is important in a world and what is to be ignored. The game designers' choices, particularly of what to strip away from a world, can be read as ideological when considered in relation to other systems" (pp. 21–22).

Games should not be underestimated in terms of the worlds, opportunities to explore, and the kinds of problem-solving that they afford and invite users to experience. Games often coexist and align with forms of print media or other games, operating across these various modes simultaneously or as they develop to market themselves or related products. Games also often involve state of the art visual effects and virtual engagements to simulate otherworldly encounters. These worlds are often rooted in fantasy genres—enlisting scenarios, tools and characters that befit extraordinary environments that can be metaphorically or directly compared with real world places. A large number of games thus present a mangling of fantasy and reality and are aligned with plots (e.g., blade runners) wherein players are transported across virtual and "real worlds" within the game. For instance, cyberpunk involves engagements in various configurations of real places such as buildings, roadways, subways and the terrain typical of locations (often cities). In such games, players are faced with situation-specific, real world circumstances including the people and events, including crises and catastrophes, that do or may occur, as well as the choice of solutions or resources that might be at hand.

Yet despite the illusion of "openness" and options, these world games represent ideological leanings and systemic tendencies tied to matters of violence and policing, personal and community responsibility, and constructions of race and gender. Most games have a following that extend to a network of other gamers that are in collaboration or competition with one another or are serving as expert advisors to other players or critics of the games themselves on technical and social fronts. The world of gaming is not without major flaws. Indeed, issues have been raised with regard to the stereotyping of women and minorities and the rampant use of violence. Studies point to the violence and degradation that games perpetuate (e.g., Dill, Brown

& Collins, 2008; Lynch, Tompkins, van Driel, & Fritz, 2016). Moreover, the gaming industry itself has been found to have a history of gender biases (e.g., Jenson & de Castell, 2018).

Matters of Equity, Empowerment and Ethics

As our digital literacies expand and growing numbers of communities become wired or gain wireless access to the Internet, it becomes well-nigh essential that individuals and groups neither be sidelined from participating nor constrained in ways that limit their ability to do so creatively and critically. In other words, individuals should be given: 1) Access, which may carry certain technical requirements; as well as 2) Opportunities, or the license to contribute creatively and critically as users pursue personal and group goals. Further, if students are to be participants and not spectators, they need opportunities to collaborate, communicate, acquire, sift through, create, and critique ideas as well as to solve problems.

These notions of participation and the capital nature of these new literacies are consistent with the Declaration of principles on building the information society that was the focus of the 2003 World Summit on the Information Society (WSIS, 2003). [8] However, taking your place as a participant may not be as straightforward as the WSIS invitation might suggest. Economic circumstances and/or social constructions of engagement with these technologies might preclude the possibility of access. Intra-national differences within both developed and developing countries highlight that issues of access are limited for economically challenged groups and individuals. (United Nations, 2006). Even within developed countries, such as the United States,

[8] The declaration (WSIS, 2003) began with a common vision:

> Principle 1: We, the representatives of the peoples of the world, assembled in Geneva from 10–12 December 2003 for the first phase of the World Summit on the Information Society, declare our common desire and commitment to build a people-centred, inclusive and development-oriented Information Society, where everyone can create, access, utilize and share information and knowledge, enabling individuals, communities and peoples to achieve their full potential in promoting their sustainable development and improving their quality of life, premised on the purposes and principles of the Charter of the United Nations and respecting fully and upholding the Universal Declaration of Human Rights.

The principles go on to argue for participation "where human dignity is respected" and where we access these informational technologies in order to:

> reduce many traditional obstacles, especially those of time and distance, for the first time in history makes it possible to use the potential of these technologies for the benefit of millions of people in all corners of the world … as tools and not as an end in themselves. …Under favourable conditions, these technologies can be a powerful instrument, increasing productivity, generating economic growth, job creation and employability and improving the quality of life of all. They can also promote dialogue among people, nations and civilizations. (WSIS, 2003, Principles 8 & 9)

participation has often been limited by personal economic circumstances. These inequities were brought to the surface on a global scale when public health restrictions resulting from the COVID pandemic forced schools to provide education online.

A great deal has been written in the media and popular press about how digital literacies can contribute to cultural continuity or disruption, expansion or erosion, and self-determination or imperialism. It has been shown that certain literacy practices may have preferential leanings and perspectives—such as Western, gendered, racist, and fantastical—that may prove alienating or perpetuate certain biases or distortions of reality. Indeed, these literacies can alternate between being sites of contestation for freedom of expression, citizenship journalism and open exchange and those for vehicles for control, surveillance or enculturation. Sometimes even digital projects that are viewed under the banner of empowerment are pursued without adequate consultation and community support, favoring instead the interests, pursuits, and passions of commercial or even scholarly enterprises. In this way, even those touted as critical may be actively overriding local considerations, governance, or ethics (Bruce & Hogan, 1998; Lam, Warriner, Poveda, & Gonzalez, 2012; Lewis Ellison, Nogueron-Liu & Solomon, 2016; Omrod,1995; Rowsell, Morrell, & Alvermann, 2017).

Digital Developments and Education

Digital advances have yielded major advances in literacy—especially when literacy is viewed as broadly encompassing multimodal engagements as well as those with the web and social media. Consider, for example, the lasting and wide-ranging literacy benefits and opportunities resulting from the provision of state-of-the-art digital access in the educational context. Longitudinal studies of those students engaged in project-based work using multimedia platforms (i.e., to explore and compose meaning) have been shown to have clear advantages related to achievement, identity, strategies and tools for learning, problem-solving, discovering, and communicating. In their 10-year study of students from Apple Classrooms of Tomorrow, Rob and his colleagues Bond and Bresler (2006) argued that by providing students with the resources and tools required to engage in rich explorations of and with new literacies, the Apple learning sites afforded greater means of access and participation, as well as more opportunities for personal, cognitive and social engagements. For these students from economically

challenged backgrounds, these possibilities were akin to "genres of power"—providing students with new texts, and new ways of negotiating meaning and ways of knowing. The literacies were also transformative in terms of students' everyday lives—especially when compared with peers without such opportunities. Indeed, the students were able to develop cutting edge uses for technology in meaningful situations. By virtue of being trusted with the tools, authority and agency within their classroom and among peers, students were able to mobilize and develop these literacies in ways that interfaced with the social fabric of their lives within and outside school and into the future.

While many studies of the digital affordances in classrooms for meaningful learning are now between 15 to 25 years old, several of the identified problems in such work have proven stubbornly resistant to correction—undoubtedly due in part to the lack of financial resources and the prioritization of standardized test preparation in many districts. Other longitudinal examinations confirmed what we now see. Cynthia Selfe and Gail Hawisher (2004) reported on a 5- to 6-year study that involved interviews with over 300 individuals. From their subset of 20 case studies, they deduced a number of themes—bringing to the fore not only the extent to which digital literacies are closely enmeshed with everyday life (perhaps for the entirety of one's lifespan), but also how certain factors (e.g., race, gender, economic circumstances) can contribute to the empowerment of some and not others. They describe how sustained engagement with the productive use of digital technologies contributes in positive (i.e., personally, socially, educationally and economically advantageous) ways to various aspects of certain people's lives, including enhancing their imagined potential for fuller, creative and critical participation in society. Since Selfe and Hawisher's work, we have also seen how, on a national scale, participation can foment widespread acceptance of distortions of reality for uncritical consumers of digital disinformation—including our students.

These studies especially highlight the premium placed upon the economic advantage afforded by students' skill at engaging in digital, new literacy spaces. Both of the aforementioned studies support the finding that power and literacy are inextricably linked, and that the development of flexible and robust digital literacy practices may need to recognize and be built upon their multiple connections to social and cultural practices. In a similar vein, Lam, Warriner, Poveda, and Gonzalez (2012), in a review of emerging studies dealing with migration,

cross border studies and mobility, noted how digital affordances gave voice to students and transliteracy tools. As they stated:

> Studies of youth practices with digital media indicated that some young people of migrant backgrounds are using online media to express and construct their multilayered identifications, develop linguistic and social resources through local and translocal networks, and reference and contest the language and cultural ideologies coming from their home and host societies. (p. 210)

Unfortunately, in school settings, meaningful or engaging digital learning may be more the exception than the rule. Though it seems paradoxical, many school sites may not support the transition of these new literacies in ways that might fully realize their potential, precluding any shifts in power dynamics that might occur (Sheehy, 2007). In some cases, then, what may be accessible outside of school appears to have surpassed what most students in schools have the opportunity to access and explore. As a result, any affordances of digital literacies that do cross over to school may not have the same saliency or worth. As Street (2006) argued, outside of schools there is often an interest in global issues, networking, multimodality, flexibility, and so on, whereas inside schools there is often an emphasis on stability and unity. Indeed, in some situations, these new literacies are framed as discrete skills—such as programming, responsible Internet usage, or presentation strategies—rather than as learning tools with complex palates of possibilities for students to access in a myriad of ways. It is as if rather than being supported in learning *with* technology—using a range of multimodal literacy tools (supported by these technologies) in the pursuit of learning—students are merely being asked to "learn the technology." What Squire (2006) argued fifteen years ago may well still hold true: The integration of digital resources with learning within most schools falls short of what digital-based games are already achieving—that is, situated learning, with an array of visual resources and an accessible network of others, tied to developing expertise and understanding through performance.

Nevertheless, as digital engagements with various media are increasingly considered literacies, there seems to be a potential for curricularizing these media that have been predominantly outside the purview of traditional schools (except perhaps in terms of addressing their possible negative effects—e.g., violence, wasted time). This curricularizing involves

advocating for the use of media from so-called informal settings (e.g., home, arcade etc.) to school settings. Whereas the use of the media (e.g., games, video, digital cameras, mobile technologies, Internet, iPods, blogs, etc.) has been left to individuals and society to define and use, schools have tended to redefine their use through a somewhat interventionist orientation. Lost in this crossover to schools may be the social and cultural possibilities—e.g., exploring constructions of identity, democratization, social interchanges, and so forth, as well as a more semiotic perspective on everyday use of media. These possibilities have increased especially with the advent and widespread use of digital tools, digital video and mobile devices (that allow for more interchanges or complex gaming or narratives). However—and also not surprising—the potential and use of digital media in one setting may not be transferable to the other. The transfer of students' engagements with these literacies outside of school may not fit well with in-school demands or norms.

As Bransford et al. (2000) summarized in their review of learning with technology for the National Research Council:

> In general, technology-based tools can enhance student performance when they are integrated into the curriculum and used in accordance with knowledge about learning. But the existence of these tools in the classroom provides no guarantee that student learning will improve, they have to be part of a coherent education approach (p. 216) … Much remains to be learned about these technologies. (p. 230)

If we are to move forward, we would hope that educators build upon what we have learned to date. In this regard, the Covid-19 pandemic may be quite telling. Within the first month of the World Health Organization's declaration of a pandemic, over 100,000 faculty members at Canadian universities were forced to pivot to online education in the first two weeks, with many depending upon platforms such as Zoom for class meetings. As Tony Bates (2020) noted, the results were mixed. Many educators reluctantly adopted online platforms with little knowledge of (and sometimes disregard for) online education, while students struggled with the isolation that sometimes is experienced as well as the mode of engagements demanded of them. Too often, educators proceeded with online tools either blindly or formatively, learning as they went—in the hopes of deftly and effectively deploying or enlisting digital tools and spaces. Unfortunately, teachers and students were unprepared. They were not able to support

various forms of participation (i.e., for groups and individuals) for a range of learning pathways, processes and products, and fell short of providing the scaffolding or other tools and forms of support and consultation. And, unsurprisingly, we saw evidence again for how economic strata have created digital castes, as schools and homes had access to very different levels of hardware, software, internet, and developmental support.

There are alternative proposals for how change might proceed more deliberatively, based upon the discussions and pursuits of digital learning that have occurred to date. For example, in accordance with what might be considered a relevance principle, a number of educators have advanced approaches to digital literacy grounded in users' worlds. In their article, "New Literacies and Community Inquiry," Bertram C. Bruce and Ann Peterson Bishop apply the lens of progressive education, especially that of John Dewey, to their considerations of the relationship of new literacies to community inquiry. In particular, they examine how community inquiry shapes and is shaped by digital literacies. Adopting a range of views of what might constitute community and the types of inquiries with which the community might become involved, Bruce and Bishop (2008) detail progressive educators' views of inquiry situated within and derived from different communities' needs and goals, as negotiated in a reciprocal fashion between individuals and groups.

Within this Deweyian framework, technologies are seen as tools for problem solving and, as such, can take various forms. They might be best viewed "as representing the ongoing processes of community inquiry" (Bruce & Bishop, 2008, p. 716) or learning, and should be considered in terms of their adapted use for inquiry. Technologies might also help achieve community goals through the emerging notion of community informatics (which addresses how technologies support community needs in areas such as health and civic engagement). In a rich, complex, and illustrative manner, Bruce and Bishop provide several vignettes of how community inquiry proceeds and new literacies have engaged and developed in different settings. Dwyer (1996), in his reflections of the Apple Classroom of Tomorrow (ACOT) project that he directed, also stressed the importance of a community which recognizes and supports the possibility of re-imagining selves across digital spaces and other literacy fields or spaces. This requires a view of schooling that emphasizes the transformation and assessment of knowledge that is performance-based and affords access to and support for multiple representations of ideas.

Similarly, and perhaps most notable, has been the formulation of the notion of the 'New Literacies" model proposed by a groups of largely critical literacy theorists identifying themselves as the New London Group. Akin to the emphasis upon relevance, this model included two components: 1) The notion that global communication requires multiple channels and media; and 2) The idea that multiple literacies are constituted by, and constitutive of, the multiplicity of cultures and linguistic contexts in which literacy practices occur (New London Group, 2000). As we detailed in the Critical Turn chapter, multiliteracies represented a way to conceptualize how literacies are situated within a changing social world—one that involves a growing diversity of literacy practices, an increasingly diverse population, and an expanding variety of exchanges that require different registers, semiotic understandings, and social engagements.

The proponents of multiliteracies argued for an approach to learning that was social, situated within the embodied participation of individuals and groups, and therefore embedded "in social, cultural and material" (The New London Group, 1996, p. 82) contexts. In so doing, they added momentum to the social turn at the same time as they fused it with multimodal digital developments and a design orientation—combining literacy(ies) practices with transformative, critical, and relevant engagements and overt teaching and understandings of design features. They argued for a shift from verbocentric notions of literacy to a more semiotic framing of multiple modes, wherein students are engaged as "remakers, the transformers, and the re-shapers of the representational resources available to them" (Kress, 2000a, p. 155). This perspective continues to evolve and gain traction; for instance, a group of U.S. scholars has developed a proposal tied to notions of connected learning with similar tenets (Ito, Gutiérrez, Livingstone, Penuel, Rhodes, Salen, Schor, Sefton-Green, & Watkins, 2013).

Discussion

Within the advent of digital literacies, the embrace of the new and multiple literacies might be viewed as stating the obvious. However, it may not be as straightforward as it seems—especially as one considers the history of literacy research and theorizing. Several scholars have argued and shown that the literacy field has tended to maintain a tradition of theorizing literacy and studying texts in a fashion which is singular and separate from the growing fabric of digital

literacies with which most of us engage with as primary and constant sources. Despite laudatory reports that social semiotic analysis achieves some understanding of the nature and power of multimodal exchanges, oftentimes these analyses seem more focused on the instrumental and regulatory functions of digital realms rather than on the interactive and personal implications and effects. The literacy field still seems disconnected from the actual meaning-making processes and emergences (ideational and social) that are happening via and within multilayered and multimodal affiliations and texts. Further, the field has tended to focus upon the individual versus group-as-meaning maker. While studies of digital literacy are beginning to embrace community dynamics and the ensemble style of engagements—as well as consider multiple-text situations and their multilayeredness and linkages—the predominant theories and models of meaning making tend to stick to the individual and one or a few threads. The study of literacy has yet to fully embrace the fabric and the composing processes of the ensemble.

This focus on the thread rather the fabric has the potential to inflate the significance of the trace or individual detail while limiting (and perhaps distorting) its relationship to meaning making—thereby misrepresenting reading as a monological experience. Yet as Lemke (1998) posits, "Literacies are legion. Each one consists of interdependent social practices that link people, media objects, and strategies for meaning making" (p. 312). Indeed, we are constantly navigating and building ever expanding and intermeshed webs of meaning as we engage with others and ourselves across face-to-face and other forms of communication, virtual and real, synchronized or not. We are similarly faced with a flood of daily web-like encounters, involving arrays of different transactions (and co-constructions) as we engage with our colleagues, coworkers and others in various time zones. At times, one retreats and hopes for reprieve from the deluge and a quiet day in solitude.

Moreover, webs and networks themselves are rarely separate from one another, although we do enact forms of selective engagement, sorting, etc. as we begin our day—perhaps checking and responding to e-mails, pursuing projects, relaxing as we peruse listservs. Such multitasking may involve a mix of direct and indirect or synchronized or non-synchronized developments—it may be that some matters are paused and resumed later as one moves on moving ahead or connects with others in a form of joint advancement. Therefore, as we move across or within networks and web-like engagements, we are sifting, linking, sampling, and following leads and paths. At the same time, we are layering and affiliating as we pursue for ourselves and others

various confirmations, understandings, plans, commitments, answers, directions or acknowledgements. This is also the world of our students.

The diversity of possibilities that might arise from these hypermedia environments captured the imagination of a range of scholars, from cognitivists to semioticians to sociolinguistics, as they envisioned the potential affordances of these digital forms. In her seminal paper, "Toward a multifaceted heuristic of digital reading to inform assessment, research, practice, and policy," Julie Coiro (2020) extends the work of the Rand's formulation of a model of reading for understanding (RAND Reading Study Group, 2002) to represent reading in the digital age , In doing so, she has posited four dimensions to help characterize the possible ways reading comprehension might proceed and present itself for the digital reader. These include characteristics of text, reader, activity and context:

Text

- Informational text
- Hybrid text
- Multimedia
- Multimodal text
- Onscreen text
- Hypertext
- Hypermedia
- Internet text
- Augmented text
- Literacy text

Reader

- Cognitive capabilities
- Reading and language competencies
- Reading dispositions and motivations
- Sociocultural identities

Activity

- Simple text activity
- Multiple texts activity
- Multiple texts activities across multiple media and/or platforms
- Critical media literacy activity
- Online research and inquiry activity
- Digital creation activity

Context

- *Response format*

  Multiple choice

  Selected responses

  Short constructed typed

  Audio recorded response

  Video recorded response

  Extended constructed typed Extended constructed design

- *Contextual design considerations*

  Timed or untimed

  Individual, partner or group

  Engagement with real people or avatars

  Face to face, remote or virtual

  Self-selected or other-selected

  Personal or task goals

- *Contextual features of community*

  School based

  After school experience

  Home based experience

  Community based experience

- *Medium platform*

Single page
Object
Bound pages
Multiple pages or objects
Digital device
Software or app
Virtual world
Headset based virtual reality
Augmented reality

Accordingly, Coiro suggests digital meaning making experiences entail different affordances and possibilities as readers engage with multiple texts, for different purposes, and across different situations (e.g., both varied and dynamic).

Spiro (1987; 2006a/b; see also Spiro, Collins, & Ramchandran, 2007) also proposes an approach to meaning making which extends to the meaning makers' ability to navigate across multiple inputs with a great deal of speed and efficiency. As he suggests, meaning making across digital material depends upon a fluidity and an ability to discern relevance and glean meanings almost at a glance. Describing digital meaning makers as "…being conductors (or jazz improvisers), rapidly bouncing excerpts from rich video clips off of each other" (Spiro, Collins, & Ramchandran, 2007, p. 98), Spiro (2006b) emphasizes that if the material is somewhat familiar and rich in content, meaning makers will:

> … capitalize on their affinity for this mode of "quick-cutting" across dense images (cf. Stephens, 1998)—and their accustomedness to nonlinear processing … to crisscross between many video excerpts to speed up and deepen the process of building interconnected knowledge from experience. (Spiro, 2006b, p. 11)

To some extent, the agility and flexibility needed to do what Spiro describes requires that meaning makers have some pre-existing knowledge of the topics, familiarity with the genres, and skill at efficiently discerning relevance across texts. They would need to be engaged as performative inquirers, with others, and in a fashion which is discursive and discerning.

Perhaps these same meaning making abilities are involved when viewing visual art—especially impressionist paintings. We can savor the detail at the same time considering it in relation to the composite. As we move from engagement to engagement, from one text to another, or from one website to the next, we engage with the elements and, rather carefully weighing the separate elements, we discern the whole. This is akin to a kind of gestaltism, but in fashion that involves more of a leap in meaning making. The impressionistic discernment of multiple sites and texts might also be tied to seeing other composites of the same work. But the discernment of these composites may or may not be immediately interrelated. These processes may or may not be tied to crisscrossing a domain, searching for the best fit, or finding relevance, as Spiro has described, in complex knowledge circumstances. They may instead be tied to achieving a composite specific to a moment, person, or the goals, interests, or satisfaction of one's pursuits—at least for now.

As communication theorists indicate and research confirms, literacy involves a relationship with the ideas which is personal and social rather than detached or individualistic, and functions on multiple and interrelated levels. At one level (or perhaps across all levels), such engagements involve conversations with one's self in the company of others. It involves, as Butler suggests, constructions that are performative and discursive (Butler, 1993, 1997). At another level, it is akin to a conversation that may entail a form of reflective meaning making tied to negotiations (e.g., across a set of e-mails or text messages or texts authored by others). For example, it might entail trying to understand what the author—either imagined or real—wanted you to think or act. It might entail exploring possible worlds and imagining or re-imagining possibilities for self. At a more macrolevel, these engagements interrelate with how we are networked and positioned with others, in both local and global spaces. These engagements thus occur in the context of navigating and journeying worlds—cultivating ideas and spurring meanings, using range of texts where ideas are explored and mixed, created and critiqued, savored and digested, and used as fuel for expression of further considerations.

One should not discount the affordances and effects of technological developments. As many have noted, digital spaces bring to the fore affordances that should not be understated. However, as Owston (1997) emphasizes, "no medium, in and of itself, is likely to improve learning … The key to the Web appears to lie in how effectively the medium is exploited" (p. 29). Certainly, digital spaces may afford alternative ways to interact with ideas and others,

including self. And, in terms of meanings, we seem to be on the frontier of a new form of public knowledge, with the advent of citizen journalism, and its counterpart, fake news—a world less filtered, with shifting notions of authorship, authority and copyright as well as new ways of making, archiving, and curating texts and news (see Willinsky, 2006).

Nor should one shy away from a theory or model of meaning making that captures how meanings are transacted within and among groups and individuals within these groups. This might entail building upon discussions to date that highlight how digital learning might be authentic, interactive, collaborative, resource rich, and inquiry driven. As Reinking suggested as he contemplated the significance of Hypertext and how digital learning is positioned in schools: …

> the computer is much more than a new device for displaying textual information or for teaching children how to read and write. It is instead a revolutionary new vehicle for textual communication that, if fully appreciated for its own merits unencumbered by lingering biases for print, can act as catalyst to bring people closer together in a democratic and relentlessly conditional pursuit of knowledge, understanding, and enjoyment. To realize this potential, we will be best served by setting our imaginations free from seeing a computer as a machine that lacks the warmth and security of a book, seeing it instead as a technological alternative providing almost unlimited potential to operationalize the humanistic values that fuel our noblest conceptions of literacy. (Reinking, 1997. P. 642.

It might involve examining ways to capitalize upon students who have only known a world with digital engagements. It might also entail considering such pursuits as those of Mayer and Moreno (2002), who developed principles to undergird the enlistment and juxtaposition of animation and other modes of delivery in some fields of learning (e.g., looking at the possibilities of simulations). As James Gee (2005, 2011) has discussed, educators might learn from the power of games, including how they afford players active engagements in simulations of real and contrived words. Through games and simulations, players might learn to discern and discriminate between symbolic representations, interpret meanings, practice problem-solving in scenarios and enact critically reflexivity.

The embodied engagements within and across these spaces occurs in a range of ways—from quite broad, even global, to quite narrow and intrapersonal. They can involve engagement across social worlds and exchanges of ideas done in a fashion akin to the exchange of goods or capital, resembling at times forms of encroachment, absorption, or adoption (akin to colonization or hybridization). They can involve exchanges of thoughts or ideas for oneself or in the context of schooling. Literacies may involve forms of mobilities that offer individuals multiple ways to locate or dislocate themselves as they relate to or interact within and across different spaces in different ways. Jean Baudrillard (1981), an early theorist about "hyperreality," suggested that we live in a world drained of authenticity as a result of the illusions perpetuated by the media and mass-produced environments (e.g., malls, amusement parks, automobiles, etc.). The end result, he argued, was an almost complete blurring of reality and unreality.

Furthermore, if meaning making is envisioned as a form of embodiment, there may need to be a shift in how we construct the meaning maker and the strategies that they employ. Cognitive-based models of meaning making tend to suggest major phases such as planning, inferencing, connecting, and monitoring. Perhaps, rather than perpetuate a "within the head" form of individualism, our models should be reconsidered so that they are more aligned with the embodied and collective engagement of meaning makers—including how students transact meanings with one another as they engage with, access, co-plan, co-author, search and explore, position, share, guide, reflect, recycle and sustain. Meaning makers are not alone. Students move in and out of groups or operate in all manner of fashions—unified or dispersed, in concert or in disarray. Even in solitude, meaning makers may view themselves as operating in multiples, especially as they interact with texts of others and their own selves. We should recognize what some have termed the ensemble nature of meaning making—namely, the social nature of meaning making, akin to a form of group co-authoring—and enlist terms which represent a better fit with such engagements. Moving forward, we might view meaning making through lenses that recognize the social nature of these processes and products of co-authorships and reflect the shifting affiliations, negotiations, and mediations they entail.

In the digital realm, educators should remain cognizant of the toxic effects of media that is neither filtered nor carefully attributed. There is a need for an orientation to media that is critical and constructive—one that prepares students to deal with societal issues and problems and equips them with the tools to judge the arguments, claims, evidence, and underlying logic

and ideology of digital encounters. Further, students should be prepared and equipped to do so in respectful, anti-colonial ways—advancing civility, deliberation, and accommodation. As Renee Hobbs (2010) discussed:

> Existing paradigms in technology education must be shifted towards a focus on critical thinking and communication skills and away from "gee-whiz" gaping over new technology tools. We must consider the balance between protection and empowerment and respond seriously to the genuine risks associated with media and digital technology. …We must help people of all ages to learn skills that help them discriminate between high-quality information, marketing hype, and silly or harmful junk. (p. xii)

To effectively and strategically participate in these realms, students require the tools by which they can make discerning judgments of what is posted on digital sites, social media or news outlets especially the credibility of any assertions, the merit of the motives, the representations that are made in accordance with their match with the laws and norms of a civil society.

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