10 Undergraduate Research and Information Literacy in the Digital Environment

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The digital delivery of both traditional publications such as journal articles and new media resources has moved to the digital environment a significant portion of reading for the purpose of conducting research. This trend has changed multiple aspects of the undergraduate research experience—from habits of annotating while reading to selecting passages for synthesizing into creative works such as research papers. Digital access to resources makes them immediately and easily available for consumption, exposing students to a wide variety of publications for any research project they confront. These efficiencies bring reading and writing ever closer temporally, while also posing urgent pressures for critical judgment and the assimilation of new ideas. Information literacy skills become paramount in such an environment due to the demand of evaluating materials and incorporating them in one's work cogently and ethically.

As the research process has increasingly become understood as conflated with reading, the relationship between research and writing remains relatively unexplored in the literature. While research for writing (that is, conducting research and then presenting the results) is almost always an expected outcome of the research process, writing for research is mentioned frequently in the literature, but almost never discussed in more than a cursory way. Indeed, conducting research generally requires reading in some format, while writing is essential for organizing new knowledge acquired through the research process and for organizing the process itself. Research, then, is a domain in which reading and writing are connected in practice, but that connection

is not well-established in theory. This chapter briefly reviews models of information seeking, explores literature related to technology and reading for research, points out practical connections between reading and writing through the research process in a digital context, discusses the importance of information literacy skills for reading and writing, and highlights the role of libraries in supporting the development of those skills.

Models of Information Seeking

The process of seeking information for the purpose of synthesizing information and producing a product—commonly referred to as research—is often called "information seeking" in the literature. Researchers have long sought to construct a model of the research process to better understand the processes people follow as they conduct research. Although information seeking has been studied at least since the 1950s, James Krikelas (1983) was the first to propose a research model applicable to the general population. Krikelas's model included four linear steps, beginning with an information need and ending when the perception of that need no longer exists. Kuhlthau's (1985) model of the information process, like Krikelas's, appears in the literature as a linear model. Unlike Krikelas, whose model was described behaviorally, Kuhlthau incorporated affective and cognitive theory into her model. Further, her model was research-based, whereas Krikelas's was primarily practice-based (Weiler, 2005). Kuhlthau's model has been validated among many different types of researchers, including college students (Kuhlthau, Turock, George, & Belvin, 1990). For a more detailed discussion of information seeking, see Haller's chapter in this volume.

Scholars of information seeking have commented repeatedly that the linearity of both Krikelas's and Kuhlthau's models does not accurately reflect the non-linear nature of most research, although Kuhlthau (1991) did note that she envisioned her model to be an iterative process. Weiler (2005) observed that Eisenberg and Berkowitz's (1990) component-based information seeking model, based on their "Big6 Skills," was intended to offer a flexible, non-linear representation of the research process, and therefore may be more consistent with the dynamic nature of learning in the age of constructivist learning theory and the flexible nature of hypertext. Like Krikelas and

Kuhlthau, the Big6 Skills present a series of steps that researchers generally follow, but are presented a non-linear fashion. Instead, the Big6 Skills are portrayed as an interconnected web that more accurately conveys the iterative and hypertextual nature of information seeking in today's world. Like other models of information seeking, the Big6 Skills are comprised of a series of steps or stages that researchers move through as they seek information: definition of the task and development of information seeking strategies; the location and use of information; synthesis of information into a written or other creative product to be shared with others; and evaluation of the product and process (see Lamb, 2001, for a comparison of a number of information seeking models). It should be noted that Krikelas's model is not included in Lamb's comparison. His was one of the earliest models, providing a conceptual framework for others that followed. In addition, Lamb presents the Big6 Skills as linear to facilitate comparison (Weiler, 2005, includes a discussion and references to resources about the webbed nature of Big6).

Most information seeking models begin with a stage involving the formulation of an idea and ending with a product. Traditionally, the product would have been a research paper. Although, in an increasingly technological world, the product could be any number of electronic, print, or visual creations. In Kuhlthau's model, the production stage is called "Presentation," and the rise of electronic publishing tools, including applications as diverse as word processing software, presentation software, blogs, video production software, and social media offer many opportunities for electronic publishing. The literature does not discuss the use of these or any writing technologies in information seeking in theoretical or empirical ways. It includes only discussions of practice. Much research is needed to better understand the relationships between information seeking and writing technologies.

The transition from linear to iterative (or webbed) models of information seeking is parallel to a similar paradigm shift in models of writing from process to post-process. Post-process models view writing as iterative, synthetic, situated, and personally constructed (Kent, 1999). Ideally, the presentation stage of information seeking results in a creative product that synthesizes new knowledge from a variety of sources. In this way, information seeking can also be seen as exactly equating with the writing process. As Berthoff (1970) noted, teachers

"design sequences of assignments which let our students discover what language can do, what they can do with language" (p. 70).

Reading is an explicit and integral part of all of major information seeking models. Reading from print was the primary method of gathering information when all of major information seeking models were developed; therefore, it is almost inextricably integrated into the research process. Writing, however, is a secondary consideration in all of major information seeking models in the sense that the writing process itself is never discussed in detail. In Kuhlthau's model, for example, the entire writing process is encapsulated within "Presentation," the last stage of information seeking. This is not to suggest that writing plays no role in information seeking. Kuhlthau (1994) and Eisenberg and Berkowitz (1990) have designed activities to assist students as they move through the stages of research. Many of those activities incorporate writing or other creative methods. Such activities might include guiding students to brainstorm ideas for research topics, helping to refine research foci, writing research questions, note-taking, or outlining. These activities are always framed by authors of information seeking models in the context of conducting research, however, and never as steps in the writing process, although it is clear that such activities are essential—indeed, integral—to the writing process.

In many ways, writing for research (as opposed to research for presentation, often through writing) really is the same as the early stages of the writing process. Typical writing activities during research include brainstorming, note-taking, annotating, and outlining the same artifacts that might be produced in the early stages of writing a research paper. The writing process does not occur in the final stage of research, but instead, like reading, is an integral component of research. Certainly, the production of polished writing occurs after information seeking is mainly complete, and the process of writing for an audience is outside the scope of information seeking models. However, research and writing are closely linked, and much more discussion of this relationship in the literature is necessary to reconnect reading and writing through information seeking.

Information Seeking and Information Literacy

While the role of technology in the information search process has been considered by many of the researchers who have developed infor-

mation search models, all of the widely recognized models were developed prior to the rise of the highly technological society in which we now live. Because they were developed in theory, in research, and in practice, all of the models discussed above have proven themselves to be, for the most part, robust across a wide array of information types, resources, and formats. Researchers have increasingly become interested in the relationship (if any) between information seeking behavior and ubiquitous access to technology.

To navigate the research process and craft a quality product, information seekers require a set of skills. The fluency of researchers with respect to seeking information has come to be widely known as information literacy. In a highly technological world, the necessity for students to use digital resources effectively, as well as increased access to information in many formats, has given rise to literacies with a variety of names. Mackey and Jacobson (2011) describe five different literacies, in addition to information literacy, found in the literature: media literacy, digital literacy, visual literacy, cyberliteracy, and information fluency. All of these different literacies arose from the differing goals, objectives, beliefs, and the needs of various professional and discipline-based organizations. Interestingly, Mackey and Jacobson, in support of the various literacies, tend to focus on the technologies that are in or out of favor within the disciplinary context of a given literacy.

Mackey and Jacobson (2011) proposed a reframing of information literacy from skills-based to "collaborative production and sharing of information using particularly interactive technologies" (p. 70). They proposed the word "metaliteracy" (p. 70) to describe a re-conceptualized information literacy that is technology agnostic and encompasses all of the literacies listed above. It is useful to observe that the acquisition of information is suggested by the incorporation of the world "literacy" in all of the constructs just described. A more holistic view of literacy would incorporate writing, as described in Chapter One of this volume. Such a construct would encapsulate the reciprocal nature of the acquisition and creation of information as modeled by the research process. Further, new technologies as described later in this chapter hold the potential to operationalize a metaliteracy that embraces both reading and writing situated in the same time and place.

Information Seeking in Digital Environments

Many of the positive influences of technology on information seeking are numerous, well-documented, and, for the most part, self-evident. For example, an extensive digital archive of historical materials available online can be accessed at any time, from almost any place, and searched in seconds. To access an equivalent print collection, a researcher might have had to travel long distances to one or more repositories, access the materials only during the repositories' open hours, and spent long periods of time searching for information relevant to the researcher's need. Dalton and Charnigo (2004) observed that some historians organize their research around travel considerations. Speed, immediate access, and self-service are the primary affordances of technology discussed relative to information seeking. This is likely because, as Weiler (2005) found, many scholars place the highest priority on time when searching for information.

Like all prioritizations, priorities in information seeking come with tradeoffs. Researchers who prioritize time over other aspects of research do so at the expense of such important matters as authority, accuracy, relevance, breadth, and depth of resources. While all of these tradeoffs required consideration prior to the advent of ubiquitous technology, technological advances have made it easier for researchers to prioritize time over the quality of information. This is not to suggest that there is evidence of a widespread decline in the quality of scholarship due to technological advances. Rather, technology presents educators and librarians with new challenges in helping students understand the standards for scholarly research.

The Internet search engine is the epitome of the balance between researchers' time and almost all standards for scholarly research. Educators and librarians often express anxiety that search engines have reduced the quality of research, particularly among undergraduate and younger students. Indeed, entering a phrase in a search engine often yields thousands or millions of results, some relevant or not, some accurate or not, some authoritative or not. The use of search engines for scholarly research raises many important questions: How do researchers know when they have "found enough"? How does immediate access to information influence researchers' self-perception of information seeking competence? How are researchers informed about the validity and authority of information resources? How do

researchers conduct an organized and logical search, and what is the role of haphazard searching and serendipitous finds? How do researchers perceive the role of educators and librarians as intermediaries in online searching? What are discipline-based differences in the use of technology for information seeking? Research has been conducted to address all of these questions. However, as technology evolves, so do any potential answers.

One of the greatest challenges facing users of online search engines is knowing when they have found enough resources to address their information needs. In a print environment where collections, for the most part, have bounds, this can be a daunting question when presented with millions of hits after entering keywords in a search engine. Herbert Spencer (1955) coined the term "satisficing" to describe a decision-making strategy whereby people make a choice when they perceive they have adequately met a need rather than finding the optimal solution.

Prabha, Connaway, Olszewski, and Jenkins (2007) conducted a study to understand how the concept of "satisficing" applies to information seeking behavior among academic users of libraries. The study consisted of focus groups in which undergraduate and graduate students and faculty members were asked about their criteria for terminating information searches. The authors found that undergraduates stopped looking for resources when they perceived that they had met the requirements of the assignments, including the number of citations, the number of pages written, or meeting criteria for a certain letter grade or score on the assignment. The study supports a similar finding by Barrett (2005) that undergraduate students stopped searching when they perceived that they had met course requirements.

Both studies support the idea that undergraduates satisfice their research around their role as students meeting course requirements. It is incumbent upon instructors, then, to design writing assignments in ways that clearly define content, writing and research requirements, and increase the likelihood that students successfully meet those requirements. Further, the cognitive complexity required by research-based writing assignments may require the support of content-based instructors, writing instructors, and librarians working collaboratively toward students' intellectual growth and development.

Bodi's (2002) analysis of the literature indicated that undergraduate students struggle with research in a few particular areas: topic se-

lection and narrowing, selecting subject headings for searching, and evaluating resources during their searches. She noted that undergraduates, as novice researchers, lack an awareness of scholarly research methods, and therefore must develop strategies to deal with the ambiguity inherent in the research process. Bodi argued that research instruction in libraries generally is not tailored to specific disciplinary needs or the abilities of students. She further argued that librarians should develop new strategies for teaching search strategies at a level appropriate to undergraduates in the context of disciplinary research at the novice level. Bodi proposed that asking questions of students is an effective strategy for helping undergraduates develop information seeking abilities, particularly for moving through the most challenging stages of information seeking. Questioning also helps students better understand the context of scholarly communication within the disciplines.

Bodi observed that students often appear to search haphazardly, as "happy to find whatever" (Bodi, 2002, p. 110). This observation supports the notion of students' satisficing for information resources, studied by Prabha, Connaway, Olszewski, and Jenkins (2007). If students' primary concern in searching for information is to meet assignment or course requirements, and an effective search process is neither one of those requirements, or if they are not taught appropriately by librarians, there is no rational reason for them to conduct a search in anything other than haphazardly. This also explains why undergraduate students perceive little need for involving librarians in their information searching.

The literature indicates that one of the challenges facing undergraduate students conducting research is in understanding methods of scholarly communication. One particularly challenging skill to acquire is the ability to evaluate the quality of an information resource and the authority of its author. As novice researchers, "even when students find the information they need, they have difficulty evaluating it and choose quantity over quality" (Bodi, 2002, p. 111). Searching for journal articles online can exacerbate this challenge. Articles found in a print journal have a contextual basis for evaluation. Researchers can readily see what organization is responsible for publishing a journal. Often, the title of the journal can be recognized as reputable, although most undergraduates likely lack this knowledge, particularly early in their academic careers. Browsing through the publication provides a

sense of the affiliations and reputations of the authors and offers a glimpse into the state of knowledge in the discipline.

O'Brien and Symons' (2007) study of undergraduates found that some students appeared to have difficulty distinguishing between websites and electronic databases. They further note that libraries and the literature often does not differentiate between the library's physical and online presence, making it even more difficult for students to understand the contextual basis for the information they find online. Research by Cockrell and Jayne (2002) supports the idea that librarians' attempts to design library websites very precisely actually confuses students, who expect to be able to find a variety of resources of different types and formats with few searches—or, preferably, a single search.

As interfaces for locating journal articles online improve, they increasingly appear as virtual manifestations of print copies. However, scholarly communication is likely to continue to move toward a Web-first or Web-only publication model. The hypertextual nature of Web-based publication increases the likelihood that scholarly work will look less like a printed publication in the future. As that trend evolves, it is essential that online authors and publishers develop new ways to contextualize publications in order for novice researchers to develop an understanding of a discipline's scholarly publications. This trend will almost assuredly affect the writing process in the future, as students have more and more opportunities to break down the traditional constraints of publishing in print. Technological innovations in writing will allow more flexibility and creativity in the design, layout, and order of text. In turn, such innovations may have an effect on writing content. The convergence of online reading and writing could also affect the research process. Time and research are necessary to better understand how technology is influencing the interaction of reading, writing, and research.

In addition to changing undergraduates' perceptions of scholarly publication, the rise of technology has changed the types of information resources available to students, as well as how they access and use those resources in collecting information for creative work, such as research papers. A number of studies have been published that examine the role of multimedia in undergraduate research. Chen and Macredie (2010) reviewed the literature regarding Web-based interaction as it relates to three human factors: gender differences, prior knowledge, and cognitive styles. Regarding gender differences, they found

that most studies indicated a difference between males and females in Web-based interactions: "In particular, females encountered more disorientation problems and had more negative attitudes then men" (p. 385). The authors did note, however, that some studies reported no gender-based differences in Web interactions.

The literature suggests that there are differences in Web-based interactions between novices and experts, particularly regarding Web-based instruction and Internet searching. Flexible paths are beneficial to experts participating in Web-based instruction, while novices benefit from structured content, such as hierarchical maps. Similar differences were found regarding Internet searching. Experts demanded more sophisticated search tools and time-saving measures to locate information, although one study suggested that experts are more likely to miss some highly relevant sites. Novices, on the other hand, use search engines more than experts and prefer structure and hypertext to help them navigate the Web. In addition, novices take more time than experts to complete broad searching tasks (Chen & Macredie, 2010).

Finally, regarding cognitive style, the literature is inconclusive about any relationship between field dependency and learning performance with respect to Web-based instruction. Field dependency is a cognitive style characterized by a tendency to experience surroundings in a relatively global manner, and to struggle with individual elements. Field independent users tend to experience their surroundings analytically, and are comfortable dealing with elements out of their context. Field dependency does appear to affect users' learning preferences. In particular, field dependent learners tended to prefer linear learning, while field independent students preferred non-linear learning. In addition, field dependent subjects in one study tended to use teaching notes and other class resources more often than did field independent students (Chen & Macredie, 2010).

The findings of Chen and Macredie (2010) are consistent with those of researchers interested in the information search process cited earlier in this chapter. The novice versus expert differences found by Chen and Macredie (2010), with respect to Web-based instruction and Internet searching, for example, parallel the differences in searching expertise found by Bodi (2002), as well as comparisons of novice and expert writers. Becker (2006), for example, reviewed the literature comparing novice and expert writers with respect to textual revision. She found wide differences in the process, perceptions, and product

quality between novice and expert writers. This suggests that the preferences, perceptions, and practices of information seekers persist in both their reading and their writing endeavors, even as the use of technology has increased dramatically over the past decade. This literature, taken together, suggests that the process of conducting research has become increasingly empowering to students at the cost of greater complexity in the sub-processes of research; therefore, greater support for students is required as they become expert seekers of information.

Chen and Macredie's (2010) findings also support the idea that libraries must take into consideration the widely varying needs of users when designing computer interfaces. As Chen and Macredie observed, however, inconsistencies and gaps in the literature require additional research on human differences in computer interaction, including the three factors that they studied, in addition to others, such as affective factors, age differences, and cultural background.

Researchers have increasingly taken interest in the design of online information sources and its effect on reading comprehension and information seeking. Vaughan and Dillon (2006), for example, studied the structure and genre of online newspapers and how users interacted with them. The authors solicited input from experts to develop criteria for an online newspaper genre, after which they designed an online newspaper conforming to their genre criteria and a separate online newspaper not conforming to the genre. For example, the experts determined that a quality online newspaper should include a menu of navigation links in the left-hand column. Several similar criteria were selected to design the genre-conformed newspaper. The criteria were ignored in the genre-violating newspaper.

After creating the online newspapers, the authors conducted a longitudinal experiment with users to understand whether any interactions existed between the two different newspapers and users' comprehension of the news content, the usability of the website, and user navigation. Results showed that users of the genre-conforming newspaper performed significantly better in all three areas (comprehension, usability, and navigation) than users of the genre-violating newspaper. Over time, users of both newspapers significantly improved their performance in all three areas (Vaughan & Dillon, 2006).

This study has a number of interesting implications for both practice and research. First, it is clear that genres can develop in relatively short amounts of time. Some genre theorists view the lifetime of a

genre as over many, many years—even as long as centuries (Vaughan & Dillon, 2006). Second, adhering to genre conventions in designing online resources may improve users' comprehension of content. Third, maintaining a consistent site promotes user comprehension and site use. Finally, the fact that all factors in both groups improved over time suggests that traditional website usability studies may not provide an accurate representation of the user's experience. Users' abilities related to a website may improve over time; thus, usability studies may need to be conducted repeatedly, or after user have had time to learn to navigate the site. Library researchers and practitioners should attend to these implications when designing Web interfaces and when evaluating websites for use by students.

In addition to the structural and generic context of websites, the visual appeal of websites may impact their use, particularly for members of Generation Y, or today's college students. Djamasbi, Siegel, and Tullis (2010) conducted a study of Generation Y'ers related to their perceptions and viewing of several websites. The first phase of the study consisted of a survey to rate the visual appeal of various websites. This portion of the study resulted in identifying four characteristics of websites present on sites that participants rated as significantly higher than pages not including these elements. The four characteristics were a main large picture, pictures of celebrities, a search feature, and little text. For phase two, three web pages featuring the four characteristics, and three pages lacking all of the characteristics, were shown to a different group of Generation Y participants. Eye movements were tracked using an unobtrusive eye-tracking device. Heat mapping of the data showed that participants fixated the longest on, and in order, the four characteristics identified in the first study (Djamasbi et al., 2010).

The results of this study, taken together with those of Vaughan and Dillon (2006), suggest very specific information about the expectations, preferences, and needs of undergraduates when using websites to access information. The findings of Djamasbi et al. (2010), in particular, present a strong challenge for librarians, who tend to be very textual in their work.

Although much of the literature reviewed in this section discusses scholarly communication, little or no reference was made to the production of knowledge in written or other formats. The research is clear that students increasingly reject reading large blocks of text on web

pages. This finding is directly related to composition and rhetoric in the context of reading and writing as a sort of supply and demand economy. If readers increasingly demand smaller blocks of text and more visual rhetoric, authors of texts will need to shift their design and composition to be read, whether the reader and the author are the same or different people. As Wysocki (2004) noted, effective composition is the direct result of careful analysis of visual and textual elements of one or more genres, and considering the intended audience. A high comfort level with reading short blocks of text may result in preferences to write in a similar fashion. Indeed, blogs, microblogs, and other social media are one indication that students' writing habits are already changing.

Information Seeking by Academic Discipline

A large body of research indicates that there are disciplinary differences in information seeking behaviors. In the context of information seeking as a unification of reading and writing, disciplinary differences are not unexpected given that research in both reading and writing has revealed disciplinary differences in the ways people read and write. The literature in this area generally takes three forms: (1) comparative studies of information seeking across many disciplines; (2) studies of information seeking within a specific discipline; and (3) studies that examine disciplinary differences incidental or tangential to non-disciplinary aspects of information seeking. Because the body of literature is so large, much of it conflicting, this section focuses on relatively recent research related specifically to undergraduate information seeking by discipline.

Whitmire (2002) conducted a study of undergraduates' information seeking behaviors. Biglan's (1973a, 1973b) model of disciplinary differences, categorizing academic disciplines along three dimensions, was the theoretical framework of the study (Whitmire, 2002, p. 631). The three dimensions are: (1) hard versus soft; (2) pure versus applied; and (3) life versus nonlife. "Hard" disciplines are those in which members of the discipline are more likely to agree about the important research questions of the field than those in "soft" disciplines. Hard disciplines include the physical sciences and engineering, while soft disciplines include fields in the humanities and social sciences (Whitmire, 2002). "Pure" disciplines, according to Biglan,

include those in which research tends to be more theoretical, such as the physical sciences, humanities, and social sciences, versus the "applied" disciplines, where research is often more practical. Such fields include engineering, business, and education. The third dimension describes the discipline's relationship to living organisms. This dimension categorizes disciplines as "life" versus "nonlife." "Life" disciplines include the social sciences and education, whereas "nonlife" disciplines include the physical sciences and engineering. Biglan's framework has been the basis of many studies related to higher education. Whitmire (2002) cited a selection of studies based on Biglan in her conceptual framework.

Whitmire (2002) used ten survey questions about information seeking activities to compare information seeking behaviors among undergraduate students along the three Biglan dimensions. She found a number of significant relationships between the various disciplines and information seeking behavior. For example, in the hard versus soft disciplines, participants "in the soft disciplines engaged in more information-seeking activities with the exception of using the library as a place to read or study" (Whitmire, 2002, p. 634). Similar results were found with students in the pure and life disciplines who engaged in more information seeking behavior than did students in applied and nonlife disciplines.

Whitmire (2002) noted that the population she studied, unlike previous studies of disciplinary differences in information seeking, was undergraduate students. She cited many previous studies of graduate students and faculty, and some of her results differed from previous findings. She attributes the differences to those in the populations studied. Whitmire, unlike several other authors, found that humanities students used indexes to locate journal articles and sought assistance from reference librarians. Whitmire's study validated previous research that showed that "physical science majors used indexes to find journal articles" (Whitmire, 2002, p. 636). Social science majors, on the other hand, sought information through citation chaining and browsing library collections. Whitmire's study contradicted another part of that prior research that showed no difference in the information seeking behaviors of social and physical scientists. As Whitmire noted, the difference in disciplinary expertise between the undergraduate students she studied, and the more expert scholars studied previously, accounted for differences in the findings over prior research.

Whitmire's study provides further evidence that librarians must tailor instruction to meet the information seeking needs of novice and expert users, and must address the differences in research needs across the academic disciplines.

While the literature reviewed thus far in this chapter provides a strong indication of the ways in which undergraduate students locate and use digital resources, none of this literature provides any insight into the impact of electronic research on writing across the disciplines. Since writing has played such a minimal role in the literature on information seeking in general, this is not surprising. However, it is reasonable to hypothesize that with dramatic changes in the ways undergraduates seek information, the ways they write for research have changed as well. Software productivity packages often include outlining functionality that, presumably, saves students time in organizing their research notes. How does such software affect students' analysis and synthesis of their research data? Conversely, how do the disciplinary conventions of reading and writing affect students' use of technological information sources? The needs of writers with respect to disciplinary standards for evidence and citation, for example, are likely affected by such things as the citation functionality of online databases, or the citation software embedded in writing software. These and similar important questions about the relationships between technology, research, and writing continue to be explored in the literature. Answers are crucial if we are to reconnect reading and writing.

Screen-Based Reading Behaviors

With an understanding of how technology has changed the ways people seek information, and how information seeking differs by academic discipline, it is necessary to examine changes in the ways people read after they have found information they sought. Reading is by far the most common method of gathering information for research. The role of writing is secondary to reading in the process of information gathering. Writing tasks such as note-taking, outlining, and annotating help readers organize their ideas. While the focus of this section is on reading, writing as it assists in reading is discussed briefly as well.

Widespread access to technology has fundamentally changed the ways users, particularly younger users, read. Some scholars have argued that digital texts threaten literacy. A more convincing argument,

it seems, is that technology has changed reading, in some ways for the better. Certainly, digital texts afford many benefits that print documents do not, including searchability, hypertextuality, multimedia formats, and even the ability to magnify the text from the reading device. Researchers are increasingly interested in the effects that on-screen texts might have on reading behaviors.

Liu (2005) surveyed professionals and graduate students to better understand reported changes in reading behaviors over the previous ten years. Participants reported a number of changes in their reading behaviors over that period, many of which can be identified as technology related. Interestingly, no participants in the study reported reading less than they had ten years previous; in fact, the majority reported reading more. This suggests that technology is not the death knell of reading, as has been suggested by some scholars. *What* and *how* participants in Liu's study read changed dramatically over the decade. A large majority (83.2%) reported spending more time reading electronic documents. Reading behaviors that increased during the study period included: browsing and scanning, keyword spotting, one-time reading, reading selectively, and non-linear reading. Reading behaviors that decreased included sustained attention, in-depth reading, and concentrated reading (Liu, 2005). While Liu did not discuss the ways in which changes in reading behavior might impact writing, it seems logical to conclude that the reading behaviors he observed might negatively impact scholars' writing. Less concentrated reading likely reduces a researcher's ability to analyze and synthesize the information to the extent required to produce scholarly writing.

Liu is one of the few authors who examined both reading and writing behaviors in the context of technological advancements by studying the annotating habits of participants. More than 50% of participants reported never highlighting or annotating documents, while all reported highlighting or annotating printed documents at least occasionally. Regarding printing for reading, all participants reported printing electronic documents for reading at least occasionally, and more than 71% reported doing so frequently. Liu cited previous research indicating that people frequently search or browse electronic documents, but are more likely to print documents for in-depth reading.

What is not clear is whether people print documents for the purpose of highlighting or annotating, or if they print them because they prefer to read the printed documents, and therefore highlight or an-

notate in the format in which they happen to be reading. Liu cited several studies indicating that people have strong preferences for reading printed rather than electronic documents, that reading from a monitor is slower than reading printed text, and that readers find online text to be more difficult to understand, less interesting, and less credible than printed versions. All of this suggests that readers have strong preferences for reading in print; however, further research is necessary to understand whether those preferences might be cultural, generational, or mitigated by improvements in screen quality and portability of electronic devices. Throughout history, the most successful and enduring technologies have been those with pages that provide the reader a sense of the length of a document, allow leafing through pages, and allow the reader to hold the document at a comfortable reading distance from the eyes.

Annotation is a key activity related to the connection between reading and writing. It is an act that allows the reader to write about what they read contemporaneously and in the same medium. While most annotations are brief and unedited, the act of annotating brings together reading and writing in a way that most other writing cannot. Annotation helps the reader understand and contextualize the text, and provides notes that may lead to more complete writing at some point in the future. This relationship between reading and writing may help explain why annotation is so important to scholarly researchers.

Given the dramatic increase in the amount of online reading, it is useful for librarians, educators, and web designers to understand how students navigate full-text databases when searching for journal articles. Interestingly, the distinction between searching for resources and reading online has blurred. Although several of the studies discussed next might appear to be about searching for texts, they actually focus on how people navigate through texts online. This distinction will continue to fade as more and more texts are published online and as the act of reading increasingly becomes an issue of online navigation.

Nicholas et al. (2008) studied the transactional logs of several electronic journal libraries to learn about students' use of the libraries to read and download articles, and followed up with a questionnaire about online search behaviors. The authors found that students spend much of their time navigating electronic journal libraries, evidenced by the number of times they clicked on navigational pages, such as menus, lists, and search pages. This suggests that web designers must

attend to the organizational and navigational structures of digital libraries to help users efficiently locate information.

Nicholas et al. (2008) also found that students, more than faculty, were likely to view the full text of articles rather than abstracts. While the authors did not discuss the implications of this point in detail, it seems of great importance to librarians and educators. As novice researchers, students may need the entire context of an article to determine whether it is relevant to their search, whereas faculty may feel they have the expertise know whether they wish to read the full-text article from the content of the abstract, or to continue with their search. Faculty need to understand that this is one of the many ways their search strategies differ from those of their students. Librarians can develop instruction to reflect students' research practice and to help them develop a research strategy using abstracts as their research experience increases. The authors noted that most electronic journal libraries require users to access full-text articles through an abstract page. This could discourage students from navigating further if abstracts are not perceived as being important to their search.

Transaction log data showed that users viewed full-text articles, on average, for less than two minutes. As they pointed out, this is clearly not enough time to carefully read a typical scholarly article. A follow-up survey of students and faculty found that 43% of faculty reported reading in print format their last article searched, suggesting a large proportion of articles being printed for reading rather than read online (Nicholas et al., 2008). This is a likely explanation for relatively short online reading times.

The study found that "scholars at research universities spent longer viewing an article than their counterparts in teaching universities" (Nicholas et al., 2008, p. 196). Overall, students spent more time reading online than did faculty. This result was supported by both the log and survey data, suggesting that students may be more inclined generally to read online than faculty. Finally, the authors found evidence that students and faculty alike may avoid reading more online than necessary. Shorter articles tended to receive relatively longer online reading time, and longer articles were more likely to be read as an abstract and less likely to be read online (Nicholas et al., 2008).

E-readers, Reading and Writing

With the recent rise in popularity of e-readers, it is becoming increasingly necessary to understand how previous research on reading remains valid; since e-reader manufacturers continue to improve the technology in an attempt to make reading electronic books simulate reading on paper. E-readers such as the Nook and Kindle, replicate for the first time the size, shape, and weight of paper books as an electronic technology, and screens have improved such that readability is far superior to older technologies. A key question is whether the affordances of e-readers are such that they offset readers' negative perceptions about reading online, including lower comprehension, speed, and credibility than their printed counterparts. The popularity of e-readers suggests that they may be the first digital technology that offers serious competition to the printed book.

E-readers and other tablet computing devices have the exciting potential to provide a technological means to reconnect reading and writing. With built-in annotation and highlighting functionality, they integrate reading and writing in a single document. Word processing applications are often available for tablet devices. While this integrated reading and writing functionality is not new to computing technology, the advantage of e-readers and tablet devices is their portability and ease of use. The remainder of this section examines questions related to the use of e-readers in reading and writing.

Very few empirical studies have been published about the potential influences of e-readers on reading. The majority of the literature around e-readers takes two forms: (1) opinion pieces that either attempt to predict the future of e-readers in libraries or lament the impending death of the printed book as a result of the rise of e-readers, or (2) non-scientific case study articles describing the use of e-readers in libraries (see Dougherty, 2010, and Gielen, 2010, for examples of such literature). It is characteristic of the literature related to any new technology takes this form. Over time, the literature begins to shift from descriptive and prescriptive to research. E-readers are such a new technology that it is likely that studies are in progress but have not yet made their way into scholarly journals.

Because empirical research on e-readers is currently lacking, this section provides a summary of questions raised in the literature about the potential impact of e-readers on reading. Dougherty (2010) pub-

lished a comprehensive summary of the benefits and problems about the potential use of e-readers in libraries. A number of the issues discussed could potentially change users' reading behaviors. First, Dougherty described the display technologies and compared them with older technologies and books. Unlike other hand-held devices and computers, e-readers are not backlit, making them easier on the eyes. He noted that the disadvantage is that, like printed books, an external light source is required for reading. Other improvements in display technology have also made e-readers easier to read.

Dougherty (2010) also raised the universal problem of content. First, some e-readers are proprietary. Although many e-readers are compatible with some standard formats, users are often required to purchase much of their content through the manufacturer's online store. Second, e-books do not fit well with traditional library purchasing models. Under current sales models, a library would need to license them like software. Libraries and distributors will continue to develop models for the shared use of e-books. Third, e-readers allow users to carry with them hundreds or thousands of books, dramatically changing the way they access information. All of these issues have the potential to change information seeking, reading behaviors, and library use.

A number of academic libraries have deployed e-books and e-readers. Dougherty (2010) provided several, brief examples. Technological compatibility, user support, security, and Web design became more important in libraries supporting e-readers, and must be considered to maximize user benefit. Users, it appears, are not completing rejecting other formats in favor of e-books. It is difficult to understand how much of this dynamic can be accounted for by the affordances of non-digital reading formats versus the simple lack of availability of many information resources in digital formats. Time and research may tell.

Research on the use of e-readers had primarily been conducted by digital content providers and manufacturers, such as eBrary and Sprinter. One notable exception is a study conducted by the American Council of Learned Societies (ACLS), an organization of American societies interested in humanities scholarship. The ACLS maintains a digital collection of nearly 2,800 scholarly works in the humanities. The Council studied the viability of constituent reading of scholarly monographs using e-readers. ACLS converted three of the titles in their collection into several electronic formats commonly read by

e-readers, and then surveyed users about their experiences reading the
scholarly works using e-readers (Gielen, 2010).

While the study sample consisted of users of the ACLS digital col-
lection—and was made up of more than 60% librarians and only 4%
students—the study produced some interesting results, even if they
cannot be extrapolated beyond the sample. More than 90% of par-
ticipants reported satisfaction with simply reading books on a digital
reader. However, for scholarly research, only 13% of respondents re-
ported preferring e-readers over more traditional sources of informa-
tion. Challenges reported by users included difficulty in navigating
the text, in highlighting and annotating, and in using equipment fea-
tures. Gielen (2010) found no clear preference for a digital book for-
mat, although XML was dropped as a format early in the study due
to navigation problems on certain e-readers. Neither did participants
indicate a clear preference for one type of digital reader over another
(Gielen, 2010).

Generalizability of the study results is questionable due to sam-
pling bias. It seems likely that librarians, the majority of the study
sample, might be more comfortable with the technology and read-
ing formats studied. The general population would likely have more
difficulty than the study participants in completing the study activi-
ties. Undergraduate students, however—presumably younger than the
96% of the sample reported not as students—might be more comfort-
able with the technology and in strategizing ways to overcome the
challenges of reading digitally.

Gielen's (2010) results indicate that many of the problems related
to reading in electronic formats discussed earlier in this chapter per-
sist, even with e-readers. While many of the issues related to the dis-
play have been resolved by e-readers, and the use of electronic reading
devices in scholarly research continues to be hampered by difficulties
with highlighting and annotating in particular. This suggests that re-
searchers have a need for technology that helps them integrate reading
and writing, particularly through annotation functionality. Gielen ex-
pressed optimism that future improvements to e-readers may alleviate
some of the challenges found by the study. Much research is needed to
understand how younger readers, undergraduates in particular, inter-
act with e-readers, and to compare reading behaviors and preferences
with e-readers versus older technologies.

Empirical research on e-readers as writing devices is also lacking. Faris and Selber (2011) raised a number of important questions related to the use of e-readers in undergraduate composition classes. The majority of their review focused on issues of reading and navigation discussed earlier in this chapter. They found that students often struggled with technical and navigation issues related to e-readers, such as file naming conventions, but that they adapted to the constraints of the product to meet their learning needs. The authors were also surprised to find that students used e-readers conservatively, primarily using only the functions necessary to meet assignment requirements. This may indicate that college students have not made the transition from print to electronic texts as completely as we may have previously thought.

Regarding writing and e-readers, Faris and Selber (2011) noted that the e-reader they tested did not include an annotation feature. Students improvised a variety of methods to meet their annotating needs, both in print and digitally. The authors saw both positive and negative aspects of students' workarounds for annotation. Students reported being more engaged with the text after devising annotation systems, but they also reported avoiding writing down long quotes that they otherwise might have highlighted (Faris & Selber, 2011).

While not an empirical study, Faris and Selber's review reinforces the results of previous research, including the importance of annotation and highlighting while reading in either print or digital formats. It also supports the idea that students are highly adaptive when using new or challenging technologies to meet course requirements. In addition, it shows that many of the questions related to digital reading and writing remain unanswered. The review ends with a long list of technology, pedagogical, and institutional questions about e-readers, many of which have been raised in this chapter.

Newer tablet computing devices such as the iPad have the potential to reconnect reading and writing in ways that e-readers have not been able to. With virtual keyboards, the ability to capture handwriting and computing resources more like full-sized computers, electronic tablets allow annotation and the electronic integration of reading and writing in ways that older technologies, including e-readers, have not been able to accomplish successfully.

Digital Information Literacy Instruction and Libraries

It is clear that changes in technology have dramatically changed the way users seek, access, and read information, and have begun affecting writing as well. Some authors have seen these changes as a threat to books and libraries. In actuality, as much of the literature cited earlier in this chapter has shown, technological advancements have changed, and perhaps increased, the need for librarians as intermediaries in the information search process. Instead of being gatekeepers of information, users need librarians to act as search experts who can help them navigate the vast, disorganized array of information resources available at their fingertips.

As the role of the librarian changes, so does the need for information literacy instruction. Traditional information literacy instruction has been linear and de-emphasizes the complexity of both digital information and the devices used to access it (Bodi, 2002). Further, librarians have often taught classes on a one-size-fits-all basis, while research and anecdotal evidence clearly show that scholars have always searched for information in ways unique to their discipline. In a world of print resources, essentially bound by library walls, this method worked because students had little other choice for seeking assistance with accessing information. This model of information literacy instruction is not likely to be sustainable going forward, as students will increasingly go elsewhere for assistance if the instruction provided by libraries is not tailored to them, their discipline, and their specific information needs.

Further, research by Kuhlthau (1991) and others has shown that information-seeking is a highly personal, non-linear, subjective, and developmental process (Weiler, 2005). The process can change for an individual and even from one search to another. Users are more likely to perceive value in information literacy instruction that takes into account these factors and provides particular attention to users as they move through the more difficult stages of the information search process.

Developing such information literacy instruction might seem a daunting task. Conceptually, however, it is congruent with the user-centric movement advocated by library and information theorists since at least the 1980s, and aligns well with the constructivist movement in education. A common question raised in response to calls for user-

oriented services is how libraries, with limited resources and serving large populations, can offer what seem to be highly customized services. There are ways to meet the increasing demands of users, even within the constraints of most library staff budgets. The most fundamental—and arguably the most challenging—change required is in staff thinking. No longer does the library provide services to the student body, but to the student. Such a fundamental shift is never easy, requiring professional development, professional dialog, strategic thinking, case studies, pilot programs, and visitations to help staff visualize user-oriented services.

Library staff must also re-conceptualize how they deliver instruction. In-person classes are becoming less desirable to students, particularly if they are not required. Information literacy instruction lends itself well to delivery via technology, including podcasts and Webinars. Librarians can design short instructional modules on specific topics tailored to users in specific disciplines or with different levels of expertise. The modules can be recorded and made available on the Web for use when and where students need them. Instructional modules must be kept updated as technology and resources change; this is not dissimilar to updating in-person instructional materials before offering a live class. One of the questions often raised about asynchronous delivery of instruction is the inability of students and faculty to interact with librarians in real time. With the widespread use of chat reference services, often on a twenty-four hour basis, assistance for students accessing online instruction can be delivered as needed. A continuing challenge for libraries is in marketing online instruction to students. Many libraries have long struggled with marketing in-person instruction. Making access and content more relevant and attractive to students will help in those marketing efforts.

Yet another challenge facing librarians in promoting information literacy in a digital world is the often complex nature of searching multiple online resources simultaneously. Users' standards for searching has become a simple, single search box characteristic of search engines such as Bing or Google. In many academic libraries in particular, searching the many available databases requires multiple searches, understanding different search strategies and thesauri, and navigating results in various formats. Way (2010) observed that, until recently, federated searching was the most promising solution to this problem. However, even federated searching presents challenges to users, in-

cluding limitations on results retrieved, speed, and integrating search results in a single list with de-duplicated results (Way, 2010).

Over the last few years, new commercial products have become available to address concerns with federated searching. One of the earliest was Serials Solutions' *Summon*, referred to as a "Web-scale discovery tool" (Way, 2010, p. 214). Other competing products include EBSCO's *Discovery Service* and *Ex Libris* from Primo Central. Way (2010) writes: "Unlike federated search tools which search across a limited number of individual resources simultaneously, these web-scale resources pre-harvest content into one single index, allowing users to search across a greater amount of content" (p. 214). Web-scale discovery tools are faster than federated searches, and they merge, de-duplicate, and rank results from multiple databases in one results list. Unlike products like Google Scholar that search the entire Web, Web-scale discovery tools can be limited to search the resources available through a library (Way, 2010).

Way (2010) conducted a study of library resource use after implementing *Summon* at Grand Valley State University. He analyzed database usage statistics prior to and after *Summon* became the main search box on the university libraries' home page. Way reported a steady increase in the use of the libraries' online databases from 2006 through 2008. In 2009, there was an unexpected and unexplained drop in usage of those same databases; however, during the study period, usage statistics did show a steady use increase of certain databases, certain online newspapers, and the library's online catalog of monographs through *Summon* (Way, 2010).

Way's (2010) results indicated that *Summon* broke down the "silos that existed based on subject content, publisher or content provider" (p. 219). Further, the Web-scale discovery service directed users to content that they might otherwise have not found, away from general databases of popular literature from which many undergraduates had previously started their research, despite the questionable content of those databases for scholarly research. Way was concerned, however, about the drop in use of more specialized, subject-oriented databases. Further research is necessary to better understand the nature of the decrease. In the meantime, Way recommended that information literacy instruction direct users to the content from those databases.

While libraries and librarians traditionally have focused their work around conducting research, primarily through reading, the shift to-

ward librarians as teachers of information literacy has resulted in a larger focus on writing as an integral part of information seeking. It would do little good for a student to conduct research and not produce a means of sharing that research with other scholars. Further, writing provides the framework for conducting research in at least two ways: as a course writing assignment and as a mechanism to organize students' thoughts as they read and gather information to meet course requirements. Librarians have increasingly become partners in writing instruction through information literacy instruction in much the same way that they traditionally have been involved in reading instruction. This shift is an important reconnection of reading and writing.

An emerging technology trend that is assisting librarians and other faculty members reconnect reading and writing is the explosive increase of social media. Blogs and microblogs, for example, situate reading, writing, and publishing in time and space. Their use as tools for scholarly research and writing are somewhat limited currently, however. Information sources and scholarly writing products generally require much larger quantities of text than the amount of information that blogs and microblogs are generally used to convey. Scholars use these and other social media for scholarly communication in ways that were not previously feasible. The inevitable evolution of social media will surely continue to reconnect reading and writing, in many unpredictable ways. The work of librarians with respect to information literacy will need to evolve as well.

Conclusion and Implications for Research

It is clear that technology has profoundly changed how users seek, access, and read information. It has also altered their needs related to information literacy. The rise of social media, for example, is a clear reconnection of reading, writing, and information seeking. Exactly how, and to what extent, technology has influenced reading and writing for the purposes of information seeking is not as well understood. It is fluid and changes with continual technological advancements. Much additional research is necessary to understand the exact nature of the relationships between reading, writing technology, and digital literacy in the context of information seeking. As with all research related to technology, research questions and methods must be updated continually to track the rapidly changing nature of technology use.

It is also not clear whether technology has changed the fundamental nature of information seeking. Because most models of the information search process are based on conceptualizations of psychology and learning, any indication that technology might be changing the information search process suggest that technology could be changing the ways in which people think. Clearly, there could be many other explanations for such changes, including information search models that are ill-defined relative to technology. However, it will be useful to continue to study information seeking to monitor such changes and to understand the origins of changes in information seeking behavior.

Many models of the information search process that originated in print-dominated environments have been criticized as being overly linear. This has become even more apparent as text has become less linear. Research is needed to better understand whether the underlying constructs of existing models are valid in highly technological environments, or if new models are required to more accurately represent information seeking in the digital age.

Extensive research has been, and continues to be, conducted relative to reading digital texts. As technology changes, scholars must continue to understand the nature of online reading and the mutual evolution of reader, medium, and text. As the newest devices for reading electronic text, tablet computing devices hold tremendous promise for changing reading, presenting the first real technological challenge to print books. Further, such devices offer the potential to reconnect reading and writing via technology. This technology is so new that little research has yet been published on the subject. More studies on tablets and their influence on reading and research are needed, and likely are forthcoming.

Rapid advances in technology have created new opportunities and challenges for libraries in developing programs of information literacy instruction for students. Much of the literature on information literacy instruction is descriptive or prescriptive. More research is needed to help librarians understand effective instructional methods as they re-conceptualize their information literacy instruction for digitally-oriented students. One of the challenges in delivering information literacy instruction is related to the disparate and often confusing nature of searching multiple online databases. This chapter cited one study of Web-scale discovery services as a method of assisting librarians and students to navigate an increasingly complex digital universe of infor-

mation resources. Much additional research is needed to help librarians understand how such tools can assist them in meeting students' information needs, and also to help developers improve and design tools that meet similar needs.

Notably absent from the literature is research on the relationships between social media, reading, writing, and scholarly communication. For example, scholars are increasingly reading scholarly journals by receiving journal tables of contents through many different technological means, including RSS feeds and text messages. Technologies such as Facebook could become methods for disseminating scholarly information; they are already are devices for scholarly communication. Social media hold tremendous potential for reconnecting reading and writing, as both are necessary and integral to participation in the communities that have formed around social media. Additional research will help scholars better understand how such technologies affect scholarly research and communication, and what impact they might have on reading and information seeking behaviors.

The digital age has introduced much uncertainty and change in the interactions between students, librarians, information, and media. This dynamic presents many opportunities for research, and exciting opportunities to better meet students' information needs. The ever-evolving nature of technology necessitates continual research and changes in the work of librarians to meet the equally fluid expectations of students. The work of librarians is as important, if not more so, than it ever has been. Librarians will continue to evolve to provide quality services to their constituents, as they have done throughout history.

Research necessarily connects reading and writing. Indeed, one could make a strong argument that reading and writing have never become disconnected in the domain of information seeking. It is clear that writing has been overshadowed by reading in scholarly discussions of information seeking; therefore, librarians and educators have been delivering an incomplete product to students. A variety of technologies—in particular tablet computing devices, web publishing, and social media—offer real potential to reconnect reading and writing. Librarians and educators must leverage these and future technologies to help students connect reading and writing to actively contribute to scholarly discourse of the future.