

The Persistence of Print among University Students: An Exploratory Study

Naomi S. Baron, Rachelle M. Calixte, and Mazneen Havewala

A revised version of this article will appear in *Telematics and Informatics* (2017)

Abstract

As use of digital devices has grown, university students (along with faculty and administrators) are considering whether academic reading should be done in print or on digital screens. Some studies have indicated that comprehension in the two media is equivalent, while other research has questioned this conclusion. Furthermore, we have little systematic knowledge about students' own attitudes and practices regarding reading in hardcopy versus onscreen.

The present investigation gathered quantitative and qualitative survey data from 429 university students in the US, Japan, Germany, Slovakia, and India. The quantitative findings revealed high levels of affirmation about advantages of reading in print. Nearly 92% said they concentrated best when reading in print, and more than four-fifths reported that if cost were the same, they would prefer print for both schoolwork and pleasure reading. Students reported they were more likely to re-read printed material than digital; they were also more likely to multitask when reading onscreen. Qualitative questions asked what students liked most and liked least about reading in hardcopy and reading digitally. Using a fine-grained coding scheme, these responses were quantified. Advantages reported for print included ease of annotation and paper's tactile properties, while among the disadvantages were lack of convenience and expenditure of environmental or monetary resources. The biggest advantage of screen reading was convenience, while the primary disadvantages were eyestrain and distraction.

1. Introduction

Widespread use of digital screens for reading dates back to the 1990s, when personal computers, affordable and reliable internet service, and communication channels such as email and instant messaging became entrenched among both professionals and everyday users. A decade later, proliferation of text messaging on mobile phones in the United States (already common in many other parts of the world) offered a portable platform for screen-based communication. However, it was the appearance of the Amazon Kindle in 2007, followed by the iPad in 2010, that drove an explosion in reading digital books, especially in the US and the UK. In the US, sales of eBook trade titles soared by 4,660% between 2008 and 2012 (Milliot, 2013), though by 2014, annual growth rate had fallen closer to 4% (New AAP Figures, 2015).

Within both lower and higher education, adoption of eBooks has been significantly driven by economic considerations, since digital books are typically less costly than print equivalents, at least when purchased new. University students commonly report that cost is their primary consideration in deciding whether to obtain a print or digital version of academic reading (Baron, 2015; Ji, Michaels, & Waterman, 2014; Rockinson-Szapkiw et al., 2013; Student Monitor LLC, 2013).

Additionally, educational institutions are increasingly posting digital materials online to learning management systems in lieu of asking students to read print versions of articles or book chapters. This evolution has a number of motivations, including convenient access to materials, the growth of online learning (for which all or the preponderance of materials are available digitally), and cost-savings for students (as supported by the open educational resources movement). Another motivating factor has been the presupposition by many faculty and administrators that given the amount of time today's so-called digital natives spend on their laptops and mobile phones, students prefer to read their academic assignments digitally.

Scholars from a variety of academic fields (including educational technology, psychology, sociology, communication, and linguistics) have been interested in understanding how learning takes place when reading on a digital screen versus in print. The published research to date falls into two categories: measurements of performance, and user attitudes and practices.

1.1 Measurements of performance

A recurring question has been whether students learn as much when reading on a digital screen as when reading in hardcopy. A growing body of studies has reported that when reading traditional continuous texts in the two formats, results from basic comprehension or memory tests are essentially comparable (Ackerman & Goldsmith, 2011; Daniel & Woody, 2013; Green et al., 2010; Holzinger et al., 2011; Kretzschmar et al., 2013; Margolin et al., 2013; Porion et al., 2016; Rockinson-Szapkiw et al., 2013). Yet objective performance generally did not correlate with participants' perceptions. Nearly all studies finding no difference in test performance also reported that participants felt they learned more (or had performed better) with print (Ackerman & Goldsmith, 2011; Green et al., 2010; Holzinger et al., 2011; Ji, Michaels,

& Waterman, 2014; Kretzschmar et al., 2013). However, the bases for such perceptions were not discussed.

Even when participants perform comparably under matched conditions using the two media, interesting differences arise when the conditions are altered. Ackerman and Goldsmith (2011) noted that when free to choose how much time to spend on the readings, participants devoted less time and had poorer comprehension in the digital condition. Research by Ackerman and Lauterman (2012) indicates that time pressure during testing reduces the effectiveness of learning when reading onscreen compared with reading in print. Considering naturalistic reading conditions (at home rather than in a laboratory), Daniel and Woody (2013) reported longer reading time for digital material, with the probable explanation that participants engaged in more multitasking when reading onscreen (see Bowman et al., 2010 and Subrahmanyam et al., 2013 for similar effects of multitasking on digital task completion).

Not all research comparing reading onscreen versus in print has reported equivalent outcomes. Mangen, Walgermo, and Brønnick (2013) found better comprehension scores when reading in print than digitally. Further work by Mangen and her colleagues suggests additional differences. Mangen and Kuiken (2014) compared reading experiences on both platforms when participants were given a text described as narrative nonfiction. Those participants reading in a print booklet reported higher levels of narrative coherence and more “transportation” (meaning losing awareness of current place or time by becoming “lost” in the story) than those reading the same piece on an iPad. Similarly, in a pilot study, Mangen et al. (2014) found that after reading a mystery story either in print or on a Kindle, print readers were better at placing the story events in chronological order (see Flood, 2014 for discussion of the study).

A recurrent theme across studies, including Mangen et al. (2014), is that participants themselves typically report preferring print and/or perceiving they learn more from it. One possible explanation for this choice is familiarity. It is likely that all participants in these studies had more experience reading in print than onscreen, especially for the type of texts presented. As LaRose (2010) observed, we should not overlook the role of habit in the way we consume media. At the same time, we need to consider additional hypotheses, including those generated by reports from readers themselves. We therefore turn to qualitative and mixed-methods analyses of how people think about their own reading practices.

1.2 User attitudes and practices: prior studies

One cluster of studies regarding user attitudes and practices has emerged from a broader research initiative, sponsored by the European Union, known as COST Action FPS 1104: New Possibilities for Print Media and Packaging – Combining Print with Digital. Researchers from Europe and Asia asked university students to write essays describing how reading in print and onscreen differ in their experience, along with observations comparing writing by hand and composing text on a digital device. We consider here only the reading data. Findings published thus far (Farinosi, Lim, & Roll, 2016; Fortunati & Vincent, 2014; Taipale, 2014, 2015) represent responses from students in Italy, Germany, the UK, and Finland.

Several themes emerged across these research reports. Regarding reading in print, students wrote that

- it was easy to underline and make marginal notes
- it was less tiring on the eyes to read print than screens
- it was an easier medium on which to concentrate
- it was preferable for longer and for more complex texts
- it was easily portable and did not require electricity

However,

- they missed the ease of searching that is available with digital texts
- paper consumption was deemed bad for the environment

In their essays about reading on digital screens, comments included

- searching texts was easily possible
- hyperlinks could lead to other useful information
- text fonts could be resized
- it was convenient to store many books in one place

At the same time, students noted that

- reading onscreen caused eyestrain
- using digital screens encouraged distraction
- it could be difficult to keep track of where they are in a digital document

Farinosi et al. (2016) observe that “Students in all three samples [from Germany, Italy, and the UK] feel that reading on screen creates a disconnection with the content[,] and paper seems to

allow readers to immerse themselves in the content better which improves learning” (p. 418). This assessment parallels findings by Mangen and her colleagues discussed above.

Individual student observations in essays provide suggestive indicators of users’ attitudes regarding reading in print versus digitally. However, one shortcoming of this methodology is that it does not enable us to determine how prevalent these individual responses are within the population surveyed. The methodology also excludes the possibility of gathering study-wide responses to a unified set of questions regarding reading in the two media. Our research presented below addresses these gaps.

1.3 Current study

Our study utilized both quantitative and qualitative methods to construct a profile of university student uses of and attitudes toward print versus digital screens for reading. Using these methodologies, we were able to go beyond the research to date by identifying and quantifying student preferences for one reading medium over another in a non-anecdotal way. Moreover, our study design enabled us to probe the relevance of several variables in driving student preference (including, for example, difference in text length, whether the reading was for academic work or pleasure, and the role of cost). Finally, we collected a set of open-ended comments from participants regarding reading in the two media.

Pilot survey work was initiated in 2010. Three small pilot studies were conducted over a three-year period, using students in the first author’s undergraduate and graduate classes in the US. While the questions varied somewhat from study to study, all three surveys enabled us to focus on a core set of issues, including how well students perceived they concentrated when reading in print versus onscreen, how often they reported multitasking when reading on each medium, how often they reported re-reading texts, their comparative perceptions of how much they learned when reading on each medium, and the impact of both cost and environmental concerns on their choice of reading platform. Results from these pilot studies are reported in Baron (2013a, 2013b).

The present study drew from refined versions of the questions used in the pilot studies, but added several new dimensions, including distinguishing between academic work (for school) and pleasure reading, as well as fine-grained coding of answers to open-ended questions about likes and dislikes regarding the two reading platforms. Additionally, the

present study included participants in five countries (the US, Japan, Germany, Slovakia, and India). Data collection occurred between Spring 2013 and Spring 2015.

2. Method

2.1 Participants

A total of 429 university students were included in the study (US: 47; Japan: 119; Germany: 82; Slovakia: 89; India: 92). All members of the study were between the ages of 18 and 26, with a mean age of 20.9. The overall sample was nearly two-thirds female (males: 32.9%; females: 67.1%), although the gender balance was reversed in Japan, since many participants there were enrolled in a business-oriented institution, which attracted male students.

As this was an exploratory study, our participant pool constituted a convenience sample. All respondents in the US and the majority in India were drawn from psychology classes. In Japan, Germany, and Slovakia, students were enrolled in a variety of classes taught by colleagues of the first author.

2.2 Survey questions

The survey consisted of twenty-three questions for which participants were asked to select an answer (or, where appropriate, multiple answers), plus five open-ended questions. Pilot-testing indicated the survey could be completed in less than 10 minutes. Note that throughout this paper, the terms “print” and “hardcopy” are used interchangeably. Similarly, “onscreen” and “digital screens” both refer to electronic reading, though the reading platform (i.e., desktop or laptop computer, eReader, tablet, or mobile phone) is generally not specified.

In the US and India, the survey was administered in English. For Japan, Germany, and Slovakia, the survey was translated into Japanese, German, and Slovak, respectively, by fluent bilinguals. Once the surveys had been completed, fluent bilinguals translated responses to the five open-ended questions into English. When questions arose about the meaning of an open-ended response that had been translated, we consulted the translators for clarification.

2.2.1 Answer-selection questions

The fully-quantitative part of the study consisted of eight sets of questions. The first set surveyed what kinds of digital devices people owned (here, multiple answers might be given, such as laptop and mobile phone) and which device they used most often when reading for schoolwork and for pleasure (here, participants needed to give one answer). The second set inquired how many hours a week respondents read for each purpose (participants were given ranges of hours from which to choose).

While we draw upon some of these data later in our discussion, the analysis presented here focuses on questions in the remaining six sets:

- Amount of time reading in each medium

Participants were asked what percent of their reading (both for schoolwork and pleasure) they did in hardcopy and onscreen.

- Cost

Participants were asked (both for schoolwork and pleasure reading) whether, if cost were the same, they would prefer to read in print or on a screen.

- Re-reading

Participants were asked how often they were likely to re-read books or articles (for schoolwork) or books or stories (for pleasure). The 4-point Likert scale included *very often*, *sometimes*, *occasionally*, and *never*. Similarly, participants were asked whether they were more likely to re-read in print or on a digital screen, or whether the choices were equally likely.

- Text length

Participants were asked to consider text length (short or long) when reading for schoolwork and pleasure, and to indicate for each condition if they would prefer reading in hardcopy or onscreen, or if they had no preference.

- Multitasking

Participants were asked how likely they were to multitask when they read in hardcopy or on a digital screen. The 4-point Likert scale included *very often*, *sometimes*, *occasionally*, and *never*.

- Concentration

Participants were asked on which reading platform they found it easiest to concentrate (hardcopy, computer, tablet, eReader, or mobile phone).

Since we did not independently assess responses to any of the above questions (e.g., through time logs, records of actual book costs and purchases, or measures of multitasking or concentration), student replies reflect personal estimates or perceptions of their own behavior patterns.

2.2.2 Open-ended questions

Four open-ended questions probed participants' strongest likes and dislikes about reading in each medium:

What is the one thing you like most about reading in hardcopy?

What is the one thing you like least about reading in hardcopy?

What is the one thing you like most about reading on a digital screen?

What is the one thing you like least about reading on a digital screen?

While answers to these questions were individually qualitative, use of a complex coding system (see Section 2.4 below) enabled us to quantify our findings.

A fifth open-ended question invited participants to offer additional comments. Because only about one-quarter of the participants provided such comments (rendering them informative but anecdotal), we did not formally code them.

2.3 Procedures

The survey was designed to be administered electronically, using the professional version of SurveyMonkey. Online administration was used in the US, Germany, and Slovakia. However, due to logistical issues, it was necessary to use a paper version for all students in Japan and most in India. While the SurveyMonkey implementation required that participants complete the current question before proceeding to the next, students using the paper version could and sometimes did skip questions.

2.4 Coding scheme for open-ended "like most" / "like least" questions

We constructed a detailed coding scheme for analyzing the four open-ended questions regarding strongest likes and dislikes about reading in each medium. The first author had previously devised a comparable coding scheme for an analysis of open-ended responses as part of a multi-country study of attitudes toward and usage of mobile phones (Baron, 2011). In

both studies, initial categories and subcategories were developed after data from the first country were collected, and these data were coded. Each time data collection from another country was completed, the new data were coded, the coding scheme was further refined, and, where necessary, earlier coding was adjusted in light of the most current rubric.

For the present study, the entire coding process stretched over two years, from initial coding of the US data (2013) to final coding of the India data (2015). The three authors participated in both construction and refinement of the coding scheme. Once the entire corpus had been collected and coded, all authors reviewed each coded response. While there were some inter-coder disagreements, the more common situation was of one or more of the authors proposing two possible codes. Consensus was nearly always reached, both through discussion and by reviewing responses we had already coded in each of the alternative categories. Only 4.1% of the open-ended responses were ultimately judged un-codable, either because the responses made no sense or because we could not reach agreement.

The full coding system contained 53 different categories. Figure 1 presents a condensed version of the scheme. The same scheme was used for all four “like most” / “like least” questions. Examples for categories and subcategories appear in the Results section (3.2) below.

Emotional/aesthetic

Enjoyment/feelings
Smell
“Real reading”
Personal preference

Physical

Holding/texture/turning pages
Operation/functionality
Damage to book/digital device
Annotation/notes
Find word or information/use internet
Locate place in text
Legibility
Eye strain
Tiring

Cognitive

Concentration/distraction
Multitasking
Memory
Interesting/boring

Access to material

Easy access
Lose/forget materials

Convenience

Portability/weight
Space/storage/organization
Ease of use/comfort

Resources

Ecological
Monetary

Fig. 1. Condensed version of coding scheme for “like most” / “like least” questions

3. Results

In analyzing our data, we needed to select a statistical strategy appropriate to the nature of our research. Our goals in this study were exploratory, not to be definitive in our findings. All data came from convenience samples of university students, not random samples, and represent a limited age cohort (18-26). Like many university-participant convenience samples, our population was heavily female (67.1%). Moreover, with regard to the five countries in which the research was conducted, sample sizes were uneven and relatively small, especially in the US (47 participants).

Given these limitations, our findings should not be construed to be representative of each national population. Therefore, while we have chosen (for the answer-selection questions) to report comprehensive data, by country, for the benefit of readers and potential researchers, we cannot make meaningful claims about statistical differences between countries. For these reasons, we report our findings as percentages, supplemented by examples (for the open-ended questions).

3.1 Answer-selection questions

Tables 1-6 summarize results for the answer-selection questions. Note that because students using the paper administration sometimes skipped questions, not all n sizes are the same.

3.1.1 Amount of time reading in each medium

Table 1 summarizes responses for average percent of time participants reported spending using hardcopy (HC) or a digital screen (DS) when reading for schoolwork and for pleasure. Note that not all students read for pleasure.

Table 1

Reported percent time reading in hardcopy (HC) or on digital screen (DS) for schoolwork and for pleasure

Country	Schoolwork		Pleasure	
	HC	DS	HC	DS
US	59.2% (n = 47)	40.8% (n = 47)	73.1% (n = 36)	26.9% (n = 36)
Japan	75.3% (n = 104)	24.7% (n = 104)	76.3% (n = 91)	23.7% (n = 91)
Germany	68.0% (n = 82)	32.0% (n = 82)	68.8% (n = 76)	31.2% (n = 76)
Slovakia	57.4% (n = 89)	42.6% (n = 89)	54.9% (n = 89)	45.1% (n = 89)
India	72.7% (n = 84)	27.3% (n = 84)	64.7% (n = 70)	35.3% (n = 70)
ALL COUNTRIES	67.5% (n = 406)	32.5% (n = 406)	67.0% (n = 362)	33.0% (n = 362)

Respondents reported devoting about two-thirds of their time using print for both schoolwork and pleasure reading (schoolwork: 67.5%; pleasure: 67.0%). However, there was considerable variation across national samples.

3.1.2 Cost

Table 2 presents participants' reported preferences for reading in hardcopy (HC) or on a digital screen (DS), both for schoolwork and pleasure, if cost of the materials were the same.

Note that not all students read for pleasure.

Table 2

Reported choice of hardcopy (HC) or digital screen (DS) when reading for schoolwork and for pleasure, if cost were the same

Country	Schoolwork		Pleasure	
	HC	DS	HC	DS
US	89.4% (n = 47)	10.6% (n = 47)	80.6% (n = 36)	19.4% (n = 36)
Japan	77.1% (n = 118)	22.9% (n = 118)	82.9% (n = 105)	17.1% (n = 105)
Germany	93.9% (n = 82)	6.1% (n = 82)	89.5% (n = 76)	10.5% (n = 76)
Slovakia	91.0% (n = 89)	9.0% (n = 89)	76.1% (n = 88)	23.9% (n = 88)
India	88.0% (n = 92)	12.0% (n = 92)	75.6% (n = 78)	24.4% (n = 78)
ALL COUNTRIES	86.9% (n = 428)	13.1% (n = 428)	80.9% (n = 383)	19.1% (n = 383)

More than four-fifths of the total pool of participants indicated they would choose print, for both schoolwork and pleasure reading, if cost were the same. The choice was particularly strong (86.9%) for academic reading (compared with 80.9% when reading for pleasure).

3.1.3 Re-reading

Students were asked both how often they re-read books or related materials (for schoolwork or for pleasure) and their likelihood of doing so on each medium. The frequency data yielded considerable variation across countries and are not reported here. However, the medium question, as reported in Table 3, showed more consistency, with the exception of participants from Japan. Again, note that not all students read for pleasure.

Table 3

Reported re-reading patterns for schoolwork and pleasure: Choice of hardcopy (HC) or digital screen (DS)

Country	Schoolwork	Pleasure
US	57.5% HC 23.4% DS 19.1% equally likely (n = 47)	66.7% HC 17.9% DS 15.4% equally likely (n = 39)
Japan	36.8% HC 23.1% DS 40.1% equally likely (n = 117)	47.2% HC 23.6% DS 29.2% equally likely (n = 106)
Germany	53.7% HC 8.5% DS 37.8% equally likely (n = 82)	68.8% HC 1.2% DS 30.0% equally likely (n = 80)
Slovakia	84.3% HC 5.6% DS 10.1% equally likely (n = 89)	72.7% HC 14.8% DS 12.5% equally likely (n = 88)
India	65.2% HC 8.7% DS 26.1% equally likely (n = 92)	54.3% HC 19.8% DS 25.9% equally likely (n = 81)
ALL COUNTRIES	58.3% HC 13.6% DS 28.1% equally likely (n = 427)	60.7% HC 15.7% DS 23.6% equally likely (n = 394)

When re-reading for both schoolwork and pleasure reading, roughly 60% of total respondents said they chose to do so in print. Around one-quarter of all respondents indicated being equally

likely to choose hardcopy or digital, leaving only a small percentage who explicitly favored digital for re-reading.

3.1.4 Text length

Tables 4a and 4b summarize responses regarding text length (when reading for both schoolwork and pleasure): Which medium was preferred when the reading was short, and which when it was long? Note that not all students read for pleasure.

Table 4a

Reported effect of text length on preference for reading in hardcopy (HC) or on digital screen (DS), for schoolwork and pleasure: Short text

Country	Schoolwork	Pleasure
US	44.7% prefer HC 42.6% prefer DS 12.7% no preference (n = 47)	41.0% prefer HC 41.1% prefer DS 17.9% no preference (n = 39)
Japan	41.4% prefer HC 36.2% prefer DS 22.4% no preference (n = 116)	50.0% prefer HC 29.2% prefer DS 20.8% no preference (n = 106)
Germany	39.0% prefer HC 28.1% prefer DS 32.9% no preference (n = 82)	41.8% prefer HC 25.3% prefer DS 32.9% no preference (n = 79)
Slovakia	42.7% prefer HC 38.2% prefer DS 19.1% no preference (n = 89)	41.4% prefer HC 36.8% prefer DS 21.8% no preference (n = 87)
India	45.7% prefer HC 34.7% prefer DS 19.6% no preference (n = 92)	39.8% prefer HC 42.1% prefer DS 18.1% no preference (n = 83)

ALL COUNTRIES	42.5% prefer HC 35.4% prefer DS 22.1% no preference (n = 426)	43.4% prefer HC 34.0% prefer DS 22.6% no preference (n = 394)
---------------	--	--

Table 4b

Reported effect of text length on preference for reading in hardcopy (HC) or on digital screen (DS), for schoolwork and pleasure: Long text

Country	Schoolwork	Pleasure
US	91.5% prefer HC 6.4% prefer DS 2.1% no preference (n = 47)	84.6% prefer HC 10.3% prefer DS 5.1% no preference (n = 39)
Japan	77.1% prefer HC 11.9% prefer DS 11.0% no preference (n = 109)	74.1% prefer HC 11.5% prefer DS 14.4% no preference (n = 104)
Germany	95.2% prefer HC 2.4% prefer DS 2.4% no preference (n = 82)	87.5% prefer HC 6.3% prefer DS 6.2% no preference (n = 80)
Slovakia	92.2% prefer HC 6.7% prefer DS 1.1% no preference (n = 89)	79.3% prefer HC 11.5% prefer DS 9.2% no preference (n = 87)
India	81.5% prefer HC 14.2% prefer DS 4.3% no preference (n = 92)	67.5% prefer HC 20.5% prefer DS 12.0% no preference (n = 83)
ALL COUNTRIES	86.4% prefer HC 8.8% prefer DS 4.8% no preference (n = 419)	77.6% prefer HC 12.2% prefer DS 10.2% no preference (n = 393)

For reading short texts, respondents displayed mixed preferences, both for academic work and pleasure. However, with long texts, responses were far more consistent. When reading long texts for school, 86.4% of total respondents reported preferring hardcopy; when reading long texts for pleasure, the overall reported preference for hardcopy was 77.6%.

3.1.5 Multitasking

Table 5 presents data on multitasking habits, specifically how often participants reported they were likely to multitask when reading in hardcopy (HC) and how often when reading on a digital screen (DS). The questions did not distinguish between academic and pleasure reading.

Table 5

Reported frequency of multitasking when reading in hardcopy (HC) or on digital screen (DS)

Country	Hardcopy	Digital Screen
US	4.3% very often 21.3% sometimes 48.9% occasionally 25.5% never (n = 47)	63.8% very often 21.3% sometimes 12.8% occasionally 2.1% never (n = 47)
Japan	8.5% very often 26.5% sometimes 32.5% occasionally 32.5% never (n = 117)	12.1% very often 33.6% sometimes 18.1% occasionally 36.2% never (n = 116)
Germany	3.7% very often 26.8% sometimes 45.1% occasionally 24.4% never (n = 82)	42.7% very often 36.6% sometimes 17.1% occasionally 3.6% never (n = 82)
Slovakia	14.6% very often 40.4% sometimes 24.7% occasionally 20.3% never (n = 89)	36.0% very often 38.2% sometimes 19.1% occasionally 6.7% never (n = 89)
India	18.9% very often 34.4% sometimes 27.8% occasionally 18.9% never (n = 90)	22.2% very often 42.2% sometimes 23.3% occasionally 12.3% never (n = 90)
ALL COUNTRIES	10.6% very often 30.6% sometimes 34.1% occasionally 24.7% never (n = 425)	30.9% very often 35.6% sometimes 18.6% occasionally 14.9% never (n = 424)

While there was considerable variation across national samples, reports of multitasking were, overall, more common when reading on a digital screen. Combining responses of *very often* and *sometimes*, 66.5% of total respondents indicated they felt they were likely to multitask while reading digitally, compared with 41.2% when reading in hardcopy. This difference was particularly pronounced for the US participants, among whom 85.1% indicated they felt they were likely to multitask when reading on a digital screen versus 25.6% when reading in print.

3.1.6 Concentration

Concentration (and not being distracted) is traditionally seen as an attribute of successful readers. Table 6 offers participants' responses regarding the reading platform (hardcopy, computer, tablet, eReader, or mobile phone) on which they perceived it easiest to concentrate. The question did not distinguish between academic and pleasure reading.

Table 6

Reading platform on which it is perceived easiest to concentrate

Country	Hardcopy	Desktop/Laptop	Tablet computer	eReader	Mobile phone
US (n = 47)	91.5%	4.3%	2.1%	2.1%	0.0%
Japan (n = 117)	92.3%	1.7%	2.6%	0.8%	2.6%
Germany (n = 82)	97.6%	1.2%	0.0%	1.2%	0.0%
Slovakia (n = 89)	93.3%	4.5%	1.1%	0.0%	1.1%
India (n = 90)	84.4%	8.9%	3.3%	1.2%	2.2%
ALL COUNTRIES (n = 425)	91.8%	4.0%	1.9%	0.9%	1.4%

More than nine out of ten respondents (91.8%) indicated they perceived it was easiest to concentrate when reading in print. While there was some variation across countries (a low of 84.4% in India to a high of 97.6% in Germany), the overwhelming choice was print.

3.2 Open-ended questions

Our coding of the four open-ended “like most” / “like least” responses generated an extensive fine-grained analysis of the data. Here (Tables 7-10) we focus on main categories and subcategories with 3% or higher total responses across countries. However, we also comment on several smaller but informative subcategories. The “Other” designation in each table includes categories with less than 3% of total responses, along with un-codable responses and instances in which no informative comment was given (e.g., “none” or “don’t know”).

For every category (and subcategory) discussed, we offer examples of responses. Each is tagged with the response identifier (country and participant number) of the student (US = United States, J = Japan, G = Germany, SK = Slovakia, and IN = India).

3.2.1 Hardcopy: like most

Table 7 presents, by percentage, responses regarding what participants “liked most” about reading in hardcopy.

Table 7

“Like most” responses about reading in hardcopy

Response Type	Percentage
Emotional/aesthetic	15.3%
Physical	61.7%
Cognitive	7.1%
Convenience	9.0%

Other	6.9%
TOTAL	100.0%

When asked what they “liked most” about reading in hardcopy, 15.3% of participants indicated something relating to an emotional or aesthetic response. Of these, nearly half (7.1% of total “like most” responses for hardcopy) talked about their enjoyment or feelings (e.g., “I just enjoy it” [US08] or “I like the smell of paper” [IN57]). Interestingly, 4.0% said that reading in print was “real reading” (e.g., “feel that I am actually reading” [J97] or “Reading is more pleasant and feels more real” [G59]). This response was especially prevalent among the Japanese participants, constituting 15.3% of all their replies regarding what they “liked most” about reading in hardcopy.

The largest single response category for what participants “liked most” about reading print (61.7%) involved something physical. Nearly one-quarter (23.0%) of all “like most” responses about print mentioned making annotations (e.g., “easier to highlight pages, write notes” [G47]). Another 12.4% praised the physicality of the book: holding/texture/turning pages (e.g., “holding the medium right in my hands” [G01] or “charm of actually turning pages” [J100]), while 11.6% mentioned visual advantages (e.g., “It does not strain the eyes” [IN06]).

Regarding cognitive issues, most comments (4.2% of the total “like most” for print responses) referred to concentration (e.g., “It’s easier to focus” [US34]), though there were also several comments suggesting that reading in print aids memory (e.g., “feel like the content sticks in the head more easily” [J34]). With regard to convenience, 4.5% of all the “like most” comments about print spoke positively about portability or weight of printed materials (e.g., “transport wherever” [SK71]), while another 4.2% mentioned ease of use or comfort (e.g., “The text is properly visible while sitting or lying” [IN65]).

3.2.2 Hardcopy: like least

Table 8 presents, by percentage, responses of what participants “liked least” about reading in hardcopy.

Table 8

“Like least” responses about reading in hardcopy

Response Type	Percentage
Physical	19.2%
Cognitive	4.0%
Access to material	5.9%
Convenience	43.5%
Resources (ecological and monetary)	10.1%
Other	17.3%
TOTAL	100.0%

The major source of discontent about reading in hardcopy (43.5%) involved lack of convenience. Most of these responses (31.7% of all “like least” comments about print) referred to overall convenience, portability, or weight (e.g., “not as handy as digital media” [G80] or “not easy to carry” [J25]), while another 11.2% complained about space, storage, or organization issues (e.g., “take[s] too much space” [SK35] or “to[o] many papers can get unorganized and hard to manage” [US21]).

Nearly one-fifth (19.2%) of negative responses about reading in print related to something physical, though the nature of responses varied. For example, 4.5% complained about damage to books or pages (e.g., “when you’re on the go they can get damaged easily” [G01] or “can get dirty” [J18]), 2.9% mentioned inability to easily find words or look up information (e.g., “It is difficult to search for specific information quickly” [IN55]), and 4.8% raised problems relating to legibility or eyestrain (e.g., “Often the very small size of the print” [G55]).

The percent of respondents voicing cognitive dislikes about reading in print was fairly minimal (4.0%), but their comments were telling, given how distinct they were from cognitive

complaints about reading onscreen (see Section 3.2.4 below). Nine participants described reading in print as boring (e.g., “It becomes boring sometimes” [IN69]) or mentioned having trouble settling down when reading in print (e.g., “it takes time to sit down and focus on the material” [US38]).

Regarding access to material when reading in print, some respondents (5.9%) expressed dissatisfaction. Among them, 2.7% of total “like least” responses mentioned lack of easy access (e.g., “Poor accessibility as compared to digital copies” [US33]), while 3.2% spoke about losing or forgetting printed materials (e.g., “a lot of papers – can be lost” [SK65]).

More pronounced (10.1%) were participants’ concerns that print wastes resources. Some comments (3.2% of all “like least” responses about reading in hardcopy) focused on ecological issues (e.g., “more damaging for the environment” [G63]), while others (6.4%) involved monetary resources (e.g., “cost of printing” [SK27] or “Hardcopy books can be expensive” [US17]). For some responses, it was not possible to discern whether the issue was environmental or monetary (e.g., “printing it” [IN34]). Comparing across countries, German students were by far the most focused on resource issues (environmental or monetary), with 20.7% of all their “like least” responses about print involving these concerns.

3.2.3 Digital screen: like most

Table 9 presents, by percentage, responses for what participants “liked most” about reading on digital screens.

Table 9

“Like most” responses about reading on digital screens

Response Type	Percentage
Emotional/aesthetic	3.7%
Physical	31.6%
Cognitive	4.5%

Access to material	16.1%
Convenience	25.1%
Resources (ecological and monetary)	8.6%
Other	10.4%
TOTAL	100.0%

Only a small number of participants (3.7%) identified something emotional or aesthetic as what they liked most about reading onscreen. This finding compares with 15.3% of all “like most” responses for reading in hardcopy. Where positive emotional/aesthetic comments about reading onscreen did appear, they involved expressions of enjoyment (e.g., “It is fun” [IN69]) or personal judgment (e.g., “it’s ‘smart’/sophisticated/stylish” [J115]).

The most common reason (31.6%) participants liked reading digitally involved screens’ physical characteristics. Many students (10.7% of overall “like most” responses for reading onscreen) mentioned functional attributes of digital devices (e.g., “The light helps me see the words” [US15]), while another 13.6% commented on being able to search for words, find information, and/or use the internet (e.g., “you can look up something right away if you don’t understand it” [G48]).

Convenience (25.1%) and access to material (16.0%) were also prominent choices for what students liked most about reading onscreen. Regarding overall convenience, 17.1% of all digital “like most” responses mentioned convenience, portability, or weight (e.g., “easy to carry” [J18]). Regarding access to material, 5.1% talked about space, storage, or organization (e.g., “doesn’t take up space (in the room)” [G37]).

When it came to cognitive issues, about a dozen students (2.9%) said what they “liked most” about reading onscreen was the ability to multitask (e.g., “I can multitask while I’m reading” [US38]). A somewhat larger number (8.6%) praised digital screens for saving environmental or monetary resources (e.g., “no cost for print” [SK53]).

3.2.4 Digital screen: like least

Table 10 presents, by percentage, responses regarding what participants “liked least” about reading on digital screens.

Table 10

“Like least” responses about reading on digital screens

Response Type	Percentage
Emotional/aesthetic	6.4%
Physical	64.6%
Cognitive	21.3%
Other	7.7%
TOTAL	100.0%

Nearly two-thirds (64.6%) of primary objections to reading on digital screens involved a physical attribute of the medium. Of these, the largest concern (45.5% of all “like least” responses regarding reading onscreen) involved visual issues. Most comments related to eye problems (e.g., “not good for the eyes” [J36] or “Eyes get tired looking at screen” [US42]). Another 6.7% complained about annotation on digital screens (e.g., “Highlighting/notes are harder to do” [G11]), while 5.1% of all “like least” comments about reading on digital screens concerned the operation or functionality of digital devices (e.g., “need of internet connection to read online” [SK37]). In addition, 4.0% were not happy with the way they interacted with a page of text (e.g., “tactile quality of the book is missing” [G68]).

Cognitive issues were on the minds of more than one-fifth (21.3%) of respondents. Nearly all of their comments involved perceptions of distraction or lack of concentration (e.g., “danger of distraction” [G12] or “no concentration” [SK87]). The complaint was especially high among US participants, constituting 42.6% of all “like least” comments about reading onscreen.

Finally, 6.4% of “like least” responses regarding digital reading involved emotional or aesthetic dimensions. Replies included comments about lack of enjoyment (e.g., “not fun to read” [J77]) or personal preference (e.g., “I hate reading on laptop screens” [US26]).

3.2.5 Other student comments

Out of 429 participants, only 125 offered additional comments at the end of the survey. The majority of these addressed positive aspects of print. In many instances, students essentially reiterated earlier responses to “like most” / “like least” questions. However, some comments revealed additional perspectives on reading preferences.

Positive comments about reading in print included:

- “reading in hardcopy makes me focus more on what I am reading” [US02]
- “hardcopy ... has a nostalgic, comforting, cozy feeling whilst reading” [US12]
- “It feels easier on my eyes to read a hardcopy, I feel like I understand it more” [US27]
- “books, paper etc. have a symbolic power for me” [G05]
- “with a book ... turning the pages is an active process in reading. Also the scent of a book is important for me if I want to feel good while reading.” [G30]
- “Printed media give me a feeling of ownership ... you don’t put digital media on your bookshelf” [G78]
- “I prefer print, even if the sources are in digital, I print it” [SK08]
- “print text is much more magic[al] compared to digital [SK43]
- “With hardcopy many emotions get attached.... Digital is superficial” [IN03]

Negative comments about reading in print included:

- “The toll on the environment is very important to me” [G66]
- “Higher cost [for print books]” [SK28]
- “On the digital screen, it’s possible to come across different articles and read them then and there, whereas in terms of hardcopy you have to take time out to read” [IN74]

Positive comments about reading onscreen included:

- “newspapers ... are fundamentally more pleasant to read online” [G55]
- “Search for information is better in digital” [SK61]

“digital screens are quite attractive because of [their] brightness” [IN27]

“I would always prefer digital screens because it seems to be something new” [IN50]

“Digital screens are preferable for better learning as there is access to multi activities at one time” [IN54]

Negative comments about reading onscreen included:

“It hurts my eyes to stare at a screen for too long so I often get distracted” [US34]

“compared to reading in hardcopy, prone to skimming (unlike reading thoroughly) on a digital screen” [J12]

“I find marking things in digital form a hassle” [G34]

There were also a number of comments expressing conflicted feelings about the two media. For example,

“I think hardcopy is much better, however to save paper I use digital for school because those reading I usually don’t care enough about to want to keep” [US18]

“I like that digital screens save paper but it is hard to concentrate when reading on them” [US30]

“Hardcopy is nicer but digital is more efficient and increasingly it has more options which make it preferable” [US37]

“Reading in digital is faster, but bad for eyes” [SK36]

Or, as a student in one of the pilot studies wrote,

“While I prefer reading things in Hardcopy, I can’t bring myself to print out online material simply for the environmental considerations. However, I highly, highly prefer things in Hardcopy – just to clarify.”

In addition to comments that explicitly favored one medium or the other, or comments that expressed conflicted feelings, several responses implied consequences of reading on a particular platform. An example:

“It takes more time to read the same number of pages in print comparing to digital” [SK30]

This observation suggests the respondent may well devote less time (and mental focus) when reading onscreen than in print. The remark is reminiscent of both Ackerman and Goldmith’s

findings (2011) and of a response from one of the pilot studies to the “like least” question regarding reading in hardcopy:

“It takes me longer because I read more carefully”

4. Discussion

We begin by summarizing findings from the current study, noting where responses to answer-selection questions and open-ended questions reinforce one another. In the process, we present likely explanations for several discrepancies we observed between participants from different countries. Our research is then set in context of previously published studies. Finally, we consider implications of the choice of reading platform for students and educational institutions.

4.1 Interpreting findings from current study

The two most striking findings from the answer-selection portion of the survey concern cost and concentration. Regarding cost, 86.9% of participants said that if cost were the same for digital and print materials for schoolwork, they would choose print, with 80.9% opting for print for pleasure reading, assuming cost parity. As for concentration, 91.8% of all respondents indicated they perceived that they concentrated best when reading in print.

Results from the answer-selection questions about the role of cost in choosing a medium for reading provide a stark reminder of the tension students face between finances, on the one hand, and their preferred reading platform (along with the medium on which they feel they learn best), on the other. For over a decade, cost has been a major factor in the rise of eBooks (both academic and trade). When the Amazon Kindle was introduced in late 2007, eBooks of bestsellers were priced at \$9.99 (Trachtenberg, 2011), which was often below the price Amazon paid publishers, and nearly always below what customers might have paid for print.

University students frequently have cost-savings forefront in their minds. As a participant commented in one pilot study, “Cash rules everything around me.” In the current survey, 4.8% of all “like least” responses about reading in hardcopy were complaints about the cost of print. There is no doubt that college textbooks are expensive. The College Board, for example, suggests that students estimate about \$1200 per year for course materials at US institutions (College Board, n.d.).

Preference for print to facilitate concentration was not surprising. However, the magnitude of this choice was unexpected, given millennials' attachment to their digital technologies. The Pew Research Center reported that in 2015, 98% of US 18-29 year olds owned cell phones and 50% owned tablets (Anderson, 2015). Regarding teenagers (13-17 years old), Pew found that in 2015, 92% reported going online daily, including 24% who indicated they went online "almost constantly" (Lenhart, 2015). In the US, 13-18 year-olds are averaging 9 hours per day on media entertainment – not including media use in school or for doing homework (Common Sense Media, 2015). (The authors are unaware of comparable statistics on university students.) In our own study, nearly all participants had ready access to one or more digital technologies: 94.4% had their own desktop or laptop computer, 23.6% owned a tablet computer, 5.6% had an eReader, and 89.5% had a mobile phone with internet access.

The open-ended "like most" / "like least" questions further evidenced students' perception that print facilitates concentration. Responding to the question of what they "liked least" about reading onscreen, more than 20% of all participants cited perceived difficulty with concentration (often phrased as problems with distraction). Similarly, 4.2% of the "like most" comments about reading in hardcopy alluded to ease of concentration or lack of distraction. Some of the additional student comments further reinforced the same theme (e.g., "reading in hardcopy makes me focus more on what I am reading" [US02]).

Responses to other answer-selection questions complement these findings regarding concentration. Take the issue of re-reading. Not all students reported re-reading books or related materials, either for academic work or pleasure. However, when those who did re-read were asked if they were more likely to do so in print or digitally, roughly 60% said hardcopy. Around 25% indicated both media were equally likely, while about 15% specified digital. Re-reading habits are particularly relevant to academic work. In principle, when preparing for an examination, students review not just class notes but assigned readings. Our research suggests print is the medium on which the majority of students are more likely to engage in such review/re-reading.

A related issue arose in the open-ended questions with regard to annotation of textual materials. In their responses to the "like most" question regarding print, nearly a quarter of all participants mentioned ease of annotation. Conversely, when asked what they "liked least"

about reading digitally, 6.7% complained about difficulty (or presumed impossibility) of doing digital annotation. Readers know that if they have annotated a work, when they return to the text it is easier to locate issues they initially found significant than if they encounter pristine pages. It therefore seems likely that ease of annotation in print encourages re-reading, which in turn should foster learning (Simpson & Nist, 1990).

Another relevant answer-selection issue involved text length: On which medium were students more likely to read a short text? A long one? Both when reading for academic work and pleasure, a sizeable majority of participants (86.4% for schoolwork, 77.6% for pleasure reading) reported preferring reading long works in print. Young adults would appear to judge that reading longer texts benefits from a medium that facilitates mental focus and less-hurried thought (Farinosi, Lim, & Roll, 2016, p. 217).

Finally, we turn to multitasking. Combining responses of *very often* and *sometimes*, 66.5% of total respondents indicated they felt they were likely to multitask while reading digitally, compared with 41.2% when reading in hardcopy. The prevalence of self-reported multitasking when reading digitally is consonant with the “like least” data we noted above regarding perceived distraction when reading onscreen, since such distraction often comes through multitasking.

If people are multitasking, it is difficult to focus on what they are reading. The literature has consistently documented the negative consequences of trying to focus on two cognitive tasks simultaneously (e.g., Loukopoulos, Dismukes, & Barshi, 2009; Ophir, Nass, & Wagner, 2009; Uncapher et al., under review).

Studies on the impact of multitasking on academic performance illustrate the problem. Research on university students in California concluded that “studying, doing homework, learning during lectures, learning from other sources, grades, and GPA likely are all negatively affected by concurrent multitasking with technology” (Carrier et al., 2015, p. 64). Work by Junco and Cotton (2012) yielded comparable findings. However, many young people do not believe that multitasking compromises their academic work. The Common Sense Media study (2015) on how young people use media illustrates the problem. Of those teenagers who said they *often* or *sometimes* engaged in multitasking (including watching TV, texting, or using social networking sites) while doing homework, the majority did not believe such multitasking affected the quality of their work.

Our study revealed marked discrepancies between reported multitasking levels in different country samples, especially between the US and Japan. In the US, 85.1% of participants indicated they multitasked “very often” or “sometimes” when reading on a digital screen, while in Japan, the number was only 45.7%. Examination of additional US and Japanese responses in our survey may explain the finding. The relevant variable is the device on which digital screen reading was commonly done. As users of computers and mobile phones know, it is easy to access multiple screens simultaneously on a desktop or laptop, while on a mobile phone, only one function is visible at a time. It is therefore simpler to multitask when reading on a computer than when reading on a mobile phone.

In the US, participants reported using computers for 93.6% of their digitally-accessed school reading but 0% use of mobile phones (with internet access) for such reading. For pleasure reading, US participants reported using computers for 64.9% of digital reading and mobile phones (with internet access) for 10.8% of digital reading. By comparison, 70.4% of Japanese participants indicated using computers for digital academic reading, while 26.1% identified using their mobile phones for this purpose. Regarding pleasure reading, only 23.5% of the Japanese participants said they read digitally on computers, while 70.4% reported doing such digital reading on mobile phones (with internet access).

It is therefore not surprising that multitasking was reported to be far higher among participants doing larger amounts of their digital reading on computers. In fact, when we asked what kind of multitasking the participants were engaged with when reading digitally, US students reported that 80.4% of their multitasking involved doing something with a computer (and 17.4% doing something with their mobile phone), while Japanese students responded that only 35.1% of such multitasking involved doing something with a computer, compared with 43.2% doing something with their mobile phone. As mobile phone technology evolves, with the likelihood of smartphones becoming able to run concurrent programs (i.e., as computers can), it will be interesting to see if Japanese students become more likely to report multitasking while reading on a digital device.

A further explanatory factor regarding our current study may be the kind of reading the Japanese were likely to be doing onscreen, particularly for pleasure. Data from 2014 indicate that 80% of Japanese eBooks are manga comics (EPUB3 Key, 2014), which are increasingly being read on mobile phones. Mobile phones have been an entrenched part of Japanese culture

since the late 1990s (Ito, Okabe, & Matsuda, 2005), long before in the US. Given their heavy use of mobile phones in general, along with the enormous popularity of manga in Japan, it should also not be surprising that Japanese students in our study were the most likely to report favoring re-reading for pleasure on a digital device.

In interpreting all of our answer-selection data, especially for US participants, it is important to keep in mind when the studies were conducted. The US surveys were administered in Spring 2013. While over 90% of these participants reported owning a mobile phone with internet connection, most digital educational materials were being accessed on computers. More recently, US educational institutions having been working to adapt electronic materials to mobile platforms, especially smart phones. As a result, we expect changes have already occurred in choice of digital device when reading onscreen – with potential implications for concentration, especially as screen size shrinks. At the same time, as smart phones have become increasingly multifunctional, we can also anticipate, as our students tell us anecdotally, that multitasking when reading in hardcopy is also rising, since students regularly have their phones readily accessible when reading in print.

Another caveat in interpreting our answer-selection findings is the educational technology practices of particular countries. The amount of digital reading reported for schoolwork was considerably higher in some countries than in others (e.g., US: 40.8%; Japan: 24.7%; India: 27.3%). While these patterns may partly reflect student choice or the fact we used a convenience sample, we should also be aware that at least in the US, many academic reading assignments are provided digitally through an online learning management system. Therefore, it is not unexpected that US students reported doing two-fifths of their academic reading onscreen.

Our discussion of the “like most” / “like least” open-ended questions is structured around the six major conceptual categories (laid out in Figure 1) in terms of which all four questions were coded. This organization is driven in part by the fact that “like most” responses about reading in print are often the obverse of “like least” responses about reading on digital screens, and “like least” comments about reading in print are commonly the obverse of the “like most” query about reading onscreen.

Emotional/aesthetic

One of the most surprising findings from the open-ended questions was the extent to which young adults in all of the countries we surveyed expressed fondness for traditional aspects of print. Participants commented that they enjoyed print, found it relaxing, and that it was “real reading.” They also wrote about liking the smell of books. In fact, among Slovak participants, 10.1% of all “like most” responses about reading in print mentioned smell.

At the same time, like beauty being in the eye of the beholder, what counts as emotionally or aesthetically enjoyable when it comes to reading platform is a matter of individual taste. A handful of participants spoke about digital reading being fun, entertaining, or modern. Interestingly, though, when responding to the question regarding what they “liked most” about reading on a digital screen, six participants explicitly wrote that they didn’t like digital screens – a telling answer to the question actually posed.

Physical

Four physical issues stood out in the open-ended data. The first involved annotation, which 23.0% praised as what they “liked most” about reading in print and 6.7% complained about as what they “liked least” about reading onscreen. When doing academic work, the advantages of having an easy system for highlighting, underlining, and making marginal notes are obvious. When reading for pleasure, many readers (especially those who re-read or share their books with others) find annotation to be an important tool for personalizing their reading.

The second physical issue concerned vision. Significantly, 45.5% of all “like least” responses about reading digitally were complaints about such issues as eyestrain or it being tiring to read onscreen. In the same vein, 11.6% of all comments about what participants “liked most” about reading in hardcopy mentioned visual advantages. We also note that several students indicated that what they “liked most” about reading digitally was the lighting or their ability to enlarge text size. As screen technologies continue to improve, we can anticipate declining complaints about visual issues when reading onscreen. However, for now, the concerns are palpable.

Third, when talking about what they “liked most” about reading in print, there were many comments (12.4%) relating to holding the book, feeling its texture, or turning pages. While we classified these comments under the “Physical” category, they sometimes

conceptually overlap with emotional/aesthetic issues. The importance of touch (technically known as haptics) when engaged in reading has been emphasized by other researchers (Gerlach & Buxmann, 2011; Mangan & Verlay, 2010).

The fourth physical issue spoke to the advantages of reading digitally. For example, students praised the ability to search (for words, for information) when reading onscreen and complained about not being able to do so with print. Undoubtedly, online access can be extremely helpful in some reading activities, such as looking up the definitions of words or gathering information while doing research. At the same time, research regarding the effects on concentration when following hyperlinks cautions us about loss of focus on the text at hand (e.g., DeStefano & LeFevre, 2007).

Cognitive

Consistent with results from answer-selection questions regarding perceptions about concentration, the open-ended questions highlighted student concern about concentrating when reading on digital screens. While 4.2% of respondents indicated that what they “liked most” about reading in print related to concentration, 21.3% complained that what they “liked least” about reading digitally involved problems with distraction or concentration. Similarly, a number of comments at the end of the survey spoke to advantages of print for mental focus.

In discussing cognitive issues that students “liked least” about reading in print, we noted nine cases in which respondents complained about print being “boring,” difficult to settle into, or, in one case, sending the reader to sleep. There were no such complaints about digital reading. The obvious questions are, why did students find print to be problematic in these ways, and why was there no mention of such issues when it came to reading onscreen.

The answers, we suggest, lie in the entertainment and distraction potential of reading onscreen. When reading print, the only direct source of mental engagement is the text itself (other than one’s own mind). When reading on a digital device, assuming it has an internet connection, a world of alternative engagement is at the reader’s fingertips. One 20-year-old American student, himself an avid reader of print, explained the issue this way in conversation with the first author: When reading on a digital screen, he expects interruptions of many sorts (text alerts, the ability to check Facebook or send a tweet). As a result, when now he is reading

print, he finds himself waiting for such interruptions rather than settling into the text, as he used to be able to do.

Access to material

Digital screens were more highly favored for accessing material. Responding to the question of what they “liked most” about reading onscreen, 16.1% of students spoke of enjoying being able to store all their readings in one place, of always having their materials available, and being able to download additional materials. By contrast, responding to the “like least” question about reading in print, 5.9% of participants mentioned the challenges of not having all their books with them at one time or losing track of sheets of paper. Undoubtedly, being organized (especially for academic work) is a virtue, and digital devices have clear benefits for many students.

Convenience

When asked what they “liked most” about reading digitally, 25.1% of all responses related to convenience, while for the “like least” question about reading in print, 43.5% of complaints involved convenience. As with cost issues, convenience (along with access to materials) is a major consideration university students must weigh when choosing the medium in which to read.

The publishing industry is continuing to evolve its distribution models. It will be interesting to see whether current experiments in offering print plus digital (and perhaps plus audio) versions of books or other text-based material at a single bundled price will accelerate (Kindle Matchbook, n.d.; Wikert, 2016). If so, readers may find that considerations of “convenience” can combine with those of personal preference and concentration by being able to use digital or audio versions of materials while on the go (e.g., on a bus or in a classroom) but print versions when settled in (e.g., in a library or at home).

Resources

In their open-ended responses, it was sometimes difficult to distinguish between concerns about finances and issues relating to the environment. Where the distinctions were clear, 6.4% of all “like least” comments about reading in print were about cost, while 3.2% were

about the environment. Complementing these responses, among “like most” replies about reading digitally, 4.0% involved money and 4.0% invoked the environment.

The monetary issue turns out to be nuanced. Some students who complained about cost offered a cost/benefit analysis (e.g., digital “like most”: “It doesn’t waste paper, especially on articles for school that really aren’t important” [US35]; additional comments: “I think hardcopy is much better, however to save paper I use digital for school because those readings I usually don’t care enough about to want to keep” [US18]). It obviously behooves faculty to select course reading materials students will find meaningful and, at least in some cases, worthy of preserving, whether digitally or in print.

Environmental considerations are nuanced as well. First, the level of concern young adults express regarding the environment (here, including the impact of print or digital technologies upon it) likely varies with such factors as national or local social agendas, recent environmental events, or individual campus cultures. In our study, German students were the most vocal about judging hardcopy bad for the environment (8.5%). US participants gave only 4.3% such responses. However, in an earlier pilot study in the US (Baron 2013a), 21% of the answers regarding what students “liked most” about reading onscreen involved something ecological, as did 17% of responses to the question of what they “liked least” about reading in hardcopy.

But second, university students, along with much of the general public, tend to assume digital reading is more environmentally beneficial than reading in print. Yet ongoing research demonstrating the negative environmental (and health) impact of materials going into construction of digital devices, along with progress on recycling and renewability of paper resources, suggests the jury is still out on the environmental consequences of each reading medium (Baron, 2015, pp. 67-71).

4.2 Comparing current findings with other research

The published literature we reviewed at the beginning of this paper highlighted a number of the same considerations revealed in our own data. Start with mental focus. Earlier studies of comprehension and memory noted that participants perceived themselves to do better when reading in print, even when their test results were comparable for digital conditions. However, when participants selected the amount of time they devoted to both tasks

(as in Ackerman & Goldsmith, 2011), students spent less time (and performed less well) when reading digitally. In our research, students mentioned – sometimes complained about – spending more time reading the same text in print as they would digitally. Given the years of acculturation even digital natives have had reading print (including instruction how to read carefully), it is not surprising to find students approaching print with different mental expectations than when reading digitally. Consistent with acculturation is Mangen et al.’s finding (2014) that participants were better at ordering events after reading a mystery story in print.

A related shared theme across studies is multitasking. Research by Bowman et al., (2010), Daniel and Woody (2013), and Subrahmanyam et al. (2013) found negative effects of multitasking while reading digitally. In our own study, students were more likely to report multitasking when reading digitally than in hardcopy. Moreover, in their “like least” comments about reading onscreen, a number of responses pinpointed distractions from multitasking (e.g., “It is so easy to get distracted, because there is so much to read on the Internet” [US01]; “temptation to do something else” [SK41]).

Considering studies deriving from COST Action FPS 1140, many of the same issues that surfaced there anecdotally also appeared in our quantified data: with print, ease of annotation but lack of portability; on digital screens, convenient storage of texts but strain on the eyes and distraction. Farinosi et al. (2016) reported students felt they could become more immersed in the content of printed text, echoing both Mangen and Kuiken’s findings (2014) and our own result that almost 92% of participants perceived print was the better medium for concentration.

A final parallel is cost. As with our own research, multiple previous studies reported price to be a primary consideration for students in choosing between print and digital.

4.3 Implications and challenges for education

The price of academic materials is a factor both students and educators cannot ignore. In the US, many university students report sometimes not acquiring required course materials because of the cost (National Survey of Student Engagement, 2016; Student Monitor LLC, 2014). When the decision is whether to procure materials digitally or in print, many students are aware they may be trading personal preference or learning gains (be they perceived or

actual) for cost-savings. This dilemma is reflected in our finding that if asked to ignore price (that is, if cost were the same for print and digital versions), the majority of students would choose print for both academic work and pleasure reading.

Our findings on concentration, multitasking, re-reading, and reading long texts lend further credence to the idea that students themselves believe that print generally supports a level of mental focus that digital reading (at least as currently practiced) may not. Given these results, we should reasonably ask why so many faculty and administrators are increasingly supporting a transition from print to digital materials.

Putting cost aside, two main explanations seem likely. The first is convenience: Library and course materials are available around the clock, regardless of student location. Students don't need to worry about losing their reading materials. There is no longer the issue of the campus store running out of copies of a required text. The second explanation is a desire to be modern. On the one hand, educational institutions feel an obligation to prepare students for the growingly digital world in which they will live and work. On the other, administrators and individual faculty members often presuppose that students would prefer to read digitally, an assumption our research challenges.

As educational institutions go forward, it will be important to undertake more in-depth research on the impact of reading medium on learning and thinking. While the studies to date are a useful beginning, we need, for example, to move beyond comparing performance on the kinds of textual passages found on standardized tests to instead measuring reflective thinking or complex analysis. Similarly, as digital textbooks themselves evolve from direct translations of linear print to platforms designed for adaptive learning or connecting with the Web, we should devote serious research attention to the question of what kinds of texts or subject matters make most educational sense in what formats. As in so much of education, one size likely doesn't fit all.

References

Ackerman, R., & Goldsmith, M. (2011). Metacognitive regulation of text learning: On screen versus on paper. *Journal of Experimental Psychology: Applied*, 17(1), 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.
- Anderson, M. (2015). The demographics of device ownership. Pew Research Center, October 29. <http://www.pewinternet.org/2015/10/29/the-demographics-of-device-ownership/> Accessed 6.29.16.
- Baron, N. S. (2011). Attitudes towards mobile phones: A cross-cultural comparison. In H. Greif, L. Hjorth, A. Lasen, & C. Lobet (Eds.), *Cultures of participation* (pp. 77-94). Frankfurt am Main: Peter Lang.
- Baron, N. S. (2013a). Reading in print versus onscreen: Better, worse, or about the same? In D. Tannen, & A. M. Trester (Eds.), *Discourse 2.0: Language and new media* (pp. 201-224). Washington, DC: Georgetown University Press.
- Baron, N. S. (2013b). Redefining reading: The impact of digital communication media. *PMLA*, 128(1): 193-200.
- Baron, N. S. (2015). *Words onscreen: The fate of reading in a digital world*. New York, NY: Oxford.
- Bowman, L. L., Levine, L. E., Waite, B. M., & Gendron, M. (2010). Can students really multitask? An experimental study of instant messaging while reading. *Computers & Education*, 54(4), 927-931.
- Carrier, L. M., Rosen, L. D., Cheever, N. A., & Lim, A. F. (2015). Causes, effects, and practicalities of everyday multitasking. *Developmental Review*, 35, 64-78.
- College Board (n.d.). Trends in higher education: Average estimated undergraduate budgets, 2015-16. <https://trends.collegeboard.org/college-pricing/figures-tables/average-estimated-undergraduate-budgets-2015-16/> Accessed 6.29.16.
- Common Sense Media (2015, November 3). Landmark report: U.S. teens use an average of nine hours of media per day, tweens use six hours. <https://www.commonsensemedia.org/about-us/news/press-releases/landmark-report-us-teens-use-an-average-of-nine-hours-of-media-per-day/> Accessed 2.27.16.
- Daniel, D. B., & Woody, W. D. (2013). E-textbooks at what cost? Performance and use of electronic v. print texts. *Computers & Education*, 62, 18-23.

- DeStefano, D., & LeFevre, J.-A. (2007). Cognitive load in hypertext reading: A review. *Computers in Human Behavior*, 23(3), 1616–1641.
- EPUB3 key to growing illustrated ebooks internationally? (2014, May 29). *Digital Book World*. <http://www.digitalbookworld.com/2014/epub3-key-to-growing-illustrated-ebooks-internationally/> Accessed 2.27.16.
- Farinosi, M., Lim, C., & Roll, J. (2016). Book or screen, pen or keyboard? A cross-cultural sociological analysis of writing and reading habits basing on Germany, Italy and the UK. *Telematics and Informatics*, 33(2), 410-421.
- Flood, A. (2014, August 19). Readers absorb less on Kindles than on paper, study finds. *The Guardian*. <http://www.theguardian.com/books/2014/aug/19/readers-absorb-less-kindles-paper-study-plot-ereader-digitisation/> Accessed 2.27.16.
- Fortunati, L., & Vincent, J. (2014). Sociological insights on the comparison of writing/reading on paper with writing/reading digitally. *Telematics and Informatics*, 31(1), 39-51.
- Gerlach, J., & Buxmann, P. (2011). Investigating the acceptance of electronic books – The impact of haptic dissonance on innovation adoption. *ECIS 2011 Proceedings*, Paper 141.
- Green, T. D., Perera, R. A., Dance, L. A., & Myers, E. A. (2010). Impact of presentation mode on recall of written text and numerical information: Hard copy versus electronic. *North American Journal of Psychology*, 12(2), 233–242.
- Holzinger, A., Baernthaler, M., Pammer, W., Katz, H., Bjelic-Radisic, V., & Ziefle, M. (2011). Investigating paper vs. screen in real-life hospital workflows: Performance contradicts perceived superiority of paper in the user experience. *International Journal of Human-Computer Studies*, 69(9), 563–570.
- Ito, M., Okabe, D., & Matsuda, M. (2005). *Personal, portable, pedestrian: Mobile phones in Japanese life*. Cambridge, MA: MIT Press.
- Ji, S.W., Michaels, S., & Waterman, D. (2014). Print vs. electronic readings in college courses: Cost-efficiency and perceived learning. *The Internet and Higher Education*, 21, 17-24.
- Junco, R., & Cotton, S. R. (2012). No A 4 U: The relationship between multitasking and academic performance. *Computers & Education*, 59(2), 505-514.
- Kindle MatchBook (n.d.) Introducing Kindle MatchBook.
- Kretzschmar, F., Pleimling, D., Hosemann, J., Füßel, S., Bornkessel-Schlesewsky, I., & Schlewsky, M. (2013). Subjective impressions do not mirror online reading effort:

Concurrent EEG-eyetracking evidence from the reading of books and digital media. *PLoS ONE*, 8(2), e56178.

LaRose, R. (2010). The problem of media habits. *Communication Theory*, 20(2), 194-222.

Lenhart, A. (2015). Teens, social media & technology overview 2015. Pew Research Center, April 9. <http://www.pewinternet.org/2015/04/09/teens-social-media-technology-2015/> Accessed 6.29.16.

Loukopoulos, L. D., Dismukes, R. K., & Barshi, I. (2009). *The multitasking myth: Handling complexity in real-world operations*. Burlington, VT: Ashgate.

Mangen, A., & Kuiken, D. (2014). Lost in an iPad: Narrative engagement on paper and tablet. *Scientific Study of Literature*, 4(2), 150-177.

Mangen, A., Robinet, P., Olivier, G., & Velay, J.-L. (2014). Mystery story reading in pocket print book and on Kindle: Possible impact on chronological events memory. Conference presentation, International Society for the Empirical Study of Literature and Media. Turin, Italy, July 21-25.

Mangen, A., & Velay, J.-L. (2010). Digitizing literacy: Reflections on the haptics of writing. In M. H. Zadeh (Ed.), *Advances in Haptics* (pp. 385-401). Rijeka, Croatia: InTech.

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.

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.

Milliot, J. (2013, May 9). BEA 2013: The E-book boom years. *Publishers Weekly*. <http://www.publishersweekly.com/pw/by-topic/industry-news/bea/article/57390-bea-2013-the-e-book-boom-years.html> Accessed 2.27.16.

National Survey of Student Engagement (2016). Engagement insights: Survey findings on the quality of undergraduate education. Annual results 2015. http://nsse.indiana.edu/html/annual_results.cfm Accessed 2.27.16.

New AAP figures show ebook growth mostly flat (2015, June 10). *Digital Book World*.

<http://www.digitalbookworld.com/2015/new-aap-figures-show-ebook-growth-mostly-flat/> Accessed 2.27.16.

Ophir, E., Nass, C., & Wagner, A. D. (2009). Cognitive control in media multitaskers. *Proceedings of the National Academy of Sciences*, 106(37), 15583–15587.

Porion, A., Aparicio, X., Megalakaki, O., Robert, A., & Baccino, T. (2016). The impact of paper-based versus computerized presentation on text comprehension and memorization. *Computers in Human Behavior*, 54, 569-576.

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.

Simpson, M. L., & Nist, S. L. (1990). Textbook annotation: An effective and efficient study strategy for college students. *Journal of Reading*, 34(2), 122-129.

Student Monitor LLC (2014). *Converting Data to Insight – Fall 2014*.

Student Monitor LLC (2013). *Lifestyle & media – Spring 2013*.

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.

Taipale, S. (2014). The affordances of reading/writing on paper and digitally in Finland. *Telematics and Informatics*, 31(4), 532-542.

Taipale, S. (2015). Bodily dimensions of reading and writing practices on paper and digitally. *Telematics and Informatics*, 32(4), 766-775.

Trachtenberg, J.A. (2011, December 15). E-book readers face sticker shock. *Wall Street Journal*. Retrieved from <http://www.wsj.com/articles/SB10001424052970204336104577096762173802678> Accessed 9.14.16.

Uncapher, M. R., Lin, L., Rosen, L. D., Kirkorian, H. L., Baron, N. S., Bailey, K., ... Wagner, A. (under review). Media multitasking is associated with cognitive, psychological, neural, and learning differences. Whitepaper report from National Academy of Sciences Sackler Conference on Children and Media, Irvine, CA, October 2015.

Wikert, J. (2016, January 17). When will content truly become mobile? Joe Wikert's Digital Content Strategies. Retrieved from http://jwikert.typepad.com/the_average_joe/2016/01/when-will-content-truly-become-mobile.html/ Accessed 2.27.16.