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Reading and Studying on the Screen: An Overview of Literature Towards Good Learning Design Practice

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Abstract

As distance education moves increasingly towards online provision, and because of the benefits provided by online approaches, students will be expected to engage with more resources available on screen. Contemporary forms of reading from the screen include reading from tablet devices, LCD monitors, and smartphones. However, print remains the preferred means of reading text, and student preference for print is accentuated when reading involves thorough study (Ackerman & Lauterman, 2012; Foasberg, 2014). Education providers face an interesting challenge. Although many learners prefer having access to printed materials, on-screen reading can improve education's convenience, portability, media-richness, engagement, support, and data-evidenced practice. In this context it is timely to consider the potential for on-screen reading from the perspective of learning design. This article considers studies related to reading on screen, and suggests good practice principles for on-screen-only learning design.

Keywords: cognitive load; learning design; online-only; on screen; print

Introduction

The screen is an everyday part of life for most people. Cell phones have evolved into smartphones, and telephony now serves only a minor role. Tablet devices are ubiquitous. Tablet sales are tipped to surpass traditional laptop and desktop sales in 2016, and mobile (and smartphone) sales will go well beyond both (Gartner, 2015). Banking, travel, retail, and multiple service sectors are all transformed as a result of online technology, and are further shaped by mobile devices and access. Information access is rapidly shifting on screen.[1]

Over time, reading from the screen has become the norm for a number of activities. The vast majority of people, for example, read and respond to emails without first printing them. Most adults in the United Kingdom now access newspapers and magazines online (Sweney, 2013), probably as a result of the uptake of tablet devices and smartphones. Books and academic journals are also increasingly electronic. In 2014, e-books comprised some 30% of all book sales in the United States (Bercovici, 2014); From January until August 2012, Amazon.co.uk sold 114 Kindle books for every 100 printed books (Malik, 2012). While evidence suggests the overall proportion of e-book to printed book purchasing may be stabilising at about 1:3 (Wallop, 2015), increasing investment in e-books and electronic journal services by higher education institutions means access to academic titles and articles is increasingly online. According to a Jisc survey, online journals have now largely replaced print versions for faculty research purposes

[1] The term 'on screen' is used here deliberately instead of 'online'. Online implies the need for consistent internet access. 'On screen' assumes that material might also be available offline – either by downloading or preloading the resources.

(Housewright, Schonfeld, & Wulfson, 2013[2]). Ready access to academic e-books is also improving, although title availability is not sufficiently ubiquitous and licencing arrangements are too challenging to make academic e-books a comprehensive solution for academic libraries at present (Walters, 2013).

On-screen opportunities

The emphasis on the electronic word, the rapid uptake of tablets and smartphones, and the availability of internet connectivity provide substantial opportunities for providers of distance education. On-screen reading is no longer as inconvenient as it once was, and reading applications continue to develop. Over the last decade or so, resource-based providers of distance education provided printed materials to students in the form of printed learning guides and readings, complemented with online discussion forums, media (frequently on videotape, CDROM, or DVD), and external internet links. Additional learning materials can also be available online, although usually in a printable format. As the on-screen world becomes more familiar and central to academic research, an on-screen-only approach to education can be considered a step forward rather than a retrograde one—particularly if an on-screen approach involves more than simply converting a traditional print resource into an electronic format.

An enhanced on-screen-only provision of education provides multiple additional benefits:

- Effective on-screen reading skills are important for 21st century professionals.
- On-screen text can be seamlessly complemented with additional resources and references such as feedback activities, illustrative media, and glossaries.
- On-screen information is extremely portable (limited only by the device used to access it), and can be made available and synchronised across various devices.
- Development of on-screen text is streamlined and more efficient, as print materials tend to be produced electronically and then require additional formatting, pagination, publication, storage, and distribution. On-screen information can be readily, immediately, and cheaply distributed and amended.
- On-screen text can be manipulated and annotated by the end-user, and user notes can be easily shared. The user can manipulate text size and (frequently) font, colour, and contrast.
- Searches can be made for keywords across the whole text.
- Electronic accessibility services such as Read&Write for Google Chrome, and close captioning services, can be used by the reader (depending on the format).
- User activity can be passively tracked through analytics.

It is clear from this list that making print material available on screen (in the form of, say, PDF or ePub files) is neither the point nor the objective. While on-screen text certainly is cheaper to distribute, the potential advantages to tertiary education institutions and their students go well beyond this. A deliberate and leveraged on-screen approach to learning design results in a learning experience that goes well beyond the limitations of a print-based paradigm.

From the perspective of online distance educators, one of the more important aspects of on-screen reading is that of learning analytics, defined as "the measurement, collection, analysis, and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs" (SoLAR 2011, in Ferguson, Macfayden, Clow, Tynan, Alexander, & Dawson, 2014, p. 121). Such data, already captured in virtual learning environment (VLE) transactions, becomes more powerful and discerning as more

[2] I used to print articles but read them on screen. However, paper provided me with security rather than focus, and this year I have stopped printing articles—although I do rotate my external monitor for a portrait view.

detail is provided. But although analytics data captured from individuals might provide insight into tutorial interventions—even where on-screen reading is not required—little can be gleaned about the design of the course. At the level of the individual student, analytics are completely meaningless if students print their course materials or read them outside the VLE. With on-screen reading analytics, "new ways of understanding trends and behaviours in students . . . can be used to improve learning design, strengthen student retention, provide early warning signals concerning individual students and help to personalise the learner's experience" (de Freitas et al., 2015, p. 1175). Improvements in the availability of analytics data will have a profound influence on the student experience for online and distance learning. Unprecedented insight into student behaviour in on-screen courses—at the collective level—will assist learning designers to craft materials based on actual use, resulting in more discerning, evidence-based and learning-friendly course materials. For example, analytics of the average time spent on a particular page, and the number of times students return to that page, can provide important clues as to the clarity of the material provided. The average study time and the influence of feedback exercises on average study time, can both be measured. As should be clear, the exercise does not aim to just garner better ways of presenting printed material on screen; instead, the intention is to optimise a text, media, and activity mix based on actual and objective feedback from collective use. On-screen materials, therefore, provide not only better access to richer materials but also their own feedback loop and evidence base. The passive collection of analytics data through on-screen engagement with materials alone provides significant potential to improve learning, and on-screen reading gives an immediate and detailed view of student progress and behaviour.

A print orientation to learning design results in a catch-22. If learning designers develop for a printable world, they are unable to model design approaches that demonstrate print independence. It is a courageous institution that seeks to adopt an on-screen approach to education, particularly because students have a negative perception of the institution merely passing on the costs of printing, and the well-documented evidence of student preference for printed materials (Ackerman & Goldsmith, 2011; Ackerman & Lauterman, 2012; Baron, 2015; Foasberg, 2014; Lauterman & Ackerman, 2014; Liu, 2005; Noyes & Garland, 2005; Vandenhoek, 2013; Woody, Daniel, & Baker, 2010).[3] Ultimately, however, the question of on-screen versus print transcends that of student preference. Learning designers must seek to provide an on-screen learning experience that goes well beyond what is printable. (This is not to suggest that nothing ought to be printed, as outlined later.)

Student success and learning should be central to the debate of on screen versus print. If an on-screen learning experience is designed so that it *improves* educational outcomes and support, debate of on-screen versus print takes on a different tone and purpose. The potential benefits of on-screen learning to students, and whether on-screen learning results in cognitive impairment, are central to this revised debate. The benefits have already been disclosed. To further advance the debate, this article now overviews the literature relating to cognitive impairment from on-screen reading, and explores the conditions for how on-screen learning approaches might better support students. The article concludes with some recommendations for developing effective on-screen learning resources.

[3] This perspective aligns with student feedback from both Open Polytechnic and The Open University. As I prepared this paper, there were no published studies identifying the percentage of students who prefer an on-screen-only education experience, but independent research conducted by Open Polytechnic indicates that it could be up to 20% of its adult distance learners.

Comparing on screen with print

Outcomes from literature comparing the comprehension of readers reading print and on screen are mixed, although a meta-theme of no significant difference (NSD) can be broadly applied. This conclusion is straightforward enough, but it glosses over some important details. Dillon's (1992) sentiment that the differences between reading from screen and paper defy single variable explanation remains valid, although some key themes can be discerned.

The NSD finding has a consistency about it. In the late 1980s, in an early study comparing reading from CRT monitors with reading print, "no significant difference was found in either reading speed or comprehension between screen and paper, or between dark and light character displays" (Oborne & Holton, 1988, p. 1). According to Dillon (1992), early studies were unanimous that comprehension is not affected by on-screen or paper reading.[4] In addition to measuring reader comprehension, early studies were concerned with the influence of hypertext (that is, text that links to other sections), which tended to have a negative effect on student comprehension (Dillon, 1992). A meta-study, prepared some 15 years after Dillon's work, concluded that:

> . . . total equivalence [for reading from paper vs screen] is not possible to achieve, although developments in computer technology, more sophisticated comparative measures and more positive user attitudes have resulted in a continuing move towards this goal (Noyes & Garland, 2008, p. 1352).

Noyes and Garland's review considers the findings from multiple studies concerned with reading speed, accuracy, and comprehension. The authors conclude that "the situation is changing and it is probably fair to conclude that greater equivalence is being achieved today than at the time of Dillon's (1992) literature review" (Noyes & Garland, 2008, p. 1371). The variability of studies noted by Dillon, and Noyes and Garland, is more recently confirmed by Jabr in a sweeping summary of literature:

> [In studies] published since the early 1990s . . . a slight majority has confirmed earlier conclusions, but almost as many have found few significant differences in reading speed or comprehension between paper and screens (Jabr, 2013, para. 6).

Echoing Noyes and Garland, Jabr concludes that "[p]erhaps, then, any discrepancies in reading comprehension between paper and screens will shrink as people's attitudes continue to change" (ibid., para. 28). Even Baron, nostalgic to the point of heavy bias for print reading, concedes that "[n]early all recent investigations are reporting essentially no differences" (2015, p. 12). Indeed, several recent studies considering e-readers alongside paper and computer screens are emphatic that there is no difference in comprehension, whether you read on screen or from a printed page (Margolin, Driscoll, Toland, & Kegler, 2013; Subrahmanyam et al., 2013). A further study suggests that familiarity with tablet devices makes a positive difference to deep-level comprehension, and concludes that tablets are superior to computer displays (Chen, Cheng, Chang, Zheng, & Huang, 2014). Another study reveals evidence of no cognitive performance difference between using printed textbooks and electronic ones when overall grades and perceived learning are considered (Rockinson-Szapkiw, Courduff, Carter, & Bennett, 2013). Growing familiarity with reading from tablets and smartphones seems to be making a difference.

Importantly, computer vision syndrome (CVS) does not seem to be a factor against on-screen reading, as reading from the screen is no more physically demanding than reading from paper.

[4] It is useful to note here that Ackerman & Goldsmith (2011) also found no difference across subjects reading from CRT and LCD displays.

According to one meta-analysis, CVS is more likely to be caused by the position of the screen than by reading from it (Koslowe, Waissman, & Biner-Kaplan, 2011).

NSD findings

A number of studies are unambiguous in their NSD findings (Margolin et al., 2013; Rockinson-Szapkiw et al., 2013; Subrahmanyam et al., 2013). Margolin et al. (2013) found no significant difference—for either recall or comprehension—between paper, computers, and e-readers. The study by Subrahmanyam et al. (2013) indicates that requiring critical engagement with material can improve comprehension. The study investigated simple, medium, and complex tasks that included recall, comprehension, and report writing for samples using print and on-screen sources; it also considered reading speed and comprehension for print, computers, and tablets while testing for the influence of user multi-tasking. While it took multi-tasking readers longer to engage with the passages, "there was no effect of medium on reading comprehension" (p. 11). The study found that even students reading from paper tend to be distracted by technologies, with texting and talking on cellphones being most common. In the second part of their study, Subrahmanyan et al. tested the rubric scores of one-page essays created by students who were provided with articles in print or by computer; or a computer, printer and internet combination. In the words of the study, "no significant differences were found between any of the three conditions for efficiency and output quality as measured by the [marking and grading] rubric" (p. 18), despite most respondents indicating they would prefer to engage with print. Subrahmanyam et al. also found no significant difference between paper, laptop, and tablet in reading or report-writing tasks. Finally, Rockinson-Szapkiw et al. (2013) found that e-textbooks are equivalent to print textbooks in terms of perceived learning and grades.

It is anticipated that technology will continue to improve the nature of the on-screen reading experience (Rockinson-Szapkiw et al., 2013). Indeed, in the Rockinson-Zsapkiw study, 90% of the 19.7% of students (n=106) who self-selected to use an e-textbook accessed it from a mobile device. It is also likely that the tools that are increasingly available to the on-screen reader (including note-taking, highlighting, social notes, enhanced displays, glossaries, and online links for further information) will continue to improve the effectiveness of on-screen reading (Subrahmanyam et al., 2013). While previous studies may have been concerned with comparing texts that are in a page fidelity format (that is, a printed page compared with a PDF version of that same page), the adaptive and enriched potential for reflowable texts (text that reapportions itself based on screen and font size) will probably result in on-screen options becoming more popular and effective. Further, there is evidence that students are becoming more familiar with digital annotation tools – to the extent that on-screen readers are more likely to type notes at source than to hand-write notes on printed materials (Rockinson-Szapkiw et al., 2013).

Contrary studies considered

The literature associated with on-screen and print reading is beset by different study design in terms of both demographics and methodology. Although the conclusion of NSD is a defensible one when literature is synthesised, some recent studies comparing computer screens and print clearly find in favour of print (Mangen, Walgermo, & Brønnick, 2013; Wästlund, Reinikka, Norlander, & Archer, 2005) or else provide more nuanced results (Ackerman & Goldsmith, 2011; Ackerman & Lauterman, 2012; Chen et al., 2014; Lauterman & Ackerman, 2014). Two prominent reasons for these differences are overconfidence and cognitive load.

Several studies (Ackerman & Goldsmith, 2011; Ackerman & Lauterman, 2012; Lauterman & Ackerman, 2014; Liu, 2005) have identified overconfidence (when a person's subjective confidence is higher than it should be for effectiveness) as a feature of how on-screen readers tend to approach their reading tasks.

This overconfidence can be partly attributed to the reader's familiarity with processing brief on-screen readings such as email (which varies in its formality) or news items. Genre of use (that is, an internal sense that reading from the screen is a more casual and rapid exercise than reading from print) may be an important factor in overconfidence (Ackerman & Goldsmith, 2011; Ackerman & Lauterman, 2012; Liu, 2005). The Ackerman and Goldsmith (2011) study found NSD in cognitive performance for on-screen and print reading when performance was subject to a limited time. However, when the two groups were permitted to self-regulate time, the on-screen group were overconfident and did not perform as well. On-screen readers invested less time, and their performance in tests was lower than that of print students although most had made notes by marking up the document as they read. However, the subsequent study of Ackerman and Lauterman (2012), using the same methodology, reversed these findings; when given free time *with suggested time guidance*, on-screen participant scores were no different from those of paper participants. Under time pressure, though, the on-screen group did not perform as well. Again, overconfidence was a factor in the relatively poor performance of the on-screen group, and there was evidence that reader preference for reading print or on screen also played a part.

Such findings indicate that there is nothing inherently disadvantageous in on-screen reading except that readers tend to approach it differently. As the Ackerman and Goldsmith (2011) study notes, "although people are reluctant to study on screen, they can potentially do so as efficiently as on paper" (p. 27). On-screen readers are possibly not aware of the reading strategies that would assist their learning, or are not sufficiently experienced with on-screen reading for it to work for them. Lauterman & Ackerman (2014) found that "the consistent screen inferiority found in performance and overconfidence can be overcome by simple methods, such as practice and guidance on in-depth processing, even to the extent that some learners become able to perform as well on screen as on paper" (p. 462). Students for whom on-screen reading might impair cognitive performance *can* learn to read effectively on screen.

Cognitive load, the extent to which a reader's limited short-term processing memory is engaged with a task, is the second prominent reason for differences in study findings on on-screen and print reading. It is claimed that the cognitive load demanded by on-screen reading is greater than that for print, either from a lack of physical clues regarding progress, haptic familiarity (not having the same ability to engage with the page by touch), or the need for readers to engage with additional navigational activity such as scrolling (DeStefano & LeFevre, 2007; Lauterman & Ackerman, 2014; Mangen, 2008; Mangen et al., 2013; Margolin et al., 2013; Wästlund, Norlander, & Archer, 2008; Wästlund et al., 2005). Paper-based text has a definite fixity compared with on-screen text, and the physicality of a book or printed work provides additional navigational clues as to how far the reader has progressed. In contrast, e-reading forces a more virtual sense of navigation. It is theorised that this difference in navigability requires an e-text reader to focus on both progress and comprehension at the same time (Jabr, 2013; Mangen et al., 2013). However, cognitive load can decrease as tasks become more familiar and as strategies are made available, and learning strategies that improve cognition can also be suggested (Kalyuga, 2009); worked examples and effective diagrams are two additional means whereby the cognitive load of learning may be reduced (Ayres & Gog, 2009). Optimising page layout can also reduce the mental workload required for reading on screen (Wästlund et al., 2008). Cognitive loading is not an inevitable outcome of on-screen design strategies.

Reader distraction, primarily as the result of increased cognitive load, is also often cited as a disadvantage of on-screen reading (Baron, 2015). Studies confirm distraction has a detrimental effect on comprehension, whether it is from the temptations of social media (receiving an IM, or opening a browser to see the latest news) or heavily hyperlinked text (tempting a reader to click elsewhere on a related theme, and breaking their reading flow). It is particularly clear that use of hypertext increases cognitive load, and hypertext should be minimised if applied at all (DeStefano & LeFevre, 2007). Education designers must take care to ensure that on-screen

reading takes place with as little distraction as possible. Innovations such as Reading View in the Microsoft Edge browser are specifically designed to reduce the cognitive load of reading web pages.

Literature suggests that, where comparative findings for on-screen and print reading find in favour of print, overconfident on-screen reading and cognitive loading are culpable. Both of these factors can be addressed through deliberate learning design.

Making on-screen learning work

The literature is clear that there are differences to the actual experience of on-screen reading, even if (ultimately) an NSD applies. Generally, literature confirms that:

- Extended text of more than 1200 words can be more difficult to engage with on screen.
- On-screen reading is typically perceived by readers of a genre to be not conducive to serious study.
- There are navigational and tactile differences between books and on-screen readers; on-screen text lacks the familiar physical markers readers use to assist with navigation and progress (resulting in haptic dissonance and increasing cognitive load).
- On-screen reading may require more mental effort (cognitive load), depending on how it is designed.

These differences indicate the means by which learning designers can improve the on-screen reading experience. In the words of Ackerman & Lauterman (2012), "computerized learning suffers not necessarily because the medium provides a less supportive technological environment, but because learners do not recruit enough cognitive resources to succeed in the task (e.g. attention, memorizing strategies, self-examination)" (p. 1817). Nor do comparative studies consider how the same learning outcomes might be addressed by print and a leveraged on-screen experience that includes analytics-based support, embedded media, social engagement, and feedback opportunities. Ultimately the solution lies in how learning designers leverage the on-screen experience to transcend what is possible in print.

If on-screen materials are to truly transcend print, a suite of learning design practices ought to be adopted. Having text on screen is not the goal. The literature indicates the following general learning design practices for effective on-screen learning, and to minimise cognitive load and improve student outcomes.

- Orientate students to the potential dynamics of on-screen reading, making them more deliberate and focused about their reading behaviour by:
    - contrasting reading as finding information, and reading as contemplating for understanding
    - encouraging electronic highlighting and note-taking to paraphrase and query the text
    - promoting focused reading, with all online distractions (such as Twitter feeds, browser tabs, Skype channels and IM clients) closed during the reading session
    - encouraging readers to monitor their progress against learning objectives, and to be deliberate about their understanding.
- If extended text is unavoidable, prompt the students as to how they should engage with it in the form of lead indicators (e.g., "Be sure you fully understand the context surrounding the diagram on p.13", "Pay specific attention to the method used in the study", or "Be sure you understand the main reasons behind the argument. It will be helpful for you to list them").
- Scaffold the cognitive load that is appropriate for the level of the student. Recognise that students taking early courses will probably need more guidance and feedback.

- Use a clean, reading-friendly on-screen interface without clutter and distraction.
- Minimise scrolling as a reader behaviour, so that text can be read in a more stationary way.
- Be deliberate in the design of on-screen text by:
    - chunking text logically, in similar sizes as much as possible
    - preparing on-screen text to optimise the on-screen display in a reflowable manner, to maximise flexibility
    - providing as much textual land-marking as possible, including diagrams, summaries, and position indicators
    - embedding activities and additional media in the text as part of a consistent presentation
    - as a guide, providing activities every 1000 words, to provide feedback and help reinforce key ideas and concepts (excepting book chapters or articles, which frequently cannot be edited)
    - minimising in-text hyperlinks and ensuring that any used are of direct relevance.
- If PDF formats cannot be avoided or extended text cannot be edited (for example in book chapters or articles), make these resources available through a print on-demand service, or provide versions that are easy to print.

Importantly, there should be a print option for extended narratives such as book chapters and scholarly articles. Given that such narratives are not easily broken up for activities, nor provide effective analytics data beyond when a student may have started or finished them, and because such files are often not screen-size friendly, there appears no good reason for print to be withheld. The challenge for learning designers is to ensure that such readings are essential, and not better summarised or alternatively presented. Whether such readings should be provided on enrolment or on demand, and who should pay for the printing, become interesting operational questions for institutions to answer.

Conclusion

The debate as to whether distance education materials should be provided in print or on screen is demonstrated to go well beyond arguments of preference, and into the area of learning design. The literature largely confirms that there is no significant difference to learner comprehension if they read from print or on screen. Those studies that do find a significant difference cite overconfidence and additional cognitive load as being responsible for the lower efficacy of on-screen reading, and both of these factors can be addressed through a deliberate approach to educational design. Ultimately, the questions of on screen versus print come down to how an on-screen experience can be provided to maximise student success and equip students for the future.

Student orientation and designing for reduced cognitive load are foundational to their successful on-screen learning experience. Learning designers must build on these foundations to further enhance student success in the form of analytics-based support interventions, evidence-based learning design, and improved learning activities. Institutionally, the added reach and convenience of on-screen education enables further strategic possibilities while, at the same time, demanding more of its online systems.

References

Ackerman, R., & Goldsmith, M. (2011). Metacognitive regulation of text learning: On screen versus on paper. *Journal of Experimental Psychology: Applied, 17*, 18–32.

Ackerman, R., & Lauterman, T. (2012). Taking reading comprehension exams on screen or on paper? A metacognitive analysis of learning texts under time pressure. *Computers in Human Behavior, 28*(5), 1816–1828. http://doi.org/10.1016/j.chb.2012.04.023

Ayres, P., & Gog, T. van. (2009). State of the art research into cognitive load theory. *Computers in Human Behavior, 25*(2), 253–257. http://doi.org/10.1016/j.chb.2008.12.007

Baron, N. S. (2015). *Words onscreen: The fate of reading in a digital world*. New York, NY: Oxford University Press.

Bercovici, J. (2014). Amazon vs book publishers, by the numbers. Retrieved from http://www.forbes.com/sites/jeffbercovici/2014/02/10/amazon-vs-book-publishers-by-the-numbers/

Chen, G., Cheng, W., Chang, T.-W., Zheng, X., & Huang, R. (2014). A comparison of reading comprehension across paper, computer screens, and tablets: Does tablet familiarity matter? *Journal of Computers in Education, 1*(2-3), 213–225.

de Freitas, S., Gibson, D., Du Plessis, C., Halloran, P., Williams, E., Ambrose, M., . . . Arnab, S. (2015). Foundations of dynamic learning analytics: Using university student data to increase retention. *British Journal of Educational Technology, 46*(6), 1175–1188. http://doi.org/10.1111/bjet.12212

DeStefano, D., & LeFevre, J.-A. (2007). Cognitive load in hypertext reading: A review. *Computers in Human Behavior, 23*(3), 1616–1641. http://doi.org/10.1016/j.chb.2005.08.012

Dillon, A. (1992). Reading from paper versus screens: A critical review of the empirical literature. *Ergonomics, 35*(10), 1297–1326. http://doi.org/10.1080/00140139208967394

Ferguson, R., Macfadyen, L. P., Clow, D., Tynan, B., Alexander, S., & Dawson, S. (2014). Setting learning analytics in context: Overcoming the barriers to large-scale adoption. *Journal of Learning Analytics, 1*(3), 120–144.

Foasberg, N. M. (2014). Student reading practices in print and electronic media. *College & Research Libraries, 75*(5), 705–723. http://doi.org/10.5860/crl.75.5.705

Gartner. (2015). Gartner says tablet sales continue to be slow in 2015. Retrieved from http://www.gartner.com/newsroom/id/2954317

Housewright, R., Schonfeld, R. C., & Wulfson, K. (2013). Ithaka S+R | Jisc | RLUK UK survey of academics 2012. UK: Ithaka S+R | Jisc | RLUK. Retrieved from http://repository.jisc.ac.uk/5209/1/UK_Survey_of_Academics_2012_FINAL.pdf

Jabr, F. (2013). The reading brain in the digital age: The science of paper versus screens. Retrieved from http://www.scientificamerican.com/article/reading-paper-screens/

Kalyuga, S. (2009). Instructional designs for the development of transferable knowledge and skills: A cognitive load perspective. *Computers in Human Behavior, 25*(2), 332–338. http://doi.org/10.1016/j.chb.2008.12.019

Koslowe, K. C., Waissman, H., & Biner-Kaplan, M. (2011). The blink frequency relationship between reading from a computer screen and reading from a printed page. *Optometry and Vision Development, 42*(3), 168–171.

Lauterman, T., & Ackerman, R. (2014). Overcoming screen inferiority in learning and calibration. *Computers in Human Behavior*, *35*, 455–463.

Liu, Z. (2005). Reading behavior in the digital environment: Changes in reading behavior over the past ten years. *Journal of Documentation*, *61*(6), 700–712. http://doi.org/10.1108/00220410510632040

Malik, S. (2012, August 6). Kindle e-book sales have overtaken Amazon print sales, says book seller. *The Guardian*. Retrieved from http://www.theguardian.com/books/2012/aug/06/amazon-kindle-e-book-sales-overtake-print

Mangen, A. (2008). Hypertext fiction reading: Haptics and immersion. *Journal of Research in Reading*, *31*(4), 404–419. http://doi.org/10.1111/j.1467-9817.2008.00380.x

Mangen, A., Walgermo, B. R., & Brønnick, K. (2013). Reading linear texts on paper versus computer screen: Effects on reading comprehension. *International Journal of Educational Research*, *58*, 61–68. http://doi.org/10.1016/j.ijer.2012.12.002

Margolin, S. J., Driscoll, C., Toland, M. J., & Kegler, J. L. (2013). E-readers, computer screens, or paper: Does reading comprehension change across media platforms? *Applied Cognitive Psychology*, *27*(4), 512–519. http://doi.org/10.1002/acp.2930

Noyes, J., & Garland, K. (2005). Students' attitudes toward books and computers. *Computers in Human Behavior*, *21*(2), 233–241. http://doi.org/10.1016/j.chb.2004.02.016

Noyes, J., & Garland, K. (2008). Computer- vs paper-based tasks: Are they equivalent? *Ergonomics*, *51*(9), 1352–1375. http://doi.org/10.1080/00140130802170387

Oborne, D. J., & Holton, D. (1988). Reading from screen versus paper: There is no difference. *International Journal of Man-Machine Studies*, *28*(1), 1–9. http://doi.org/10.1016/S0020-7373(88)80049-X

Rockinson-Szapkiw, A. J., Courduff, J., Carter, K., & Bennett, D. (2013). Electronic versus traditional print textbooks: A comparison study on the influence of university students' learning. *Computers & Education*, *63*, 259–266. http://doi.org/10.1016/j.compedu.2012.11.022

Subrahmanyam, K., Michikyan, M., Clemmons, C., Carrillo, R., Uhls, Y. T., & Greenfield, P. M. (2013). Learning from paper, learning from screens: Impact of screen reading and multitasking conditions on reading and writing among college students. *International Journal of Cyber Behavior, Psychology and* Learning, *3*(4), 1–27. http://doi.org/10.4018/ijcbpl.2013100101

Sweney, M. (2013, August 8). More than half of Britons access news online. *The Guardian*. Retrieved from http://www.theguardian.com/media/2013/aug/08/half-britons-access-news-online

Vandenhoek, T. (2013). Screen reading habits among university students. *International Journal of Education & Development Using Information & Communication Technology, 9*(2), 37–47.

Wallop, H. (2015, January 9). The Kindle is dead, the book is back. Or is it? Retrieved from http://www.telegraph.co.uk/culture/books/booknews/11335718/The-Kindle-is-dead-the-book-is-back.-Or-is-it.html

Walters, W. H. (2013). E-books in Academic Libraries: Challenges for Acquisition and Collection Management. *Portal: Libraries and the Academy*, *13*(2), 187–211. http://doi.org/10.1353/pla.2013.0012

Wästlund, E., Norlander, T., & Archer, T. (2008). The effect of page layout on mental workload: A dual-task experiment. *Computers in Human Behavior*, *24*(3), 1229–1245. http://doi.org/10.1016/j.chb.2007.05.001

Wästlund, E., Reinikka, H., Norlander, T., & Archer, T. (2005). Effects of VDT and paper presentation on consumption and production of information: Psychological and physiological factors. *Computers in Human Behavior*, *21*(2), 377–394. http://doi.org/10.1016/j.chb.2004.02.007

Woody, W. D., Daniel, D. B., & Baker, C. A. (2010). E-books or textbooks: Students prefer textbooks. *Computers & Education, 55*(3), 945–948. http://doi.org/10.1016/j.compedu.2010.04.005

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Nichols, M. (2016). Reading and studying on the screen: An overview of literature toward good learning design practice. *Journal of Open, Flexible and Distance Learning, 20*(1), [33–43].