What Academics Want When Reading Digitally

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ABSTRACT

Researchers constantly read and annotate academic documents. While almost all documents are provided digitally, many are still printed and read on paper. We surveyed 162 academics in order to better understand their reading habits and preferences. We were particularly interested in understanding the barriers to digital reading and the features desired by academics for digital reading applications.

Categories and Subject Descriptors

H.1.2 [**Models and Principles**]: User/Machine Systems—*human factors*; H.5.2 [**Information Interfaces and Presentation**]: User Interfaces—*evaluation/methodology*

Keywords

Human behaviour; usability; technical reading; digital documents; e-books

1. INTRODUCTION

Researchers spend significant amounts of time reading academic documents such as conference papers, journal articles and theses. The time devoted to reading grows as the number of publications and available digital information increases every year [3, 10]. Academic documents are characterised by a consistent logical hierarchy and the use of footnotes, endnotes (references), figures and tables. Hillesund [5] shows that academic documents are read non-linearly, and that annotation plays an important role. Pugh [11] identifies different reading techniques: scanning and searching, in order to locate specific information; skimming, to gain a basic understanding of the text and its structure; and receptive and responsive reading to fully read the text, which includes note taking and annotation.

The majority of academic documents are provided digitally, often as PDF files [9, 10]. PDF documents encode a fixed layout and are therefore presented in the same way, independent of device. Specialised software for reading PDF

files exists for all common devices, and is stable, mature and freely available. It typically provides annotation, dictionary lookup and position syncing between devices. Digital reading used to equate to reading on a desktop computer but now includes reading on eReaders, tablets and smartphones.

Here we present the results of a survey of 162 academics investigating their reading device preferences, reading habits and the features they would like supported by digital reading applications. Such a survey is important because it is several years since the last in this rapidly changing field. We found that paper and desktop computers still dominate academic reading, both being used about equally. Smartphones and eReaders are almost never used for academic reading but tablets are not infrequent.

The most novel and interesting aspect of the survey were questions asking what features respondents desire from a digital reading environment. The answers revealed that many did not want reading on digital devices to replicate that of print but rather to take advantage of new kinds of navigation and layout adaptation. This is in line with Chartier's suggestion from the late 1990s that "digital text inevitably requires new ways of reading" [2]. Of course, as Marshall points out, "to promote the transition to reading on the screen, it is vital to make the experience as good as the experience of reading on paper" [9].

2. METHODOLOGY

The survey was designed as an online questionnaire. All participants could complete the survey directly in their web browser at their own pace. The survey was voluntary and no payment or reward was offered. All responses were anonymous. The survey questions and responses were in English.[1] The survey consisted of 18 questions and required approximately 10 minutes to complete. About one-third of the questions were closed-ended and involved selection from predefined responses while the remaining questions were openended.

The invitation for participation was advertised in a weekly newsletter sent to all academic staff and students at Monash University. Additionally, colleagues from the Ludwig Maximilian University of Munich and Fraunhofer institutes in Munich were invited via email lists. The survey was available for three months from December 2013 to February 2014.

We used a coding process [12] to categorise all the responses. For the open-ended questions, all textual responses were read independently by two members of the research

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[1]One participant responded in German and the responses were translated by a member of the research team.

team who independently chose categories of responses (with surprising consistency). Final categories for each question were decided by discussion between these two team members. One of the research team members performed the coding by reading all responses and recording the matching categories. This matching was checked by another team member who flagged any perceived inconsistencies, which were then discussed by the team to determine the final coding. The entire questionnaire, plus the responses and processed data, are available online.[2]

3. ANALYSIS AND DISCUSSION

A total of 162 participant surveys were analysed. The gender distribution was slightly uneven: 58% females to 42% males, with 5 respondents not giving their gender. The sample consists of a diverse range of ages from under 25 to above 65, with 60% under 35, and 41% in the "26 to 35" bracket.

Device usage

The first survey question asked respondents to indicate how often they read academic papers using: *Print, Desktop* (including laptops), *Tablet, eReader* and *Smartphone*. Allowed responses were: *Most often, Often, Occasionally* and *Never*. From the responses we extracted two data sets: Frequency and Preferred. Frequency assigned each device a ranking of *Never, Occasionally* or *Often* where *Often* was true if the respondent had indicated either *Most often* or *Often* for that device. Preferred was a boolean indicating if the participant selected that medium as their most often used.

Device	Preferred	Often	Occ.	Never
Print	56%	71%	23%	5%
Desktop	53%	83%	14%	3%
Tablet	8%	16%	30%	54%
eReader	2%	4%	12%	84%
Smartphone	0%	0%	27%	72%

Print and desktops are by far the most frequently used devices for reading academic papers, followed by tablets. Smartphones and eReaders are rather uncommon. We confirmed that this difference was significant at the 0.05 confidence level using a Kruskal-Wallis H ($\chi^2(4) = 477.3246$, $p < 2.2e - 16$). Post-hoc analysis using pairwise comparisons with the Wilcoxon rank sum test using a Bonferroni correction indicated that Print and Desktop were significantly more frequent than eReader, Tablet and Smartphone and that Tablet was significantly more frequent than eReader and Smartphone.

This device preference was supported by the data on most preferred device, i.e., Print and Desktop were used most often for reading academic papers, followed by Tablets. Smartphones and eReaders are very uncommon. We used a χ^2 test with equal probability null hypothesis ($\chi^2(4) = 159.6567$, $p < 2.2e - 16$). We used a two-way χ^2 test and Fisher's exact test to examine if gender, age or field of study affected preference for Print or Desktop. We found that participants from BIOMED (life sciences, health, psychology and psychiatry) read on Desktop significantly more often than other fields ($\chi^2(6) = 14.0295$, 0.02931; Fisher $p = 0.02665$). These results were not significantly affected by gender or age.

To put this in context, Liu [7] evaluated how the reading behaviour in the digital environment has changed be-

tween 1993 and 2003. He found that "the digital environment has begun to affect people's reading behaviour" in that more time is spent on browsing and scanning as well as non-linear reading. Notably, he points out that in-depth reading of academic articles is still dominated by paper. Sellen and Harper provide similar evidence in various studies [13]. Tenopir found that more than two-thirds of electronic reading actually involved immediate downloading and printing on to paper [15]. Our findings suggest that some five years later print usage has decreased and that print and reading on digital devices are now equally common.

It is not surprising that smartphones are rarely used. Small screen require users to scroll a lot, especially reading PDF documents which are not reflowable. This causes increased effort and interruption in the reading flow for continuous reading. As a result, in-depth reading is very difficult on such devices. Similarly unsurprising are the results for eReaders. Their shortcomings are well documented: navigation problems finding tables and figures [17]; issues with switching modes as well as annotating, highlighting and bookmarking [16]; non-optimal display of figures and lack of cross-referencing to jump between documents [1]. Our results suggest that Tablets are the small mobile device of choice for reading academic papers.

Reading habits

Several questions explored the reasons why respondents read academic papers, how they read them, and the environment in which they read. We asked respondents to indicate all the reasons why they typically read an academic paper (multiple-choice). The most common reasons were: finding particular facts or results (82%); skim-reading to check for relevance (81%); detailed reading for full understanding of paper (76%); and learning about an area (72%). Reviewing was also reasonably common: conference/journal review (40%); student paper (31%). Interestingly, 38% of respondents read academic papers for entertainment or interest.

Participants tended to begin reading with the Abstract (84%), the Introduction (15%) or Conclusion (13%). In terms of perceived importance, participants rated the Conclusion (38%), Results (32%), Abstract (28%) and Methods (26%) sections as the most critical.

Another (open-ended) question asked respondents how they typically arranged their work area when reading academic papers. Our coding-based analysis showed that 69% read at their desk, 45% read away from their desk, with some 8% reading while travelling. Without any prompting, more than half of the participants (57%) explicitly mentioned that they keep annotation materials such as pens nearby while reading. This is further evidence that annotation is considered an integral part of the academic reading process.

Many people's responses indicated they chose reading locations free of distractions or interruptions, and some specifically mentioned the use of relaxation aids such as music or coffee. Many of the responses suggest a pre-planned, almost ritualistic aspect to reading where people carefully prepare themselves and their environment for the reading task:

> "I sit at my desk (whether at home or in my office at Uni) with my laptop/PC in front of me (whether I am reading off screen or not, so I can google/look up additional things as I go). I have pens (black and red), highlighters, and post it notes (in matching colours) on the desk. If I

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have printed articles etc, then I pile all the papers I have not read yet on the left of the computer, and once I have read them I put them in a pile on the right. I always have a drink with me, usually a bottle of water and/or coffee. I also have note/scrap paper available if I need to write notes for myself or for any ideas not appropriate to annotate on the paper itself." (#132)

We had two open-ended questions on annotation. The first asked where participants make annotations, notes or corrections when reading a paper and the second enquired how they link these to specific text. Most people annotate the document itself (both PDF and paper, 85%). Some annotate a separate physical document (25%) or a separate digital document/annotation application (19%). This was dependent upon the most frequent reading media, ($\chi^2(2) = 9.2682$, $p = 0.009715$), with those reading Print more likely to annotate the document (95%) vs Desktop (77%) or Tablet (83%). However, even for those who preferred Print many would also annotate on separate physical documents (22%) or separate digital documents (29%).

Annotations were linked to corresponding text in a number of different ways: Linking with lines or arrows (28%); By proximity, i.e., placing nearby notes (25%); Highlighting, underlining or circling text (25%); Using keys such as numbers, asterisks, symbols, or colours (16%); Layout-dependent description, e.g., "Second sentence in column 2 on page 3" (11%); Logical description (including quoting text), e.g., "Section 2, paragraph 3, sentence 2" (9%). There was no indication that this depended upon the reading media.

We asked participants about the kinds of resources they commonly use to source background information when reading a paper (multiple-choice) and how these are accessed (open-ended). Virtually all respondents use on-line resources such as Google Scholar or Wikipedia (97%) and many use physical documents (67%) and colleagues (36%). They access these resources on the same reading device (49%), a nearby computer/laptop (60%), in printed form (19%), or on a mobile device such as tablet or phone (7%).

Reasons for reading on paper

A key aim of the survey was to better understand why academics still commonly read printed documents. Ease of **annotation** was mentioned by 44% of respondents who frequently cited the convenience, freedom and accuracy of creating annotations on paper. This reaffirms previous results [7, 13] and shows once more that directly annotating the document is very important for academic reading.

Physical comfort was the second most common reason given for reading on paper (29%). Respondents mentioned that paper is more comfortable on the eyes and easier to hold and view than an electronic device. Given that many academics spend a lot of their day in front of a computer, switching to another medium for reading is not surprising.

Portability (15%), **tangibility** (13%), easier **navigation** (13%) and **better comprehension** (9%) were other reasons given for preferring to read paper. Portability was mentioned as an advantage for reading papers outside of the office, especially when travelling. Battery life and airport security were mentioned as issues for digital reading. The importance of tangibility has been confirmed by previous studies [4, 6, 7, 8]. Physical touch plays an important role in collaborative work on a paper as well as in proof-reading [14]. Interestingly, age affected the importance of tangibility ($\chi^2(4) = 15.5399, p = 0.003703$; Fisher $p = 0.003648$) with only participants older than 25 mentioning it. In terms of navigation, respondents appreciated "quick random access" (#16), that it is "easier to flip back and forth from page to page" (#112), as well as "shuttling to and from references" (#82).

Habits and personal preferences also play a minor role with several participants stating: "I am a print generation so used to it." (#83); "Habit, and I like the feeling of real paper." (#72).

Desired features for digital reading

Several questions explored desired features in digital reading software. A multiple-choice question asked participants to select the kinds of adjustable layout options they would like to have for digital reading. We found that adjustable font size is important to 76% of respondents, while varying the font family was much less important (22%). Also fairly unimportant were user adjustment of background colour and text colour (both 19%). Adjustable margins were important to 33% of the respondents, and ability to alter the orientation of the content was important to 54%. Almost half of the respondents (48%) wanted to be able to change the numbers of columns used to display the document and 57% of participants wished to be able to vary the amount of text shown on the screen. 43% of respondents wanted control over placement of figures and tables, while 35% desire adjustable placement for references and footnotes. This shows that the layout options provided by non-technical reading applications like the Kindle are not enough for academic reading and that more flexible layout is required.

We also asked an open-ended question about how a paper should ideally be laid out on digital devices. 23% responded that they would like the same layout as on paper, with many of these people expressing surprise that other layouts would even be possible. 21% of respondents volunteered that they like to have a single column layout with reflowed text. Respondents also said that they would like the layout to adapt to different screens (12%) and that the text should allow continuous scrolling (10%). Interestingly, a few participants wanted more drastic layout changes such as a dedicated stream for just the document text (2%). Others wished to have linked content—such as figures, footnotes, tables—"nearby" (9%).

In terms of navigation within the document, the most frequent requests were for hierarchical navigation (14%) and hyperlinked navigation (15%) where the user could jump to a desired figure, section or paragraph. A few respondents (7%) requested the ability to work with a collection of documents or library, rather than with a single document. Many people (22%) volunteered that they desired better annotation support in general. Additionally, some people requested more space for annotations (8%), annotation syncing (2%), as well as the ability to export annotations and notes (6%).

4. CONCLUSIONS

This research aimed to provide better understanding of why so many researchers still read on print and to identify the current barriers to the use of digital devices. It is intended to inform the design of future digital reading environments for academics and other technical professionals.

Our results suggest that future digital reading environments should take into account the following issues.

Navigation: The typical academic reading workflow is non-linear. As most academic papers have similar structure, readers know what to expect in particular sections and thus wish to jump to them directly. Reading features requested by participants that correlate with this behaviour were content indexes, hierarchical and hyperlinked navigation.

Annotation: Annotation is a key aspect of the academic reading process. The ease of annotating on paper and the relative inflexibility of digital annotation remains a major reason that people still prefer to work with print. There is a clear need for digital reading software to provide more flexible annotation features, including various styles of annotation links, syncing and export of annotations, and improved display of in-place annotations within the document.

Tablets: Tablet computers have greatly increased in availability and popularity in recent times. While still not commonly used for academic reading, they have become the mobile device of choice for this purpose. It is important to focus on improving the academic reading experience on such devices to support mobility as many academics wish to read outside the office, especially while travelling.

Layout: While some wanted the print and digital version of a document to look identical, many did not. Participants requested reflowable adaptive layout, and even radically different presentation such as a single scrollable text stream. Presentation of references, figures and tables close to their referencing text and the ability to enlarge figures and tables to be full-screen on demand would seem useful features.

Contextual literature: Participants requested the ability to work with a collection of documents or library. This is currently not something that most digital reading applications have focussed upon. Unsurprisingly we found that almost all academics use online resources for finding background information and viewing related work while reading. This action usually interrupts continuous reading regardless of whether they are reading on paper or digitally. Through careful design we should be able to allow this to be done faster and less jarringly on digital devices.

Physicality: Our study shows there are some aspects of the physical reading experience that cannot be achieved in digital form due to the difference of the mediums. These are things such as the feeling of paper, the physical experience when page flipping, having less distractions, positioning or storing paper in a particular place, as well as being away from digital screens. Our belief is that while we need to be aware of these limitations, by offering well designed and task-specific interfaces and features, digital devices can become the preferred medium for certain modes of technical reading.

Acknowledgments

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