



## Screen and Paper Reading Research – A Literature Review

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To cite this article: Gemma Walsh (2016) Screen and Paper Reading Research – A Literature Review, Australian Academic & Research Libraries, 47:3, 160-173, DOI: [10.1080/00048623.2016.1227661](https://doi.org/10.1080/00048623.2016.1227661)

To link to this article: <https://doi.org/10.1080/00048623.2016.1227661>



Published online: 06 Sep 2016.



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## Screen and paper reading research – a literature review

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### ABSTRACT

Due to the proliferation of information available online and through academic libraries, students are increasingly reading from the screen. Academic documents can be long and complex, requiring sustained concentration to read deeply. This paper reviews current literature on the advantages and disadvantages of electronic and paper media for academic reading. Theoretical and empirical research into screen reading in academic institutions falls broadly into the following categories; reading and comprehension theory, the effect of a document's platform, design and tools on reading, and screen versus paper research studies. These categories inform and provide the structure for this review. This paper concludes by considering how academic librarians can manage their collections and deliver library services in response to recent screen reading research. This overview of the literature on reading theory, the platforms and tools integral to reading electronic documents, and screen versus paper reading research, will enable academic librarians to make more informed collection management and library service decisions.

### KEYWORDS

Screen reading; reading theory; academic reading; universities; education

## Introduction

The proliferation of electronic information available online and through academic libraries has meant students are increasingly reading from the screen. As a result there has been much research on the reading of electronic documents in comparison to their print counterparts. Recent studies suggest that speed and recall differences between media are insignificant (Yoram Eden & Eshet-Alkalai, 2013; Young, 2014), and that electronic documents that optimise hypertext and multimedia to engage students can lead to improved learning outcomes (Rockinson-Szapkiw, Courduff, Carter, & Bennett, 2013; Stoop, Kreutzer, & Kircz, 2013b; Sun, Chich-Jen, & Kai-Ping, 2013). Despite this, screen reading studies also suggest that many students prefer to print out academic documents (Stoop, Kreutzer, & Kircz, 2013a), consider information from the printed page to be more trustworthy (Qayyum & Williamson, 2014) and find navigation and annotation functions of electronic documents inferior to paper (Stoop et al., 2013a). Many researchers also question the effect of electronic reading on deep reading skills, comprehension and the development of long-term knowledge and critical thinking. Such research is important for those teaching in universities, such as

The University of Melbourne, that aim to produce graduates who can think creatively and critically (The University of Melbourne, [n.d.](#)).

This article reviews some of the literature on screen reading, identifying research on how the brain reads and comprehends text. Also investigated are the influences that document design, format, annotation tools and navigation aids have on reading preferences. Recent screen versus print reading case studies that illustrate how electronic and paper documents are being used are also reviewed. The paper thus aims to provide an understanding of reading theories and print and screen reading research, which will assist academic librarians in making more informed collection management and library service decisions.

## Scope

This paper reviews current literature on the benefits and issues surrounding screen and print reading within academic institutions. Whilst an in-depth review of current literature has been undertaken, the author has also identified seminal reading research by Rothkopf (1971), and Dillon (1992) that underpins more recent reading research and theory. Research on screen reading in academic institutions falls broadly into three categories, reading and comprehension theories, the role reading platforms, navigation and annotation aids play on reading academic documents, and specific print versus screen case studies. These categories have been used to inform and provide structure to this review. This paper also explores how academic librarians can manage their collections and deliver library services in response to screen reading research.

Due to the constantly changing nature of electronic platforms and tools, there is an emphasis on journals and monographs which have been published within the last six years. Peer-reviewed journal articles were sourced from information management databases such as Emerald, ProQuest, Informit and Taylor & Francis. As the functions of electronic documents are evolving with improving markup and navigational technology, non-academic literature from industry specific publications has also been reviewed. Despite an effort to source material from Australia, most of the articles are from English and American publications. By reviewing literature from a broad range of sources, this paper aims to provide academic librarians with an understanding of the current issues surrounding screen reading in academic institutions.

## Reading and comprehension

### *Reading theory*

According to Durant and Horava (2015), before the internet there were two ways to read. One was driven by the need to find particular information or fact for a specific purpose. The other linear form involved concentration and emotional engagement (Durant & Horava, 2015; Sun et al., 2013). More recently, hypertexts within electronic documents allow readers to leave one resource and explore a range of alternative resources, providing a less linear, reading experience (Anderson-Inam & Horney as cited in I-Chia, 2012). HTML and XML can also enable information to be presented as a multi-layered experience, quite different to the traditional print-on-paper experience.

In evolutionary terms, the act of reading is a fairly recent learned behaviour that uses the neural tissues initially developed for language, coordination and sight (Wolf, 2010). On a practical level, reading is a combination of recognising words and deciphering their meaning, as well as comprehending the wider context within which the words are read (Duran, 2013). Reading theorists note that comprehension of text, in comparison to basic reading, requires higher levels of cognitive and linguistic skills for the reader to be able to understand both the literal and inferential meanings of text (Cornoldi & Oakhill as cited in Sun et al., 2013).

In 1971, Rothkopf tested the effect of text location for information recall. Rothkopf confirmed prior studies by Underwood (1969 as cited in Rothkopf, 1971) and Bower (1970 as cited in Rothkopf, 1971) which found information's spatial attributes positively affect memory. These theories of spatial recognition, wherein information is recalled in relation to where it is read within a document, have been explored by more recent researchers studying memory and comprehension differences between linear (paper) and non-linear (e.g. HTML) formats (Durant & Horava, 2015; Payne & Reader, 2006; Stoop et al., 2013a). Payne and Reader (2006) note the importance of understanding these spatial recognition theories when designing online documents for optimal navigation, information recall and comprehension.

In 1985, Tulving (as cited in Mangen, Walgermo, & Brønnick, 2013) developed a comprehension theory that is now regularly referred to in comprehension studies as the 'Remember-Know learning paradigm' (p. 62). According to Tulving, there are two ways by which the brain recognises information; remembering (episodic memory) and knowing (semantic memory). To remember something, the brain recollects information in relation to its context. Sometimes, as Rothkopf (1971) identified, one can remember something specifically by its location within a document. Remembering can develop into knowledge. To know something is a deeper form of information retrieval, more long term and with fewer contextual associations. Some academics suggest that the longer term category of 'knowing' is seen as a result of good learning and one that higher education should aim to foster (Garrison & Cleveland-Innes, 2005; Mangen et al., 2013).

A neuroscientist who has written extensively on the cognitive processes involved in reading believes that reading deeply is integral to furthering comprehension, deductive reasoning, critical thought and insight (Wolf, 2010). She suggests that those who have advanced reading skills are able to contextualise and infer deeper meaning from text as it is read. The ability to read deeply and analytically can take years to develop and the focusing skills it fosters are integral to independent learning (Wolf & Barzillai, 2009).

Carr (2010) explored the effect of increased online reading on the human brain. He proposed that the ability to read deeply enables students to integrate memorised information into knowledge. Carr identified the language and visual ability areas of the brain that were stimulated when reading print. In addition to these, the decision-making and pattern analysis areas of the brain were also stimulated when reading online. This over stimulation may negatively affect readers' ability to reflect, absorb and recall information as effectively as information in the paper form. As the brain becomes accustomed to reading less deeply from the screen, Durant and Horava (2015) question the negative effect on the development of deep reading skills and the richness of writing that may follow.

Cull (2011) suggests developing deep-reading skills is an important part of education, and in light of increased screen reading, needs to be encouraged. Cull believes fostering deep

reading skills, and therefore independent learning in academic institutions, will also ensure students continue to learn after graduation. Identified attributes of the Royal Melbourne Institute of Technology's graduates include the ability to be active, lifelong learners (Royal Melbourne Institute of Technology, [n.d.](#)). The University of Melbourne's graduate attributes include the ability to think critically and creatively, whilst also being able self-direct learning into the future (The University of Melbourne, [n.d.](#)).

### *Academic documents*

In recent years, university students have increasingly communicated online with peers and staff, utilised e-journal and e-book subscriptions, searched the internet for electronic information and downloaded electronic learning materials via online student portals. Within academic libraries, electronic resources have grown as a cost effective alternative to print resources, with a range of multi-borrower licensing and purchase packages available (Herman, 2014; Lam, Lam, & McNaught, 2009). Many universities in Australia, including The University of Melbourne, have a collection policy to prefer electronic access of serials and monographs over hardcopies, when licence and access conditions are deemed acceptable (The University of Melbourne, 2016). Students and academic staff benefit by being able to access these resources 24 h a day via their personal computers, multimedia devices and e-readers.

Many researchers who have explored the effect of format on reading and comprehension, question whether electronic documents are an improvement on their print predecessors within education (Daniel & Woody, 2013; Durant & Horava, 2015; Yoram Eden & Eshet-Alkalai, 2013; Herman, 2014; Young, 2014). Rockinson-Szapkiw et al. (2013) and Stoop et al. (2013b) wrote that electronic documents have the potential to provide an engaging, interactive learning environment via hyperlinks and multimedia. However, in 2011 Rose found that most academic documents were not written for the internet, but were scanned versions of paper originals with few hyperlinks or multimedia. While this is changing, the design of much academic electronic material is still based on print-on-paper predecessors.

According to I-Chia (2012), academic reading also requires a high level of concentration and text comprehension, often aided by interaction with the document, including annotating, highlighting and bookmarking (Kol & Scholnik, 2000; Stoop et al., 2013a). The ability to easily markup paper documents may be one reason why, although increasingly speed and recall differences between the media are found to be minimal, students express a preference for print versions of lengthy academic texts (Rose, 2011; Stoop et al., 2013a). Interestingly in 2015, the university students in Gilbert and Fister's research on e-textbooks initially expressed a preference for printed books, but were subsequently satisfied with the e-book once they had been given a chance to use an e-book for an assessment task. In 2013, students also expressed a preference to use print books over electronic, despite minimal differences in their post-test quiz results (Daniel & Woody, 2013).

Within academic institutions, students are also writing, editing and reading their own work as part of course assessments and exam revision. Few differences in correcting errors or understanding content between paper and electronic text were found. The researchers concluded that as screen reading had become a daily activity for students, they were becoming more competent reading and editing electronically.

In 2012 Staiger reviewed a range of studies on e-book usage amongst academic communities and found consensus amongst readers on the benefit of being able to access e-books from anywhere, at any time. Students across disciplines also tended to dip into e-books for particular information, as opposed to reading the document in its linear form. Gilbert and Fister (2015) acknowledge that it is difficult to compare the use of academic e-books to printed books as there is little research into how students and academics actually read monographs. Most recent research on e-book usage across academic disciplines suggests that there is not a marked difference between how students from Science, Technology, Engineering and Maths (STEM) disciplines use e-books compared to their non-STEM peers. However, students within some faculties do seem to be using e-books more than others.

A large survey of university students found that natural sciences and engineering students were most likely to have used an e-book for academic purposes, whilst veterinary medicine, biomedical and applied human services were least likely to have used an e-book. Preferences for e-books over printed books were also higher amongst continuing education, business and engineering students. The percentage of liberal arts students who preferred e-books over paper monographs was only marginally higher than the agricultural and veterinary students. Many respondents preferred the print book because they found computers strained their eyes. They would often print sections of electronic documents to read from paper. The research also concluded that many students found paper documents easier to navigate and missed the ability to shelf browse that print books and journals enabled (McLure & Hoseth, 2012).

A later study (Gilbert & Fister, 2015) found that students who said they would use an e-book for research purposes were mostly from the fine arts (which included communications), and natural science faculties. Carroll, Corlett-Rivera, Hackman, & Zou, 2016 paper analyses results from surveys completed by university students and researchers in 2012 and again in 2014. The surveys were designed to identify changing use and preferences between paper and electronic texts amongst the academic community. The study found little difference between STEM and non-STEM disciplines. Instead they found students proclivity for print declined between 2012 and 2014. By 2014 32.9% of students across all disciplines noted they had 'no preference' when questioned on a preferred format. This was a sharp increase from 23% since 2012 and suggested that students across all faculties were becoming used to using e-books for their studies.

## Screen reading platforms

Reading on e-readers is easy on the eyes, conducive to deep reading and may be a way to offer access to electronic material without the distracting pop ups, advertisements and alerts of tablets and PCs (Durant & Horava, 2015). However, a 2012 survey of library administrators found that 60% of those who owned an e-reader used it for entertainment, not academic reading (Zimmerman 2011, as cited in Staiger, 2012). Many navigation, annotation and mark up tools integral to reading academic e-texts are also not supported by e-readers (Richardson & Mahmood, 2012). Participants in Stoop et al's (2013a) study found that annotation functions on e-readers were not yet as intuitive as post-it notes and margin comments on paper documents. E-reader manufacturers have recognised this, with these functions slowly improving on their devices. Despite this, from 2011 to 2012 sales of e-readers fell 36% as multifunction devices became more popular and the use of e-readers

for academic reading amongst students declined (Durant & Horava, 2015). This may be because e-readers do not support the use of hyperlinks, sound or video to enhance content. Material on e-readers is in a static, linear form, offering no added value to paper other than its portability. Instead students are increasingly reading electronic material on multimedia tablets, laptops and PCs (Durant & Horava, 2015).

There has not been a large amount of literature on the use of tablets for academic reading. In 2013, one study found the gesture interfaces on tablets were difficult to control and split screen designs decreased text readability (Nielsen, 2013). Chen, Cheng, Chang, Zheng and Huang's (2014) study explored the effect of the tablet, computer or paper for comprehension and found that those who were more familiar with tablets performed markedly better on the comprehension test compared to novice tablet users. However, because of the multi-function capabilities of tablets, users may also be prone to distraction (Stoop et al., 2013a; Cull, 2011), thus affecting comprehension and retention of information (Carr as cited in Durant & Horava, 2015). Unfortunately, laptops and desktop computers may not be much better. Mangen et al. (2013) note the effect of screen resolution, backlighting and illuminative effect of LCD screens may affect the visual processing of text and therefore comprehension. Distracting pop-ups are also a hindrance to concentrated reading from personal computers and laptops (Stoop et al., 2013a; Cull, 2011).

## Document design

### Content

Durant and Horava (2015) suggest that books as tangible objects with a beginning and an end are quite different to the intangible, limitless, cross-textual potential of e-books. Research suggests that students liked the idea of utilising electronic documents for interactive learning (Stoop et al., 2013b; Rockinson-Szapkiw et al., 2013). Unfortunately, the initial enthusiasm of students in Stoop et al.'s study was diminished when electronic documents did not live up to their expectations of innovative design and inclusion of multimedia. Jabr (2013) questioned why electronic texts were trying to replicate their paper predecessors when they could offer much more with visuals and interaction. Stoop et al.'s (2013b) research suggested that the format of a document needs to consider its content. They found that data- and fact-based education material were more likely to work with electronic documents, than texts that required cognitive reasoning. Interestingly, while many studies found that students do still prefer to print online documents that require in-depth reading (I-Chia, 2012; Liu as cited in Cull, 2011; Tuncer & Bahadir, 2014) they also want to learn via a digital realm with content that is integrated and interactive (Rockinson-Szapkiw et al., 2013; Stoop et al., 2013b).

### Navigation

Studying the reading of e-books, McKay (2011) found that reading navigation behaviour was dependent upon whether the reader was scanning for information or reading it in more depth. Readers generally fell into four groups; those moving steadily through the pages; those moving through a chunk of pages then going backwards; those making a noticeable leap forward before focusing on a section; or those examining sections close together before



jumping forward and stopping to read another section. Stoop et al. (2013a) also found readers tended to jump around textbooks as part of the research process. Importantly, they found that this behaviour was consistent across electronic and print mediums. Also noted was the potential for slow navigation and scrolling speeds, which hindered the reading of electronic documents (Stoop et al., 2013a; Young, 2014; Richardson & Mahmood, 2012). As identified by McKay (2011), readers of academic documents use the headings, titles and bold text to navigate, pause and change direction within the document. I-Chia's (2012) research also found that when reading from the screen, readers scanned for hyperlinked headings and used the links to find further information. However, at a graduate level, because students were printing out complex documents, the hypertexts in these documents were not used.

Many other studies also found that participants preferred to print out documents that contained complex information for reading (Tuncer & Bahadir, 2014; Martin & Platt, 2001; Liu as cited in Cull, 2011). One reason cited was the less intuitive nature of non-linear electronic documents. Reading from the screen, it can be difficult to ascertain how far one is through a multi-page article, while also contextualising the passages within the document (Jabr, 2013).

E-book publishers are increasingly offering readers more visual functions to ease the electronic reading process. These include page turning visualisations, text scrolling and searching functions, links to multimedia, and visual cues that show the reader how many pages into the document they are (Lam et al., 2009). Researchers note the need for creators and distributors of electronic documents to understand the importance of traditional book features such as a table of contents, identifiable book sections, reading cues and a structure that ensures readers are not lost in the digital space (Malami et al., as cited in Lam et al., 2009). As long as electronic documents are more difficult to navigate, students will prefer the paper counterparts (Sandberg, 2011).

### **Annotation**

There has not been an extensive amount of recent research into the annotation functions of electronic documents. Annotation is an integral part of academic reading and annotating electronic material is not as effective as highlighting and margin notes on paper copies (Martin & Platt, 2001; Stoop et al., 2013a). Whilst annotation functions on e-readers and PDF reading programs are improving, they do not yet match the functionality of their print counterparts (Stoop et al., 2013a). Spencer (2006) found that 75% of the students they studied printed online material if they needed to annotate it. Stoop et al. (2013a) reported that for lengthy, information rich documents students still preferred handwritten annotations in the margins of their printed page. Martin and Platt (2001) note that students have learnt to study with a range of paper documents around them that they mark up as they research, and there still is not an easy way to replicate this behaviour in the electronic environment.

Publishers have developed, and university librarians have promoted, a range of file and reference management software, including Endnote (owned by Thomson Reuters), Zotero (open access software by George Mason University) and ReadCube (owned by Macmillan). These products assist with referencing, and provide annotation and markup tools and search and note-taking functions for PDF documents. Whilst these assist to organise, reference and mark up online documents, they rely on metadata and require a certain amount of user expertise and data entry to gain the most out of them (Hughes, 2014). As annotation



functions develop and students learn to study from the screen, the online alternatives may become more popular (Martin & Platt, 2001).

### **Data visualisation**

One of the advantages of an electronic document is its ability to provide visual enhancement of text and images. Results of studies, when summarised via data visualisation tools such as interactive graphs and maps, are easier to understand and faster to read than the same information in text (Green, Perera, Dance, & Myers, 2010). Information retention may also be improved with the use of animations, diagrams (Tuncer & Bahadir, 2014), and hyperlinks and visual displays that enhance user experiences (Duran, 2013; Anderson-Inman & Horney as cited in I-Chia, 2012).

Small embedded videos of information can also educate students in a more entertaining manner than solely text-based chapters in a text book. Green et al.'s (2010) study looked at comprehension differences between numerical data illustrated through graphs and tables, compared to written paragraphs on paper and screen. Results suggested that between text in print and text in electronic media there was little difference in recall rates. However, when presenting numerical information in a table or graph format, recall rates were superior to the same information presented in a paragraph of text (Green et al., 2010). According to Green et al. (2010) this supports previous research that found data visualisation tools enables complicated data to be easily comprehended (Card et al. as cited in Green et al., 2010; Winn as cited in Green et al., 2010). While a data Journalist at The Guardian notes the benefit data visualisation tools in encapsulating key concepts from large data sets he also cautions that the same tools can interpret and therefore visualise the information in a number of ways (Burn-Murdoch, 2013). As a result data scientists can potentially mislead their readers. They should therefore link their images to data sources and note how scientifically rigorous the study was.

### **Screen vs. paper research**

Many screen reading studies cite Dillon's, 1992 paper that reviewed a range of literature to determine if one medium was better than the other for reading. Since 1992 there have been great advances in technology and specific issues with electronic documents as they were then, for example cathode ray tubes and flickering screens, are no longer relevant. However, Dillon shed light on several problems with reading studies 20 years ago that are still relevant today. These included the subjective nature of reading, the unique environmental circumstances of each study, the different outcomes measured across reading studies and the predominance of studies that focused on speed and accuracy for short texts as opposed to qualitative comprehension of multi-page, complex information. These factors help explain some of the seemingly contradictory results of reading research.

One of the most comprehensive studies of screen and paper reading in an academic environment was undertaken by Noyes and Garland in 2003. In their study, 50 University of Bristol students were asked to study economics material, a subject that they were all unfamiliar with, before completing tests which required some content to be remembered within its broader context. This was in order to identify if one medium was superior to the other in terms of mastering more long-term knowledge of a subject as opposed to

short-term remembering. Though the study found minimal speed and recall differences between screen and paper, they did find that the transition of knowledge from the episodic memory to the semantic memory was more efficient from paper. Based on their subsequent 2004 study, Noyes and Garland propose that reading from paper led to better information retention and knowledge.

Two papers published by Stoop and colleagues in 2013 investigate students' use of print and electronic documents. The initial study compared students' use of print and electronic versions of a text book. Those students who accessed the electronic textbook on e-readers and laptops complained of the inflexible nature of the text for annotating (Stoop et al., 2013a). Half the students bypassed the e-reader's locked format to print the document and the other half wanted to but didn't know how and found the printed textbook option too expensive. From this study, it would seem that students would have a preference for paper over electronic documents. In the second study, research was undertaken on the use of an interactive learning map as an education resource. Various web pages were used to illustrate different information, as opposed to one long screen of text to scroll. The students in the study were enthusiastic about the potential of the electronic document to enhance their reading experience. However despite their enthusiasm, the researchers also found that students' comprehension of complex information was greater from paper than electronic documents (Stoop et al., 2013b). In conclusion, researchers noted that for long, complex texts, paper still garnered better learning and information retrieval results. Electronic documents, when designed for the medium, did however, have the potential to engage students.

Rockinson-Szapkiw et al. (2013) also found that higher education students using the electronic version of a core textbook were more actively engaged in learning than those using the printed textbook, however there was no difference in their final grades.

Another study published in the same year found that once participants had acquired a certain degree of technical skill, there was little difference in comprehension outcomes between learners reading on screen or paper (Sun et al., 2013). Further they found that the ability of hypertext ability to integrate information within electronic documents had a positive effect on cognitive processing for middle-age learners, facilitating a deeper understanding of the content. This study also suggested that the age of the reader, not the medium, may affect one's memory capacity. In their study, the 45–49 year age group's comprehension was better than the 50–54 year age group regardless of the document format. Note, the content studied was advertising material of 1000 words as opposed to a complex academic document.

In 2014, participants in a study also performed equally well reading across both mediums. In the study, participants were tested on their information retrieval from general news articles printed in *The Guardian* and *The Economist*. The text of each story was concise and well written and the navigational cues of the paper editions were replicated on the screen. Though results showed little variance between comprehension results of screen and print reading, participants still voiced a preference for the print versions. The study also found that the high sensory nature of online documents, as well as their annotation, navigation and formatting flaws, may promote skim reading (Young, 2014).

In their study of a small group of 18–25 years olds Qayyum and Williamson (2014) found that for news, online media was considered faster, more up to date and easier to access than a printed newspaper. This cohort may have been familiar with reading from the screen prior to the study. Interestingly, amongst participants, the printed newspaper

was seen as a more authoritative source of news and valued as a less distractive way to read the news during leisure time.

Tuncer & Bahadır's, 2014 study of 78 students reading in each medium, found those who read from the screen did not perform as well as those reading from paper. Performance was measured by pre- and post-test knowledge scores. In this study, the course was an Introduction to Computers lesson within a vocational faculty. It is not known how accustomed participants were to reading from the screen prior to the study.

In recognising the increasing amount of screen reading students of higher academic organisations undertake whilst preparing for exams and writing assignments, Yoram Eden and Eshet-Alkalai (2013) also researched active reading behaviour of electronic and paper documents. They identified active reading as reading whilst editing a document, and studied this behaviour across print and electronic media. In their study, 93 students read, edited and improved short electronic and printed documents. Assessors found that students performed equally well across both media, and that though those reading from the screen were faster, their performance was not lower than their colleagues actively reading from paper. This suggests that as students have become accustomed to reading from the screen they are becoming efficient in both media for active reading.

Daniel and Woody (2013) also found little difference in comprehension outcomes between electronic and paper documents. In their study of nearly 300 students reading a chapter of a text across print and electronic formats at home and in a lab, they found little difference in comprehension outcomes but did note that those reading the e-textbooks took longer to do so and found different parts more useful. This study also found that students reported high levels of multi-tasking when using the electronic text from home. Daniel and Woody noted that print enabled improved concentration, without the distractive nature of advertising and communication pop-ups. They suggested further study was required regarding how to make electronic documents more interactive.

In summary, such variables as participants' existing technology expertise, their age, prior knowledge of the subject tested and length of the test documents make it difficult to compare comprehension results across various studies. However, from recent research it appears that most studies find little difference between the print and screen for reading comprehension (Daniel & Woody, 2013; Grzeschik, Kruppa, Marti, & Donner, 2011; Sun et al., 2013; Young, 2014). Unfortunately many studies do not focus on reading complex academic documents. Those that did (Noyes & Garland, 2003; Stoop et al., 2013a) conclude that participants gain a better understanding of the content when reading from paper. While participants of some studies (Daniel & Woody, 2013; Qayyum & Williamson, 2014) noted the distractive nature of advertisements and pop-ups within electronic material, others found that the interactive capabilities of electronic documents had the potential to actively engage students in learning (Stoop et al., 2013b; Rockinson-Szapkiw et al., 2013). These results suggest that each medium may have a role to play in education, particularly as students become more accustomed to reading and editing electronic documents.

## **The role of librarians and academic staff**

Within academic institutions, students read for many reasons including to find specific information, to learn, to develop deeper understanding and knowledge, and to edit and proofread assessment tasks. Whilst Durant and Horava (2015) write about the importance

of deep reading skills to facilitate cognitive analysis, other researchers note the ad hoc nature of textbook reading, regardless of format (McKay, 2011). If, as Durant and Horava (2015) suggest, increasingly reading from the screen is affecting the ability for critical thought and concentration amongst students, then libraries need to continue to offer hard copies of complex documents, or at least ensure licencing enables the printing of documents that require deep reading skills. If learning outcomes such as comprehension and knowledge, benefit when the interactive nature of electronic documents is optimised (Rockinson-Szapkiw et al., 2013; Stoop et al., 2013b), then universities also need to promote and support lecturers in their use of multimedia. Nielsen (2000 as cited in Mercieca, 2003) suggests integrating e-books into the content of courses and directly linking them to practical exercises. According to Rose (2011), key to ensuring a responsible pedagogical reaction to technology is communicating with students about their screen reading experiences and being aware of those experiences during this period of change (Rose, 2011).

Cull (2011) notes that reading complex material requires time to digest the information and reflect upon its ideas. Librarians and lecturers should therefore encourage students to take the time to read deeply in order to develop critical thinking and lifelong learning skills, regardless of changing technologies. Libraries can facilitate deep reading by providing quiet spaces for students to read from computers and the printed page (Cull, 2011). It is also important for librarians, in recognising the ongoing preferences by students to read lengthy material from print to promote multiple print stations and printed textbooks.

The studies reviewed in this paper indicate that students are excited by the potential of electronic documents to enhance learning, and that reading from electronic documents has little detrimental effect when measured against reading from paper (Rockinson-Szapkiw et al., 2013; Stoop et al., 2013b). Librarians can promote this potential of electronic documents by providing students with access to a range of media. Academic publishers, librarians and lecturers have an opportunity to create, use and explore electronic documents that are engaging and interactive. When procuring electronic versions of paper documents, librarians need to consider the electronic version's navigational aids and printing possibilities. As part of information research training, librarians and academics can highlight the skills required to effectively search for and critique electronic content. Academic librarians can also facilitate research into how e-books are used within each discipline, whether it be for in-depth reading or fact-finding objectives, and align their collection accordingly.

In 2011, the Dean of library services at Western Carolina University (Sally as cited in Durant & Horava, 2015) professed that as places where ideas are fostered, developed and circulated, libraries have a role to facilitate access to print and electronic formats that lead to different ways of thinking. Academic librarians are in a particularly good position to seek innovative electronic material to recommend to lecturers and students. Durant and Horava (2015) suggest hybrid collections of a range of print and electronic media would address a variety of academic learner needs. Librarians, as facilitators of access to this academic content, need to be aware of current research in the field of screen reading to enable them to make decisions of long-term benefit to students and academic staff.

## Conclusion

The studies explored throughout this paper note that, despite the minimal speed and comprehension differences between print and screen, students still like to read lengthy academic

material in print (Rose, 2011). Perhaps this is because the electronic documents are not utilising the features that make it so different to paper. Research suggests that students are initially enthusiastic to engage with electronic documents in education and that learning outcomes can be improved when electronic documents utilise interactive multimedia (Stoop et al., 2013b). However, academic documents require a level of concentration quite different to other forms of reading. Reading complex, lengthy paper documents may aid contextual analysis and a deeper sense of knowing (Durant & Horava, 2015). Based on this research, it is important that we do not dismiss the paper form from academic libraries, particularly in universities that aim to equip their graduates with critical thinking and independent learning skills. It is up to academic librarians to facilitate access to print and electronic documents in libraries, provide spaces for deep thought and enable seamless printing from databases. Academic librarians can facilitate these measures, and by keeping up to date with the latest research on screen and paper reading, will be able to make more informed collection management and library service decisions.

## Notes on contributor

*Gemma Walsh* is studying her Master's in Information Management at RMIT University, Melbourne. She also works in The University of Melbourne libraries and is interested in how students engage with their education material now that much of it is delivered digitally.

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