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Digital reading

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Digital reading: An overview*

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Abstract

Purpose: Digital reading is an important research topic in contemporary information science research. This paper aims to provide a snapshot of major studies on digital reading over the past few years.

Design/methodology/approach: This paper begins by introducing the background in digital reading, then outlines major research findings.

Findings: The paper demonstrates the growth of interest in information science and other disciplines in digital reading behavior. Five areas are highlighted: Digital reading behavior, print vs. digital, preference for reading medium, multi-tasking and learning, and technological advancement and traditional attachment.

Research limitations: Only major studies in the North American and European countries are covered.

Practical implications: Understanding reading behavior in the digital environment would help develop more effective reading devices and empower readers in the online environment.

Originality/value: The paper represents a first attempt to compare, evaluate, and synthesize recent studies on digital reading. Implications for the changes in reading behavior are discussed, and directions for future research are suggested.

Keywords   Reading, Behavior, User studies

1   Introduction

The widespread use of digital resources has brought about significant changes in reading practice and behavior as people spend more time reading online. Since 2004, Google has partnered with major university libraries and other libraries to

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scan print books in their collections. According to *The Economist*[1], "Amazon now sells more copies of e-books than paper books. The drift to digits will speed up as bookshops close. Borders, once a retail behemoth, is liquidating all of its American stores." Electronic resources at libraries are increasingly popular. For example, the number of usage of electronic resources at the Peking University Library has tripled, from about 10 millions times in 2006 to 30 million times in 2011[2].

Cull[3] stresses: "Since readers are very familiar with reading — we do it every day in many aspects of our lives — it is often taken for granted. It is easy to forget how crucial reading continues to be to the formation and communication of human knowledge. It is central to the operation of modern society. However, because reading is so important, a seemingly small change is likely to have profound ramifications. Far from a small development, online digital text represents a revolution in human learning and communication that we are only beginning to understand." This paper begins by introducing the background in digital reading, then outlines major research findings. Implications and future research directions are also discussed.

2   Impacts of digital technology on reading

The increasing mechanization of print facilitated a shift from intensive reading to extensive reading. Around 1750 there was a dramatic change in the way people read documents. Before this time, people were reading *intensively*. They had only a few books to read and they read them over and over again. By the early 1800s, however, people started to read things *extensively*. They read all kinds of materials, especially periodicals and newspapers, and moved through one item after another[4]. With the advent of computers and the Internet, the recent decades have witnessed another drastic change in the way people read: Browsing or scanning is becoming a principal reading pattern in today's information-intensive environment. Birkerts stresses[5]: "In our culture, access is not a problem, but proliferation is. And the reading act is necessarily different than it was in its earliest days. Awed and intimidated by the availability of texts, faced with the all but impossible task of discriminating among them, the reader tends to move across surfaces, skimming, hastening from one site to the next without allowing the words to resonate inwardly." As a result, we "know countless more 'bits' of information, both important and trivial, than our ancestors."

Bolter states[6]: "The shift from print to the computer does not mean the end of literacy itself, but the literacy of print, for electronic technology offers us a new kind of book and new ways to write and read." Digital media contribute to a transformative shift in reading. They also introduce a number of powerful advantages that are traditionally absent in the print environment, such as interactivity, nonlinearity, immediacy of accessing information, and the convergence of text, images,

audio, and video. Lanham[7] compares the difference between print literacy and digital literacy. He asserts that "In the world of print, the idea and its expression are virtually one. The meaning takes the form of words; words generate the meaning. Digital literacy works in an inherently different way. The same digital code that expresses words and numbers can, if the parameters of expression are adjusted, generate sounds and images. This parametric variation stands at the center of digital expressivity, a role it could never play in print."

While new media bring unprecedented freedom for readers, they also induce a new form of constraint[8]. In the print environment, the text is fixed and the author determines the order in which ideas are presented. In hypertext, however, the author provides options, but readers choose the order through activating links[9]. The proliferation of hyperlinks has a profound impact on people's reading behaviors such as nonlinear reading (e.g., jumping from page to page and from site to site). Even for readers who start reading from the same page, what they read may be different depending on which link is activated. Hyper-reading may also reduce the sustained attention to any textual source and lead to more fragmented reading, since each page on the Web has to compete with many other pages for the user's attention. In terms of hypertext linking, the author's conception of the connection's relevance may not be the same as the reader's. Links imposed may not be logically associated with the original topic, which may send readers to a site for no discernible purpose and result in disorientation[10].

A number of scholars argue that the arrival of digital media together with the fragmentary nature of hypertext is threatening sustained reading. Birkerts[11] and Stoll[12] note that the digital environment tends to encourage people to explore many topics extensively, but at a more superficial level. Hyperlinks distract people from reading and thinking deeply about a single subject. In a study of readers who read either a stimulated literacy hypertext or the same text in a linear form, Miall and Dobson[10] also find that "hypertext discourages the absorbed and reflective mode that characterizes literacy reading." Thirunarayanan[13] observes that "if a Web page does not load within three seconds, people click their way to another Web page or site. Clicking is fast becoming a substitute for thinking. Clicking requires less effort than thinking and is in some instances less painful than thinking."

3   Research on digital reading

Over the past 15 years, especially with the popularity of e-readers, digital reading has been a focus of numerous studies. The intellectual ferment attending this dramatic development has brought with a wealth of new studies and approaches.

3.1 Digital reading behavior

A recent survey by Gartner Inc.[14] shows that the time people spend reading on a screen is now almost equal to the time spent reading from print. With the growing amount of digital information available and the increasing amount of time people spend on reading electronic media, the digital environment has begun to affect people's reading behavior.

Liu[15] investigates reading behavior in the digital environment by analyzing how people's reading behavior has changed over the past ten years. His study shows that with an increasing amount of time spent on reading electronic documents, a screen-based reading behavior is emerging. This screen-based reading behavior is characterized by spending more time on browsing and scanning, keyword spotting, one-time reading, nonlinear reading, and reading more selectively, while less time is spent on in-depth reading, concentrated reading, and decreasing sustained attention. While people today spend more time reading than they did in the print-only past, the depth and concentration associated with reading has declined. Liu's findings have been further confirmed by a series studies at University College London[16,17] and University of Stavabger, Norway[18]. Nicholas and Rowlands[19] characterize reading behavior in digital libraries as "power browsing", where scholars seldom read text online for a long period of time. In study of how expert readers handle printed and digital documents, Hillesund[18] attempts to explain differences in digital reading and paper-based reading. He finds that online reading is characterized by browsing, skimming, and bouncing—that is "discontinuous and often fragmented reading." In contrast, concentrated reading is typically done on paper. Online reading tends to encourage discontinuous reading. Baumann[20] finds that nearly 6% of students and 8% of professors read the e-books they consult entirely.

Mangen's study[21] indicates that digital reading is dominated by shallow forms of reading (e.g., scanning and skimming), and digital text makes us read in a shallower, less focused way. Carr[22] notes that while there is nothing wrong with browsing and scanning, "What is different, and troubling, is that skimming is becoming our dominant mode of reading." Cull[3] further stresses that: "University educators are well aware of the Internet's pervasive illusion of instantaneous knowledge. In a world influenced by a powerful online culture, we must remain committed to motivating our students to take the time required for in-depth reading. Independent learning, which continues to be based on in-depth reading, will always take time."

3.2 Print vs. digital

Many recent studies have found that online reading and reading on print differs significantly in a wide range of aspects.

Sellen and Harper's studies[23] show that the computer system is superior in many aspects such as storing, distributing, and retrieving documents. Paper, on the other hand, is heavily used in tasks that required certain levels of sustained attention (e.g., editing, planning, and collaboration). Liu's study[15] finds that annotating and highlighting while reading is a common activity in the print environment. However, this "traditional" pattern has not yet migrated to the digital environment when people read electronic documents, probably because technology as of now does not allow easy annotating.

Many studies also show that reading a digital text leads to lower comprehension compared to a printed text[24,25]. However, based on a study of 66 college students in the US, Moyer[26] finds "no statistically significant differences in comprehension across print, ebook, and audiobook modalities. Participants' levels of comprehension for each text were the same regardless of the format in which it was received." Eden and Eshet-Akkalai[27] examine the active-reading activities of students, who were asked to read, edit, and recognized errors in *short* articles, in a print and a digital format. Again no significant differences are found between the performances of students in the two formats. The finding suggests that today's young readers are proficient in digital reading as they read from print, because digital reading has become an everyday practice among them. However, Eden and Eshet-Akkalai's study focuses on student reading activities and performances on *short* articles. Future studies on student performances on *long* documents (e.g., research papers and textbooks) would improve our understanding in this important area.

Readers' choices and preferences for digital reading and reading on paper are contextual. Previous research demonstrates that people prefer reading online over reading on paper when they read short documents (e.g., emails), when they do casual reading (e.g., news and entertainment), or when they feel bored. Readers, however, prefer reading on paper over reading online when they read lengthy documents (e.g., textbooks), when they need serious/in-depth reading, when they read something that is difficult to understand, when they read scholarly/research papers, or when they need to take notes[28].

Many studies reveal that note-taking while reading seriously is a common practice in the print environment. However, today's kids who were "born digitally" may not have the same need to physically highlight and annotate on hard-copy books. Future studies are needed to continually monitor the changes in reading behavior in the digital landscape.

While it is true that students can view a lengthy document (e.g., e-textbook) on a cell phone or iPod, it is unlikely that they can concentrate on a tiny screen as long as on a printed textbook. A study conducted by Jakob Nielsen in 2010 reveals that

compared with print, iPad readers were 6.2% slower and Kindle readers were 10.7% slower[29]. Future research on the impact of e-readers and mobile reading will improve our understanding in this area.

3.3 Preference for reading medium

Research finds that readers' choices and preferences for reading medium are very diverse and contextual[30]. Despite increasing popularity of digital resources, we should note that not a single type of format has ever proven adequate for all needs and ideal in all situations. Administrators and librarians need to be aware of students' continued desire to read on print as a source for in-depth reading[3]. For example, even though e-textbooks offer a number of features and functions that are not available with printed textbooks such as searchability, built-in dictionary, crossing referencing, and ease in copy and paste; it is somewhat surprising that e-textbooks have not been embraced as whole-heartedly anticipated. According to the National Association of College Stores, digital versions make up no more than 3% of recent textbook sales[31]. A recent report published in *New York Times* also reveals that students still cling to traditional paper textbook in the digital age[31]. The most critical challenge with wider acceptance of digital textbooks is reading and navigation. Students usually highlight texts and write in the margin of their paper textbooks as a way to improve retention and comprehension. While devices have improved overtime, adequate note-taking and note management mechanism remain problematic for many college students. E-book devices can support expansive skimming, but have not yet crossed the critical hurdle of supporting the intertwined reading and note-taking[32].

3.4 Multi-tasking and learning

Multi-tasking while reading is not a new issue (e.g., reading while watching TV or listening to the radio), but the online reading environment brings this issue to a new level of research attention. Since people are so connected, they no longer exist in their own space. Many people, especially younger ones, tend to work simultane-ously on several tasks with multiple windows open. One participant in Liu's study[15] notes: "I have to admit that my attention definitely decreased when I read online. I checked my fantasy football scores and stock quotes, surfed favorite news sites, and listened for the ping of e-mail from a particular response I was expecting." Rubinstein et al. finds that people who engage in multitasking behaviors, such as switching back and forth between the two tasks, may spend 50% more time on those tasks than if they just concentrate on one task before starting the other[33].

Birkerts[11] observes that the younger generation growing up in the digital environment is lacking the ability to read deeply and to sustain a prolonged engagement in reading. In an article, "From Thinkers to Clickers," Thirunarayanan[13] warns: "As interactions with the Web increase, the clicking and wandering behavior gets more deeply entrenched among human beings. Such aimless cyber wandering eventually becomes a substitute for meaningful thinking." Many scholars have raised concerns about the potential effects of superficial digital literacy on learning. Raab[34] warns that "A 2007 study showed that frequent television viewing during adolescence caused attention deficiencies—a fact that can only make you wonder what the added effect of all the new technology has done to the average attention span and the ability to read anything longer than a blog entry."

With the increasing popularity of hand-held communication devices, many people have developed an addiction of constant connection, such as cell phone texting[3].

Digital technology allows us to have instant access to volumes of information that help us improve comprehension. On the other hand, the improved access creates a new challenge for readers as to what material they choose to read. In a world where choices and opportunities are part of our daily lives, we need to set priorities on the kind of materials we want to access. Future studies should focus on the long-term effects on learning (e.g., distraction and memory retention).

3.5   Technological advancement and traditional attachment

According to Hillesund[8], reading is influenced by the design of handheld devices and current multipurpose personal computers (e.g., iPad) because new designs introduce new ways of using hands and fingers (e.g., touch screens). New technology may make it possible to perform onscreen reading activities for an extended period of time. How the arrival of new devices affects reading practices is another interesting area for future research.

It is also important to study how reading practices evolve amidst rapid technological advancement. Studies have shown that people have traditional attachment to print media (e.g., page numbering, ownership, and smell). Fixity is an inherent feature of paper documents, while fluidity comes with digital documents. Fixity is instrumental to maintaining communicative stability and repeatability. There are no page numbers for books on the Kindle. What would happen when an instructor asks students to turn to a certain page of the e-textbook? Young[35] stresses that "The trickiest part of teaching with electronic textbooks is getting everyone on the same page – or to the same part of the digital text." Studies also show that printed documents provide a sense of ownership that is absent in their electronic counterparts.

Many people like the smell of print books. According to Darnton[36], nearly half of French students now still consider the smell of a print book to be a key aspect

of their reading experience. However, it is unclear that this traditional attachment will continue to extend to the next generation of online readers. It should also be noted that the newest generation of readers (i.e., the texting, chatting, blogging, and YouTubing kids) is likely to have a very different experience toward digital reading. It is also important to examine how what reading practices have changed or remain unchanged in the online reading environment. Ongoing research on the evolving reading habits is needed, as we continue to experience rapid technological and societal changes.

4   Conclusions

In an increasingly digital environment, readers (especially younger readers) are likely to gradually develop the screen-based reading behavior, and to increasingly use a variety of strategies (e.g., browsing and key-word spotting) to cope with the information-abundant environment. On the other hand, readers will continue to use print media for much of their reading activities, especially in-depth reading. In-depth reading usually involves annotating and highlighting. People's preference for paper as a medium of reading (especially in-depth reading) also implies that paper is unlikely to disappear in the digital age[37,23].

Rather than deprecating digital technology as hurting our reading quality in the online environment, we should embrace its potential and expect technological advances will reduce the problems even further. While many people do not see digital media as a source for concentrated reading, we should keep in mind that technology is constantly improving and reading practices themselves are evolving.

References

1   The Economist. The books business: Great digital expectations. 2011-09-10. Retrieved on July 3, 2012, from http://www.economist.com/node/21528611.

2   Zhao, A. Academic libraries should not be marginalized (in Chinese). People's Daily, 2012-04-06. Retrieved on July 3, 2012, from http://www.qstheory.cn/kj/jygc/201204/t20120406_149652.htm.

3   Cull, B.W. Reading revolutions: Online digital text and implications for reading in academe. First Monday, 2011, 16(6). Retrieved on July 3, 2012, from http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/3340/2985.

4   Darnton, R. Towards a history of reading. Wilson Quarterly, 1989, 13(4): 87–102.

5   Birkerts, S. Reading in the electronic era. Logos, 1996, 7(3): 211–214.

6   Bolter, J.D. Writing spaces: The computer, hypertext, and the history of writing. Hillsdale, NJ: L. Erlbaum Associates, 1991.

7   Lanham, R.A. Digital literacy. Scientific American, 1995, 273(3): 198–200.

8   Hillesund, T. Digital humanities: Why worry about reading. University of Stavanger Open Research Archive. 2011. Retrieved on July 3, 2012, from http://brage.bibsys.no/uis/handle/URN:NBN:no-bibsys_brage_17599.

9   Ross, C.S. Reading in a digital age. 2003. Retrieved on July 3, 2012, from http://www.camls.org/ce/ross.pdf.

10   Miall, D.S., & Dobson, T. Reading hypertext and the experience of literatu*re.* Journal of Digital Information, 2001, 2(1). Retrieved on July 3, 2012, from http://jodi.ecs.soton.ac.uk/Articles/v02/i01/Miall/.

11   Birkerts, S. The Gutenberg elegies: The fate of reading in an electronic age. Boston, MA: Faber and Faber, 1994.

12   Stoll, C. Silicon snake oil: Second thoughts on the information highway. New York, NY: Doubleday, 1995.

13   Thirunarayanan, M. From thinkers to clickers: The World Wide Web and the transformation of the essence of being human. Ubiquity, 2003, 4(12). Retrieved on July 3, 2012, from http://0-ubiquity.acm.org.millennium.lib.cyut.edu.tw/article.cfm?id=777955.

14   Gartner Inc. Survey analysis: Consumer digital reading preferences reveal the exaggerated death of paper. Retrieved on July 3, 2012, from http://www.gartner.com/resId=1651116.

15   Liu, Z. Reading behavior in the digital environment: Changes in reading behavior over the past 10 years. Journal of Documentation, 2005, 61(6): 700–712.

16   Rowlands, I., Nicholas, D., & Jamali, H., et al. What do faculty and students really think about e-books? Aslib Proceedings, 2007, (59)6: 489–511.

17   Nicholas, D., Huntington, P., & Jamali, H., et al. Viewing and reading behaviour in a virtual environment: The full-text download and what can be read into it. Aslib Proceedings, 2008, (60)3: 185–198.

18   Hillesund, T. Digital reading spaces: How expert readers handle books, the Web and electronic paper. First Monday, 2010, 15(4). Retrieved on July 3, 2012, from http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/viewArticle/2762/2504.

19   Nicholas D., Rowlands, I., & Clark, D., et al. UK scholarly e-book usage: A landmark survey. Aslib Proceedings, 2008, (60)4: 311–334.

20   Baumann, M. E-books: A new school of thought. Information Today, 2010, 27(5): 1–48.

21   Mangen, A. Hypertext fiction reading: Haptics and immersion. Journal of Research in Reading, 2008, 31(4): 404–419.

22   Carr, N. The shallows: What the Internet is doing to our brains. New York, NY: W.W. Norton, 2010.

23   Sellen, A., & Harper, R. The myth of the paperless office. Cambridge, MA: MIT Press, 2002.

24   Morineau, T., Blanche, C., & Tobin, L., et al. The emergence of the contextual role of the e-book in cognitive processes through an ecological and functional analysis. International Journal of Human-Computer Studies, 2005, 62: 329–348.

25   Van Den Broek, P., Kendeou, P., & White, M. J. Cognitive processes during reading: Implications for the use of multimedia to foster reading comprehension. In Bus, G., & Neuman, S. (Eds.) Multimedia and Literacy Development. New York, NY: Routledge, 2009: 57–74.

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26 Moyer, J. E. Teens today don't read book anymore: A study of differences in comprehension and interest across formats. Ph.D. Dissertation. University of Minnesota, 2011. Retrieved on July 3, 2012, from http://conservancy.umn.edu/bitstream/116037/1/Moyer_umn_0130E_12132.pdf.

27 Eden, S., & Eshet-Alkalai, Y. Print versus digital: The effect of format on performance in editing text. In: Eshet-Alkalai, Y., Caspi, A., & Eden, S., et al (Eds.) Proceedings of the Chais Conference on Instructional Technologies Research 2012: Learning in the Technological Era. Raanana: The Open University of Israel. Retrieved on July 3, 2012, from http://www.openu.ac.il/innovation/chais2012/downloads/c-Eden-Eshet-Alkalai-63_eng.pdf.

28 Liu, Z., & Huang, X. Gender differences in the online reading environment. Journal of Documentation, 2008, 64(4): 616–626.

29. Nielsen, J. iPad and Kindle reading speeds, 2010. Retrieved on July 3, 2012, from http://www.useit.com/alertbox/ipad-kindle-reading.html.

30 Liu, Z., & Luo, L. A comparative study of digital library use: Factors, perceived influences, and satisfaction. Journal of Academic Librarianship, 2011, 37(3): 230–236.

31 Foderato, L. In a digital age, students still cling to paper textbook. New York Times. 2010-10-19. Retrieved on July 3, 2012, from http://www.nytimes.com/2010/10/20/nyregion/20textbooks.html.

32 MacFadyen, H. The reader's devices: The affordances of ebook readers. Dalhousie Journal of Interdisciplinary Management, 2011, 7(1). Retrieved on July 3, 2012, from http://dalspace.library.dal.ca/dspace/bitstream/handle/10222/13823/MacFadyen%20-%20The%20Reader%E2%80%99s%20Devices.pdf?sequence=1.

33 Rubinstein, J. S., Meyer, D. E., & Evans, J. E. Executive control of cognitive processes in task switching. Journal of Experimental Psychology: Human Perception and Performance, 2001, 27(4): 763–797.

34 Raab, R. Books and literacy in the digital age. American Libraries, 2010. Retrieved on July 3, 2012, from http://americanlibrariesmagazine.org/features/07132010/books-and-literacy-digital-age.

35 Young, J. This could be the year of e-textbooks, if students accept them. Chronicle of Higher Education, 2009-09-07. Retrieved on July 3, 2012, from http://chronicle.com/article/The-Year-of-E-Textbooks-/48305/.

36 Darnton, R. The case for books: Past, present, and future. New York, NY: Public Affairs, 2009.

37 Liu, Z. Paper to digital: Documents in the information age. Westport, CT: Libraries Unlimited, 2008.