Brief summary on online reading vs. print reading

Center for Teaching and Learning, Fall 2008

In this document, we will provide an overview of research findings on the following questions: Do students read printed text differently than texts presented online? What format do students prefer and why? How do they take notes online and on paper? We conclude with recommendations for the classroom.

Finding Highlights:

- Reading paper texts is faster than reading texts presented online or displayed on a screen
- Readers can orient themselves within the text better on paper
- It is harder to annotate online texts and keep notes
- Working with PDF documents: students tend to copy and paste sections of texts; the more specific their selection was, the better it helped them understand the material
- Students prefer paper documents over online documents
- They are less likely to read online texts than paper texts

1. Do students read printed text differently than texts presented online? Is there a qualitative difference?

Our CTL research associate concluded that rather little research has been conducted on the question of differences between printed versus web-based reading, and most of the studies addressing these differences were done in the nineties when online and digital technology was just starting to shape the learning environment in higher education. In the following section, we review some of the research findings and will also include one section on the usability of PDF documents.

Reading speed, reading methods, and reading comprehension
Do we read slower or faster when reading online?

According to the studies we found, participants read 10-30% slower when reading online (see for example, Nielsen, 1995). These differences in reading speed are assumed to be due to a declined sense of orientation when reading long lines of online text presented in single wide columns (Kurniawan & Zaphiris, 2001). This notion is supported by Dyson (2004) who reviewed the impact of the physical layout of texts presented for online reading. The author found that not only the length of a line but also the number of characters per line is an important variable influencing the speed of reading. Kurniawan & Zaphiris (2001) further report that people reading paper texts use different methods to keep track of where they are in a passage. Some used their finger to point to the words they were reading. Others tended to use a pencil or a pen to guide them through their reading path. These methods were observed to be used less often when reading documents presented online, although some users did use their mouse pointer to guide them in keeping track of their reading location (Kurniawan & Zaphiris, 2001).

In another study by O'Hara & Sellin (1997), students were videotaped while reading an article in print and digital form. Both groups of students (print vs. online) were asked to create a

brief summary of the source article. The main goal of the study was to learn more about the qualitative differences between reading printed text and reading text online. The authors found that subjects reading paper articles used annotations, marginal notes, and asterisks to deepen their comprehension of the text. Subtle changes like the thickness of a line were used to indicate the degree of importance of some piece of text and asterisks were used to link disparate sections of text. In contrast, students reading the texts displayed online expressed frustration about reading on-screen since annotating was a cumbersome process requiring them to draw boxes or change text style[1]. As a result, only one subject of the group did annotate his text. All other subjects relied on the cut-and-paste functions to create a summary outline.

As a second variable, the authors compared how readers navigated through the document. Findings show: (1) navigation of the printed text was quick, automatic, and interwoven with reading, whereas navigation online or on a screen was slow, laborious, and detracted from reading; (2) paper readers used fingers to support navigation and to stay oriented within the text, while online readers failed to make explicit use of cues, such as page length; and (3) paper readers used physical outlines as a memory tool, while online readers had only pictures as anchor points.

As a final variable, the authors investigated spatial layout which was found to be important for gaining an overall sense of the structure of a document and for integrating reading with writing. Results show that paper documents were flexible and dynamic, providing quick access for cross-referencing, and supported the juxtaposition of documents for reading and writing. However, online texts did not provide such flexibility, since readers were limited to a window view of the document. Based on their findings, O'Hara & Sellin (1997) suggest that annotation use, quick navigation, and spatial layout are important variables that support readers in their comprehension of the text.

Finally, it should be noted that most of these studies reach back to the early or late nineties. It is likely that new and especially upcoming generations of students, who grew up in the digital age, experience online reading in a fundamentally different way than previous student generations.

Usability problems when reading PDF documents

The majority of peer-reviewed articles available online are PDFs. Initially, PDF documents were designed to be distributed for printing and not to be read on a computer screen. Jakob Nielsen (2001), who has extensively researched the usability of hypertext, points out that PDF readers show higher task time compared to those who read HTML texts. The slower reading of PDF files might be caused by various factors. For example, PDFs are optimized for letter-sized sheets of paper but not for display in a browser window, which impacts the readers' navigation of the document. Slow navigation/scrolling movement from the top to the bottom of the page and jumpy transitions from one page to the next further slow down the reading process and diminish the reader's sense of orientation within the text. Finally, PDF format (most often read with simple Acrobat reader software) lacks efficient note-taking, search, and navigation tools necessary for effective processing of the material and deep learning. Eventually, advanced formats and software need to be developed to better accommodate the reading and processing of

[1] The study was done in the late nineties, a time in which highlighting tools were even less developed than nowadays.

online and digital texts. Since HTML documents are easier and faster to read, Nielsen recommends giving online learners the option to read documents in both PDF and HTML formats.

2. Do students prefer to read print or online?

Given the discussed research, it is not surprising that many students still prefer reading printed texts over online texts. For example, in a qualitative interview study by Martin & Platt (2001), students reported that they found reading online tiresome, slow, and impractical. Moreover, reading texts displayed online hindered the simultaneous use of several documents. In another survey of 500 students taking an online business course, Spencer (2006) found that 67% of all respondents (N = 254) read less than 30% of the available online course texts on their computer screens. Students choose to print an online text:

(1) when they needed to work concurrently on other documents (92%),

(2) if the article was long and/or complex (82%),

(3) if they needed to study the article in preparation for an exam or assignment (80%), or

(4) if they needed to take notes on the article.

Finally, the most common reasons why students prefer print reading over online reading include: ergonomic or eyestrain problems, the need to annotate and highlight, and the wish to spread out materials. One of the surveyed students discussed his preference of print over digital or online texts:

> *I'm studying right now and I have my text book open beside me and my printed course notes and some other materials on the other side of me and I am typing into my computer. This is much easier and faster than flipping back and forth between screens and I don't lose my place as easily. (Spencer, 2006, p.10)*

The above findings raise the question whether students are in fact comfortable with reading and studying materials presented online or on their computer screens. Is it too early to remove printed course materials? Future research should investigate how variables, such as age, gender, computer literacy, and type of course might influence the preferences of learners for online versus paper reading. In the meantime, professors might offer both offline and online course materials.

3. How do students read and take notes with online texts?

Students commonly take notes on an online text and/or digital document using the cut and paste functions. This technique, however, may be inefficient. Recent research shows that many students struggle to encode web-based information while taking electronic notes (Igo et al., 2005, Igo et al., 2006). As a result, they recall little of the information they cut and pasted into a Word document (Igo et al., 2005). Also, students demonstrate difficulties in transferring information derived from a online text (Katayama, Shambaugh, & Doctor, 2005). Igo and his colleagues (2005, 2007) further found that students who selectively pasted shorter passages of text showed

higher learning efficiency than students who pasted large passages into their notes. The authors conclude that students who pasted shorter passages paid more attention to the main idea of the text, thus using an elaborative cognitive process. In contrast, students pasting large sections of electronic text likely did not read the text carefully enough for memorizing and learning to occur. Another way to increase memory involves actually typing the web-based information into a document instead of pasting it. The slower process of typing seems a more elaborate strategy for memorizing than pasting and thus increases the likelihood of recall at a later point (Katayama, Shambaugh, & Doctor, 2005).

Finally, it should be noted that more research is needed to understand how electronic note-taking impacts memory and learning. For example, new online tools such as *web clipping tools*[2], especially designed for note-taking, have yet to be studied. Furthermore, there is a need to investigate how students use forums and interactive websites to share or interactively create study notes. Another interesting field for research is to better understand how students handle the range of different note-taking strategies available to them such as cutting and pasting, clipping, typing, handwriting, or the collaborative creating and sharing of notes. With each successive student generation, these questions may need to be re-addressed, since each generation will enter college with a different level of computer literacy and technical skills.

Conclusion

As the above findings illustrate, different types of texts and media call for different reading strategies. It might be helpful to teach students different strategies for note-taking, not only for lecture, lab sessions, or seminars, but also for web-based research. Finally, future improvements to software for reading documents online, as well as innovative interfaces for electronic documents, may overcome many of the shortcomings and inconveniences that online reading currently suffers from, improving online reading's standing vis-a-vis print reading.

Recommendations for online reading

Provide assignments and research questions that promote reading activities that support the construction of knowledge and prevent shallow, fragmented reading and word tracking. This may include tasks that focus on

- Recognizing interconnections within the material.
- Analyzing multiple perspectives and representations.
- Testing generalizations until proven otherwise.
- Seeing context dependence of subjects.
- Identifying how similarities and differences unfold in various materials.

The above activities are common features of the cognitive processes involved in understanding complex subjects or concepts and are particularly suited to support deep web-based learning (see DeSchryver & Spiro, in press).

[2] Web clipping tools help users to capture and save materials from the Internet including text notes, images, complete web pages, documents, or PDFs even if source website is gone.

Recommendations for online note taking:

- Ask students about their note-taking strategies (typed notes, handwritten notes, cut and paste, clipping etc.). Share and model your own note-taking techniques with students.
- Discuss with students which type of note-taking strategies has been most useful to them when working with books, articles, or websites. For example, do students use various methods simultaneously or do they have a favorite note-taking method?
- Recommend to students who use cut and paste functions to select main ideas instead of paragraphs as a means to enhance deeper processing of web-based information.
- Inform students that typing notes can be more effective for test preparation than cutting and pasting since typing is a more active process for encoding and learning information than pasting.
- Better yet, create assignments that discourage students from using the cut and paste function. Instead, engage students in higher cognitive processes by asking them to compare, apply, analyze, or synthesize online materials as part of their note-taking process.
- Think about assignments that require students to focus on questions rather than on answers. Through the process of developing meaningful questions, students will have to understand more deeply what they read and cannot rely on cut and paste functions.
- Be open to learning from your students about their note-taking strategies. New technologies likely will be developed to improve web-based learning and students often are the ones who know first about new online tools and trends.

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Key words for literature search

On online reading: information literacy, computer literacy, digital literacy, online reading skills, print reading comprehension, literacy & technology, new college learner & academic literacy, multimedia learning of reading, hypertext reading.

On online note-taking: electronic note taking, CP note taking, and web-based note taking.