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Congeniality of reading on digital devices: Measurement and analysis of reader experience

Garret Voorhees

Congeniality of Reading on Digital Devices: Measurement and Analysis of Reader Experience

by Garret Voorhees

A thesis submitted in partial fulfillment of the requirements
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Primary Thesis Advisor: Professor Charles Bigelow
Secondary Thesis Advisor: Professor David Pankow

School of Print Media
Rochester Institute of Technology
Rochester, New York

Certificate of Approval

**Congeniality of Reading on Digital Devices:
Measurement and Analysis of Reader Experience**

This is to certify that the Master's Thesis of

Garret Voorhees

has been approved by the Thesis Committee as satisfactory
for the thesis requirement for the Master of Science degree
at the convocation of

May 2011

Thesis Committee:

Primary Thesis Advisor

Secondary Thesis Advisor

Graduate Thesis Coordinator

Chair, SPM

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Abstract

Reading on digital devices is becoming increasingly common. Large markets have developed for both physical reading devices and web-based reading platforms. Each device and platform offers distinct features and supposed advantages, but the experience of reading a printed book is still considered superior by some reviewers. This study sought to identify the strengths and weaknesses of digital reading and to determine whether, or how, design factors influence the reader's experience.

An initial evaluation of digital reading devices identified the most common form factors and established parameters to be evaluated by testing subjects in subsequent surveys. Two surveys were conducted, which involved subjects reading texts on various platforms. The subjects were students, faculty or staff of the Rochester Institute of Technology.

The first survey, conducted in the RIT Cary Collection, concentrated on physical devices. The devices selected were an Apple iPad, laptop computer, Apple iPod Touch and Amazon Kindle, with a paper booklet representing traditional reading media. Nineteen subjects read a short story on each device and evaluated their experience on a paper questionnaire. Subjects were asked to identify strengths, weaknesses and difficulties encountered with the interfaces. While reading,

subjects were timed and observed to measure average reading speed and interaction with the devices. Reading in a web browser on a laptop was consistently disliked by subjects. This reading platform was considered to have the greatest room for improvement and became the focus of the second survey.

The second survey was conducted online and involved subjects reading texts in a web browser. The initial sample for this survey was 52 subjects, though only 12 of those subjects (23%) completed the entire survey. The first portion of this survey involved subjects reading short texts for comprehension at three sizes and evaluating them for reading speed and comfort. The second portion involved subjects reading on three different web-based reading platforms and evaluating their experience with each. Google Books, Treesaver and Open Library reading platforms were selected for the survey because they offered a range of features. Google Books represents a utilitarian design attitude, Treesaver presents content in an editorial design format, and Open Library displays scanned pages of public domain books.

In the second survey, text sizes perceived by subjects as read fastest were actually read slowest on average, indicating that readers' perceptions of reading speed do not necessarily correlate with performance.

The Open Library reading platform displays scanned pages of books printed before digital reading was conceived and which therefore were not designed for reading on platforms with low resolutions, variable screen sizes, and non-paper substrates. This platform was disliked by a majority of subjects and presented the most interface difficulties. This suggests that large-scale book scanning projects might yield less desirable reading experiences for users.

The subjects' reading performance across both surveys was consistent. The range of average reading speeds on devices from Survey 1 closely matched the range of average speeds for the various text sizes in Survey 2. This indicates that varying the size of text affects performance to approximately the same degree as changing the reading devices.

The outcome of this study indicates that design factors have a strong effect on the reading experience. Subjects from both surveys formed strong opinions about the interfaces, type sizes and styles and indicated that these influenced their decisions to read books on digital devices.

Chapter 1

Introduction

Topic Statement

This thesis analyzed the reader experience while reading digital texts on both dedicated reading devices and on personal computers (within a web browser).

Significance of Topic

Digital books are an increasing portion of the publishing market but are still in their infancy, having existed for only about 20 years, when compared to printed works, which have existed for over 500 years. There is potential for improvement in the congeniality of reading in a digital format.

Reason for Interest

Effective communication of information is the basis of my work as a graphic designer. I would like my work to help to transform the book into a new and more effective medium, while maintaining the legibility, congeniality and effectiveness of the traditional book. Improved readability of digital content can benefit readers, designers, and general content consumers. Culturally, wider distribution of well-designed book content can aid literacy and education.

Chapter 2

A Review of Literature in the Field

Background Literature

Historians and scholars of culture have characterized the printed book as an important vehicle for information. Elizabeth Eisenstein (1979) wrote that the shift from written to printed texts “revolutionized all forms of learning” and that “it produced fundamental alterations in prevailing patterns of continuity and change.” Marshall McLuhan (1962) said that print “translated the dialogue of shared discourse into packaged information.” Lucien Febvre and Henri-Jean Martin (1979) wrote that printing helped to “establish standardised conventions in…spelling, grammar and vocabulary” and that it “helped to render the national languages increasingly sophisticated as modes of expression”.

Digital books are increasingly popular, and offer distinct advantages over a traditional printed format. It is projected that 15 to 20 percent of the book reading public will own electronic devices suitable for reading digital books and that 25 percent of all books sold will be in a digital format by 2015 (Cassassus, 2010). Amazon announced in the summer of 2010 that their sales of digital books now outnumber sales of printed hardcover books (Miller, 2010). At the time, 180 digital books were sold for every 100 hardcover books.

The greatest limitation of printed books–physical size–is alleviated in a digital format. The more information a printed book contains, the larger it must be. Digital books allow us to carry an entire library in a device that is smaller and lighter than a single printed book. Other limitations of printed books include a slower acquisition process, inability to dynamically search a text and utilizing a static type size that cannot be adjusted based on the reader.

However, the digital reading experience is not the same as that of a printed book. Pogue (2010) said that “we are in the Neanderthal period” of digital reading. He criticized slow page turning, lack of audio and video integration and use of proprietary file formats that “won’t exist ten years from now” (Pogue, 2010). The words on the page, the line breaks and the knowledge acquiesced from a book may be identical, but the digital experience is different. When reading on digital devices, the path to knowledge is often hindered by distractions or barriers to reading: unintuitive interfaces, low resolution displays and dependence on a wireless connection to acquire a book. When reading on a personal computer, distractions arise from Internet sites and other applications.

Dedicated reading devices include products like the Amazon Kindle or Barnes & Noble Nook whose primary function is to display reading texts on the screen. These reduce or eliminate some of the common distractions of digital reading and have become popular consumer products. Since Amazon introduced the

Kindle in 2007, the prices have gone down, the screen resolutions have increased and wireless networks for book acquisition have become more available. The latest iteration of the Amazon Kindle was announced to be the best-selling product ever on Amazon, within six months of its release (Amazon, 2010). Despite improvements in screen resolution, responsiveness of interface and clarity of text, the reading experience is still different. Dedicated reading devices function as empty containers for content; every book looks the same, formatted with the same margins and with a limited palette of typefaces–often just one (Highsmith, 2010). Though printed books are typically set in one typeface that cannot be changed, the designer has the ability to select typography that is most appropriate for the content.

Reading texts in web browsers is an alternative to reading on dedicated devices. Browsers provide a more accessible solution, being available on devices that many people already own or have access to, including desktop, laptop or mobile devices. Scalable web page designs make it possible for content to be formatted according to the device used.

Some limitations are present when reading on computer screens, however. Their displays typically operate at lower resolutions than dedicated reading devices; they are often less maneuverable than a printed book or a dedicated reading device; they are ergonomically uncomfortable for long periods of reading.

Beginnings of Digital Books

There have been several ventures into creating digital books for consumers, including products that now seem ahead of their time and which appear similar to available products now. The Apple Newton, introduced in 1993, supported a proprietary file format for digital books and allowed users to read on the small, low-resolution screen (Hormby, 2006). The Palm Pilot, introduced in 1997, offered similar functionality and there are still online communities distributing compatible e-books (eBookMall, 2011).

The Rocket eBook was introduced in 1998 with features similar to those of the Amazon Kindle, released 9 years later. Amazon.com's review of the Rocket eBook sounds similar to contemporary reading devices (Amazon, 1999):

> The Rocket eBook fits in the palm of your hand and stores the equivalent of 10 novels. Why fuss with bulky paperbacks on your travels when you can download them through the Internet and then read them at your convenience?
>
> Some electronics manufactures have sought to replace the paperback novel with an electronic reader. The concept is simple: Create a handled computing device that can store the text of several books and thus negate the need to buy the physical books. The execution is not simple: Printed books are so perfectly well suited for their intended task that no battery-operated, LCD-sporting device can compete with them. Still, the Franklin Rocket eBook presents a worthy and fun alternative to the printed medium, if not a replacement. You control the unit with three buttons and four icons on its touch-sensitive screen, which let you select a stored title, navigate the title's chapters and pages, and decide how you want to display them (horizontally or vertically or for left or right-handed holding).

Sony introduced the LIBRIé exclusively in Japan in 2004 (see Fig. 1), with a form factor that was very similar to the first-generation Kindle (Wikipedia, 2010). A “form factor” is defined as the geometry and ergonomics of an object.

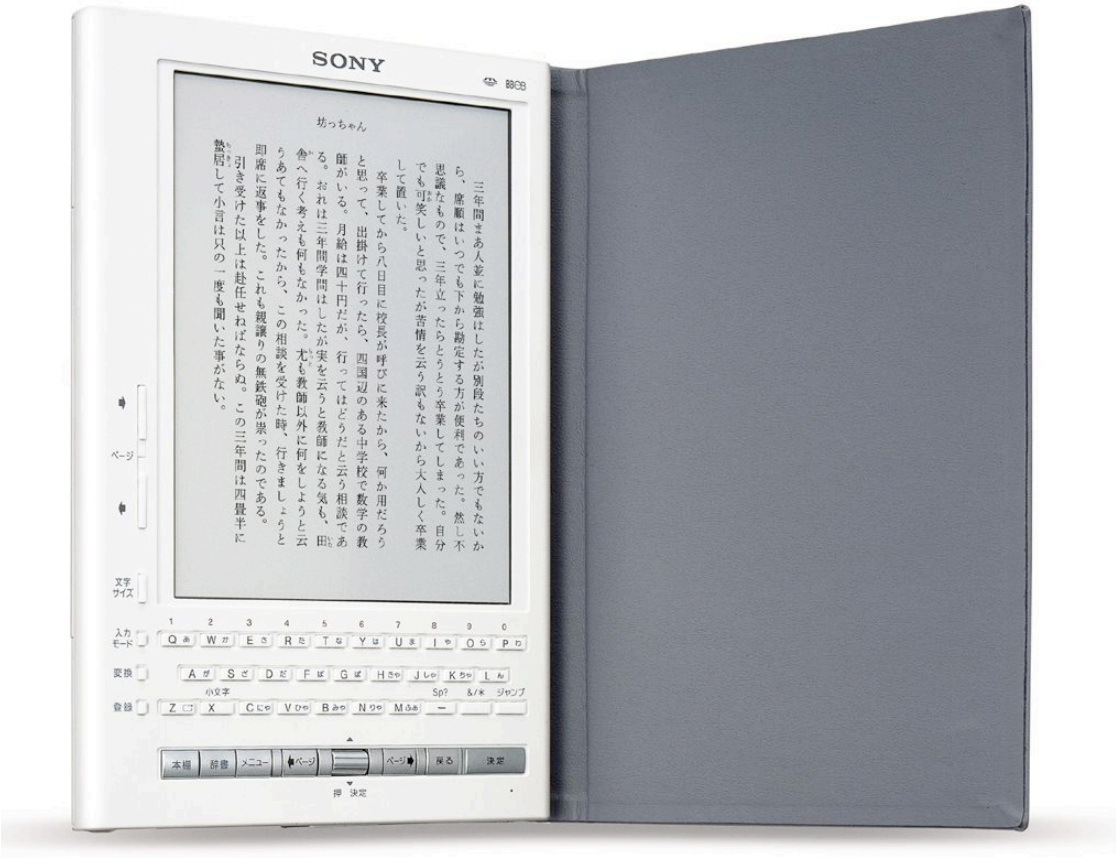

Figure 1. Sony Librié reading device, released only in Japan.

A study by Adler, Gujar, Harrison, O’Hara and Sellen (1997) considered the critical differences between reading on computer screens and in print. They cited many of the shortcomings of digital reading such as its inflexibility and difficulty switching between or comparing multiple documents. This is still a challenge today.

Bill Hill of Microsoft examined the essential elements of readability in his study, *The Magic of Reading* (1997). Hill sought to develop a “general theory of readability” for digital books and made a number of predictions that were surprisingly accurate. He asserted that digital books function better in vertical orientation and in non-scrolling formats (“static pages were processed more efficiently than pages scrolled at the reader’s preferred rate”). At the time of his writing, “reading from the screen was found to be 28.5 percent slower.”

Hill predicted two different types of electronic books–one device that is “smaller, more portable, and equates more or less to the printed paperback” (similar to today’s Amazon Kindle) and another device that “will have color and support for sound, and will take advantage of these and other capabilities to take electronic books beyond the books of today” (similar to today’s Apple iPad). Hill predicted that books will “take as input a defined data structure designed to allow automatic formatting of the content”. This is how ePub and other standardized digital book formats function currently. Hill’s work was a compromise between traditional book design and integration of technology to enhance the reading experience.

Progress

Expansion of web usage and knowledge of human-computer interaction have led designers to consider screen reading from a more analytical perspective. Craig

Mod, a designer and digital typographer, advocates the use of HTML for digital book development, enabling broad device support and sufficient typographic control. In his article “A Simpler Page,” (Mod, 2011) he wrote:

> …there is now a generation of designer for whom working with HTML and CSS is more intuitive and quicker for design iterations than using specialized software like InDesign. This is the generation of designers that will be most capable of bringing the best of print aesthetics to the web with nuance, balance, and mastery of implementation.

Mod also developed a design template for tablets and browsers, called Bibliotype, that established a well-designed baseline for digital books (Mod, 2011). The source code is freely distributed and modification is encouraged. Tools like these remove some of the development barriers of web design and enable designers to present their content more effectively in a digital format.

Contemporary users are increasingly aware of the subtleties of typeface selection and layout. Applications like Microsoft Word give users a large palette of fonts and the users quickly develop favorites and preferences. Websites like MySpace (founded in 2003) allow users to personalize their own page, selecting color, type style/size and layout.

Supporting Technologies

Web browser technologies are finally catching up to user desires for customization and personalization (Lie, 2007). Though it has been supported for a number of years, web font embedding is now reliable in nearly every web browser, including mobile devices like the iPhone. Web font embedding allows fonts to be loaded on a web page from a central server and displayed with the rest of a page; designers were previously limited to fonts available on the end user's computer. Companies like Typekit, Webtype and Monotype are now offering dedicated web font hosting that is cross-browser and cross-platform compatible. Google offers a library of fonts that are freely available and hosted on their own servers. Some of the fonts offered have been tuned to function well on lower and unpredictable resolutions. Web designers are no longer limited to a small set of web-safe fonts (fonts that are bundled with most operating systems and are considered to be available on most computers).

The number of available platforms for reading digital content is constantly expanding and users are generating discussion on forums and through social media networks. It is important as a reader to be aware of new development and regularly sample content in new and different forms. No one reading platform has yet been entirely successful, but there are many platforms with good ideas.

Chapter 3

Research Objectives

- What are the strengths and weaknesses of current digital reading platforms?
- Can design improve, enhance or aid the congeniality of digital reading?

The objectives of this thesis were to analyze the current state of digital reading, identify which elements effectively communicate the content and which hinder that communication. This analysis includes the level of sophistication of typography, the platform's usability and the flexibility of a digital reading platform to accommodate different types of content.

Chapter 4

Methodology

Evaluation of Current Devices

This study began with a general evaluation of digital reading platforms and a focus on dedicated reading devices. A number of devices are now available as consumer products, each offering distinct features. The following devices were selected for evaluation:

- Amazon Kindle DX
- Amazon Kindle 3
- Barnes & Noble Nook
- Borders Kobo
- Apple iPad
- Apple iPod Touch

The parameters relevant to reading for each device were tabulated so that the devices could be compared (see Appendix A). Physical device size, screen size, screen resolution, screen contrast, color depth, connectivity, storage capacity, level of typographic customization, cost (MSRP), and method of acquiring books were considered.

When possible, an entire novel was read on each device and subjective notes were made about ease of use of each interface, ergonomics, quality of typography, and clarity of display.

Survey 1

Overview

The first survey, presented in a questionnaire format, was designed for a sample of 25 subjects. However, only 19 subjects participated in the survey. The survey was promoted through faculty within the College of Imaging Arts and Sciences and via email to students. The subjects were limited to RIT students, faculty and staff. Subjects were compensated for their cooperation with tokens for an on-campus coffee shop.

Selection of Devices

A subset of devices from the evaluation was selected to represent the most common form factors and display types (see Fig. 2). The following were selected:

- Paper (acted as a control, printed in black and white at high resolution)
- Apple iPad (large form factor, LCD display, full color)
- Laptop with web browser (largest form factor, LCD display, full color but distinct input method, lowest resolution)
- Apple iPod Touch (smallest form factor, color LCD screen)

- Amazon Kindle 3 (medium form factor, grayscale display, dedicated reading device)

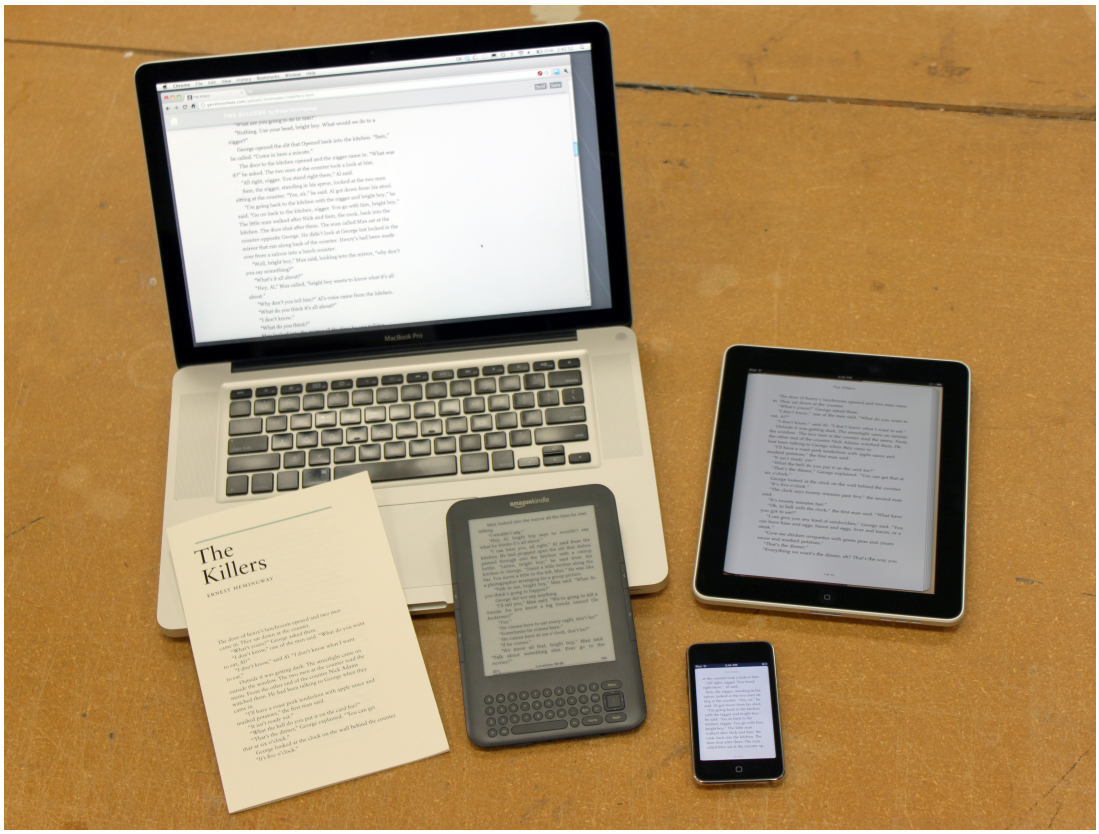

Figure 2. A comparison of the devices chosen for Survey 1, illustrating the various form factors and screen types.

Survey Procedure

Nineteen subjects read five short texts, one on each device, with an average length of 2748 words, and answered questions after each text. The device reading order was the same for all subjects. All subjects eventually read all five selected stories, but the order of those stories varied. The story reading order was assigned based on their subject ID.

Survey questions for each device included reading comprehension, comments about their experience with the device, difficulties encountered with the interface and how much they enjoyed the story itself (see Appendix B for survey forms). Each subject was timed so that their reading speed (words per minute) could be calculated for each device.

Before reading the texts, subjects filled out a questionnaire regarding their reading habits and previous experience with digital books. After reading all of the texts, the subjects filled out another form evaluating the reading platforms they tried and the importance of selected features of a digital book:

- the ability to share your e-books
- the ability to read on multiple devices
- the ability to search text within book
- the ability to make annotations in text
- the ability to change typeface/page layout

The survey was conducted in a reading room at the RIT Cary Collection. Subjects read the texts in a quiet, isolated corner of the space and sat in a comfortable leather chair below recessed ceiling lighting (see Fig. 3). The survey conductor sat about eight feet away while timing the subjects and making

observations about their posture, noticeable discomfort and how they physically interacted with the device.

Figure 3. A subject using an iPad in the Survey 1 reading area.

When reading on the laptop, subjects moved to an adjacent room where the laptop was set up on a small table (see Fig. 4). Subjects sat at a padded chair at

the table for the duration of that reading and then moved back to the other room for the remaining readings.

Figure 4. A subject completing the laptop portion of Survey 1.

The texts selected were all short stories written by Ernest Hemingway. Hemingway is “known for his concise prose, and curt style” and “developed the unique ability to say more with less” (Gibson, 2011). “Hemingway’s writing was direct, forceful and poignant, reaching his audience in a remarkably authentic manner.” The New York Times (1926) wrote about his novel *The Sun Also Rises*:

> It is a truly gripping story, in a lean, hard, athletic narrative prose that puts more literary English to shame. Mr. Hemingway knows how not only to make words be specific but how to arrange a collection of words which shall betray a great deal more than is to be found in the individual parts.

A concise writing style is appropriate for a survey in which the subjects have varying reading habits and experiences. This establishes a consistency across the texts and baseline of reading difficulty.

The following short stories were selected from Ernest Hemingway's *In Our Time* (1930) and the *Short Stories of Ernest Hemingway* (1953):

- Che Ti Dice La Patria? (3273 words)
- Cross Country Snow (1751 words)
- Soldier's Home (2791 words)
- The Battler (2946 words)
- The Killers (2979 words)

The responses written by the subjects were manually entered into a spreadsheet and the quantitative data was analyzed. The more subjective data, like their comments, were analyzed separately.

Survey 2

Overview

The results from the first survey informed the structure of the second. Survey 2 focused on web-browser-based reading, similar to the laptop portion of Survey 1. The entire survey was conducted online, and subjects were not observed while taking the survey. The subjects were again students, faculty and staff from the RIT community and volunteered their time without compensation. 52 subjects began the survey but only 12 subjects (23%) finished the entire survey.

The online survey format was selected because it is possible to collect a much larger data sample. Each individual doesn't need to be observed and multiple subjects can take the survey at the same time, remotely.

Survey 2 was similar in content to the first survey. Subjects filled out a page of background information (see Fig. 5), including their reading habits and experience with digital books.

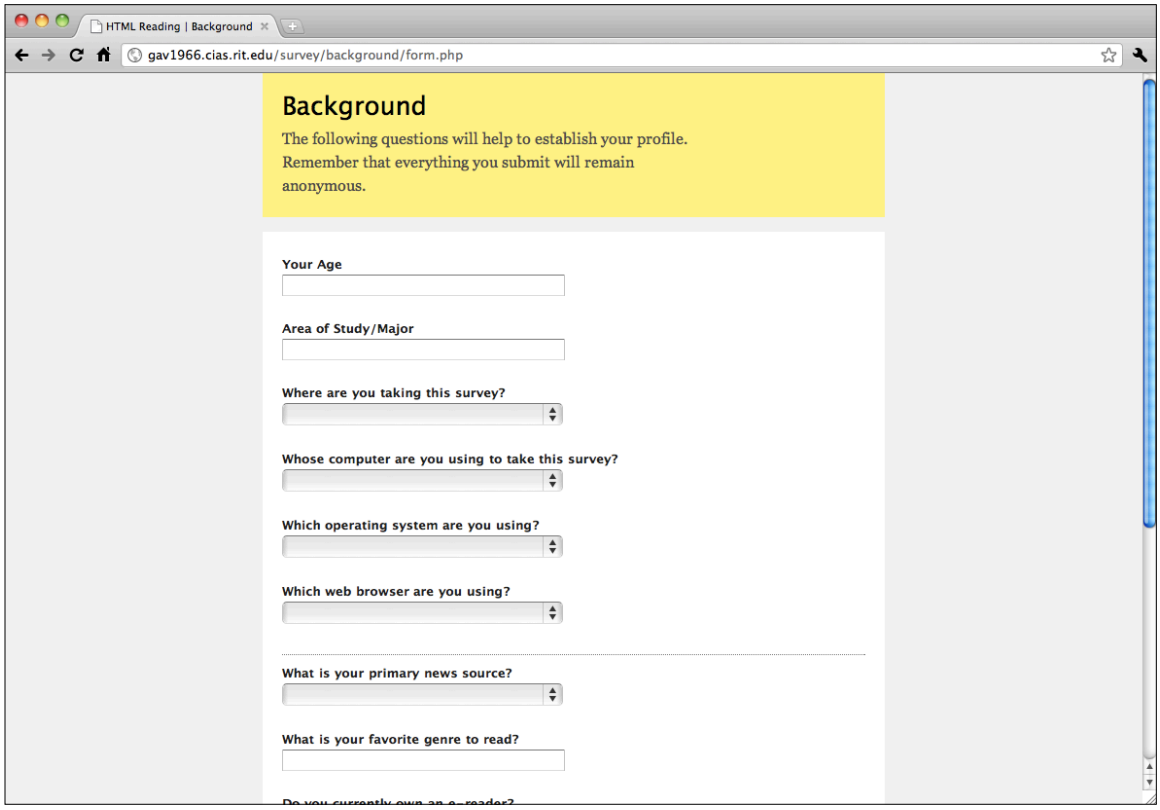

Figure 5. Screenshot of Survey 2 background questions.

Comprehension Section

Subjects would then read three short texts (average length: 424 words) that were available as sample texts for the SAT reading comprehension test (see Fig. 6). Each text was set in a different size, but the leading was always proportionate and the line length was consistent across all three.

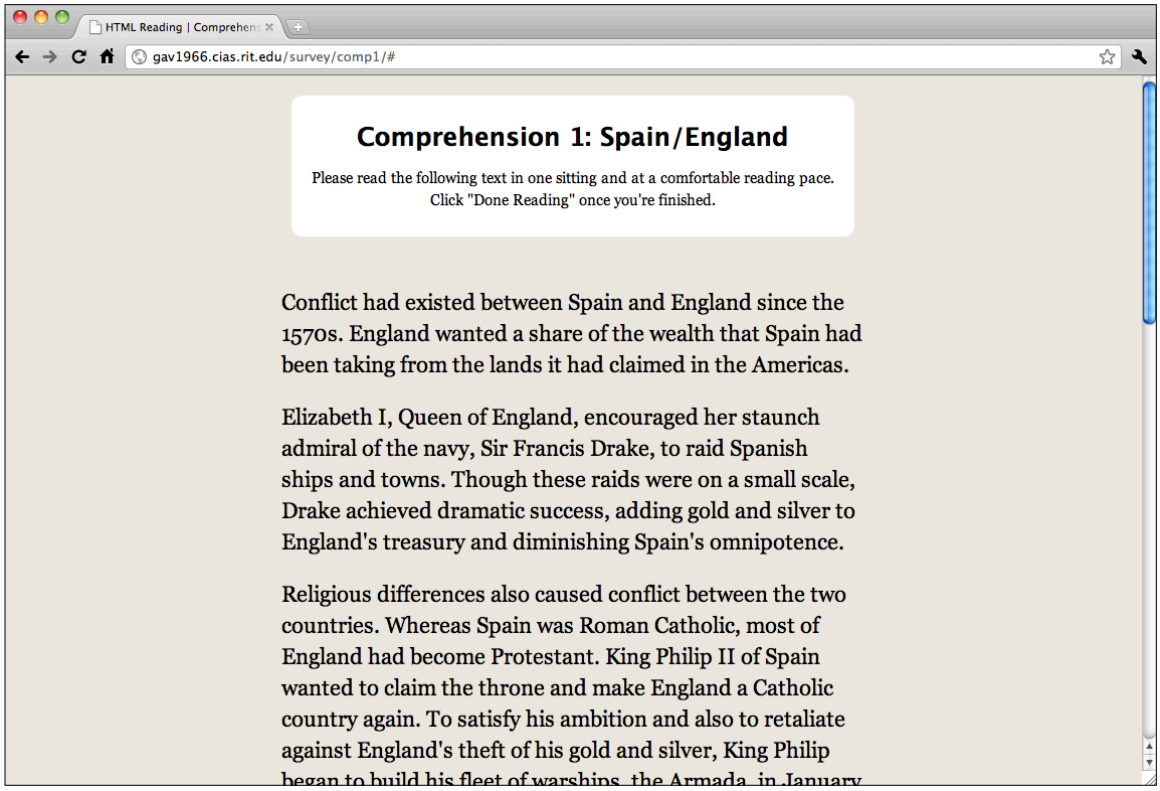

Figure 6. Screenshot of the first comprehension reading from Survey 2.

The texts were selected to be approximately the same length and complexity, as determined by the Flesch-Kincaid readability test (Kincaid, Fishburne, Rogers, Chissom, 1975). This test uses the average number of syllables per word and words per sentence to approximate the difficulty of a text. The ease level is measured on a scale of zero (most difficult) to 100 (least difficult). A score between 0 and 30 is considered university graduate level, and a score between 60 and 70 is approximately the 13- to 15-year-old student level.

Table 1. Parameters for the texts selected for Survey 2.

	Text 1	Text 2	Text 3
Subject	Spain/England	Wright Brothers	Anastasia
Word Count	412	435	426
Ease Level	55.45	55.43	55.22
Grade Level	10.19	9.66	9.78

The texts selected for Survey 2 were within 1 point of each other on the ease level scale and were estimated between a 9th- and 10th-grade level (see Table 1). They varied at most by 23 words in length.

Each text was set at a different size, all in a one-column scrolling layout. The smallest size (15 pixels) was based on newspaper typography, the medium size (22 pixels) was based on hardcover book typography and the largest size (32 pixels) was roughly twice the size of the smallest. The assumed reading distance on a computer screen was 20 inches (Shieh & Lee, 2006).

The survey timed the subject while reading each of the texts. The timer was started when the subject clicked “Start Reading” and finished when they clicked “Finished Reading,” at which point a new page with questions related to that text loaded.

After each text, the subject answered five comprehension questions in a multiple choice format and was given a space to leave any comments they had about that reading format (see Fig. 7).

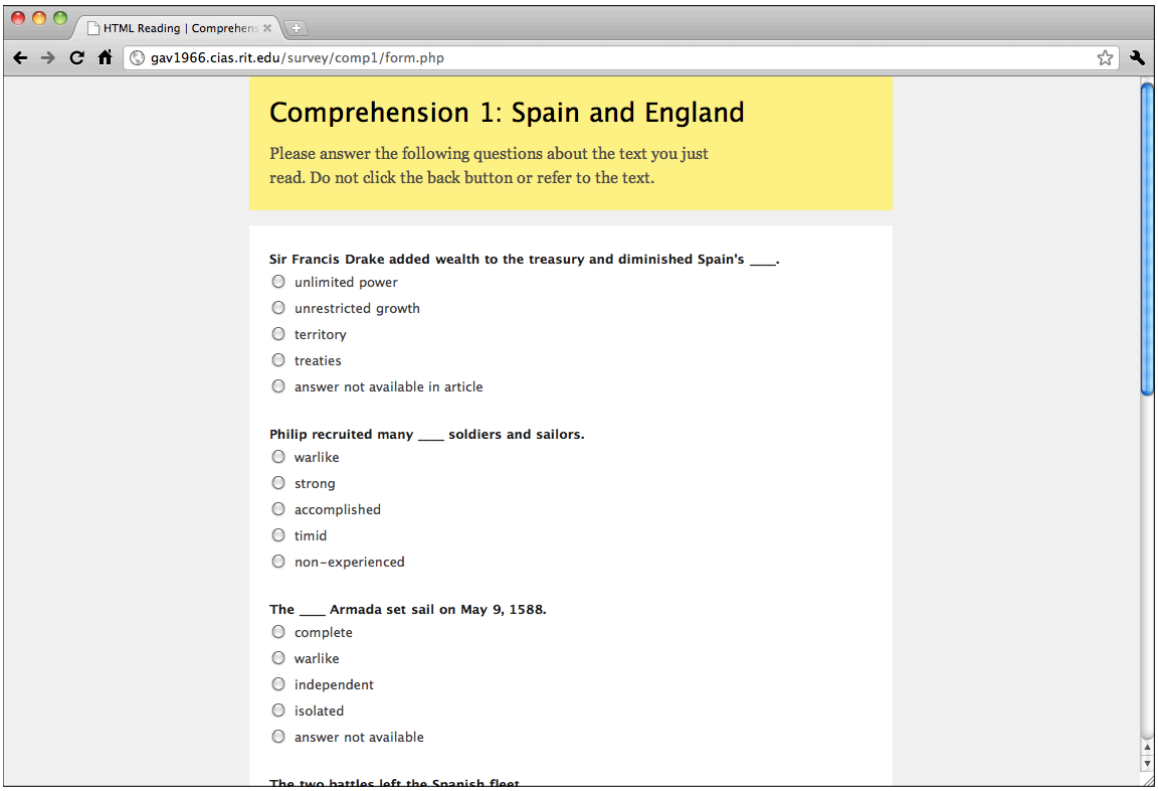

Figure 7. Screenshot of comprehension questions following the reading of a text in Survey 2.

Style Section

After reading three comprehension texts, subjects then tried three different digital reading platforms which are currently available. These platforms were selected for their distinct ways of presenting content to the user:

- Google Books (simplest interface, most scalable)
- Treesaver (editorial style content, most designerly)
- Open Library Reader (scanned pages, archival)

Each platform had a small task associated for the users to complete. The tasks were tuned to the strengths of each platform, utilizing elements that were distinct about each:

- Google Books: Read the first chapter of *Alice in Wonderland* and, using the interface, find a printed copy of the book for sale online
- Treesaver: Find and read an article (“Be Still My Phone”) from within an online publication
- Open Library: Navigate to and read pages 83 to 86 of Mark Twain’s *Life on the Mississippi*

Subjects were asked short questions about how they completed the tasks, what difficulties they encountered, how they would rate each platform and general comments (see Fig. 8).

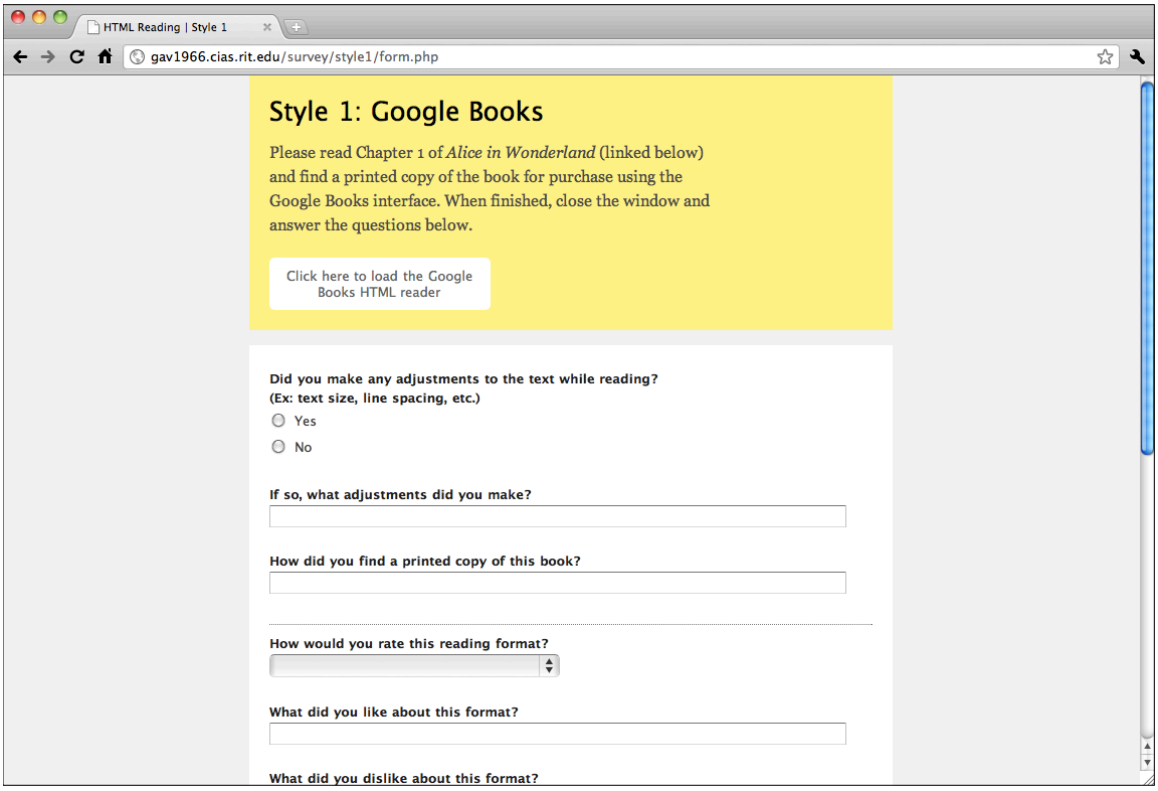

Figure 8. Screenshot of questions related to a reading platform from the Style section of Survey 2.

When finished with the three reading platforms, a final summary page (see Fig. 9) asked about their overall preferences and how important various features in browser-based reading were:

- the ability to make annotations
- the ability to copy/paste text
- the ability to share content
- the ability to change text size
- the ability to change font/text style

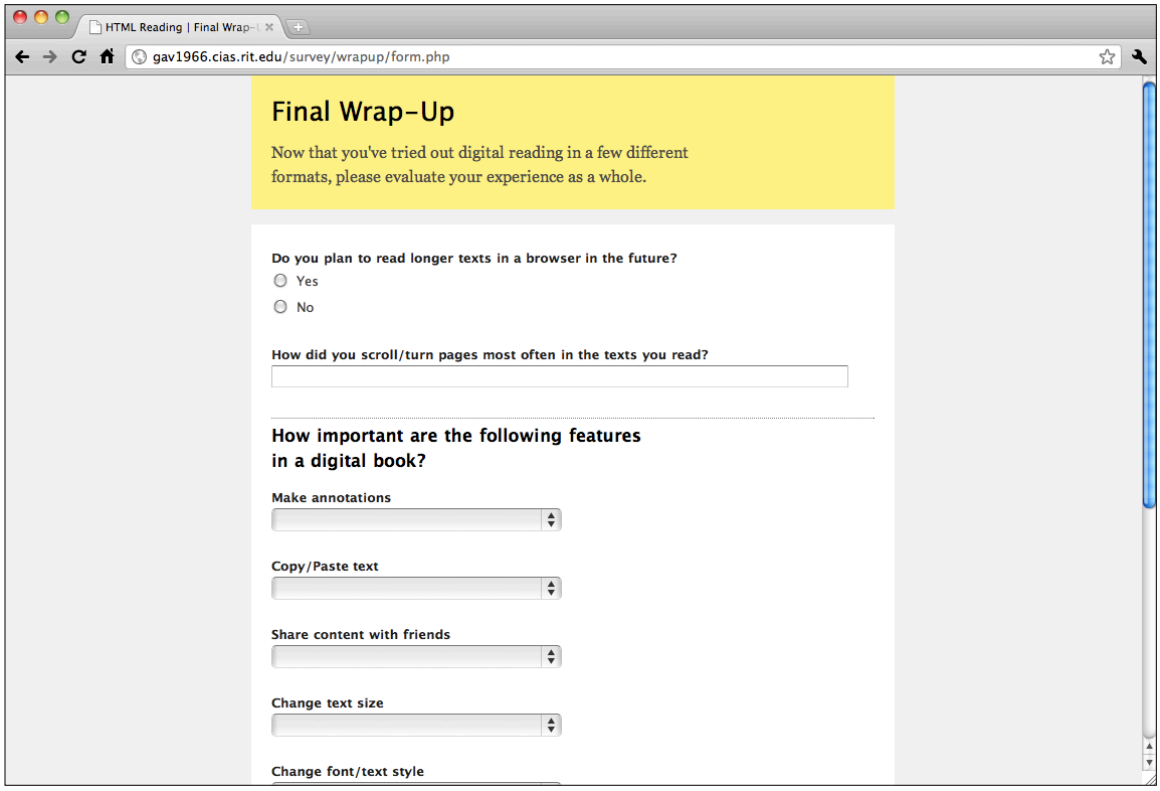

Figure 9. Screenshot of the final wrap-up questions from Survey 2.

Each subject was assigned a unique and anonymous ID number, and all of the data collected was written to a MySQL database. Their start and end times for the survey also were recorded so total survey duration could be calculated. The MySQL database was then exported to an Excel document and analyzed.

Chapter 5

Results

Evaluation of Devices

Amazon Kindle DX

Figure 10. Amazon Kindle DX (first-generation).

A first-generation Kindle DX (see Fig. 10) was evaluated. This is a larger format reading device that is comparable to a hardcover book in size (7.4” wide, 10.4” tall). It uses a 16-level grayscale e-ink display (at a resolution of 150 pixels per inch, or ppi) to render the text and basic graphics (like book covers). Turning pages is accomplished with physical buttons on the right side–a larger button to go forward and a smaller button to go back.

On page turn, the screen quickly inverts to black and flashes white as it resets and loads the next page. This is a requirement of the e-ink technology and was somewhat distracting when first using the device. This flash also creates a pause that can interrupt the reader's concentration when the end of the page falls in the middle of a sentence.

Only one font for body text, PMN Caecilia, was observed on the device, with no options for alternatives. Helvetica is used for other interface elements.

Amazon Kindle 3

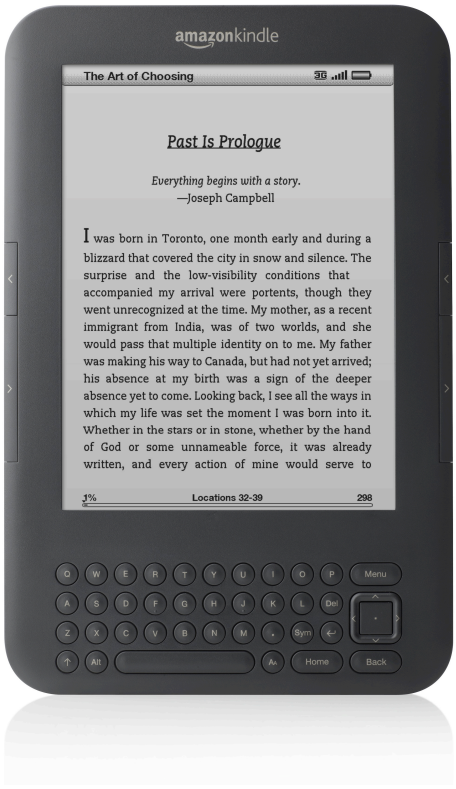

Figure 11. Amazon Kindle 3.

A third-generation Amazon Kindle (see Fig. 11) was evaluated. This is a smaller form factor (4.8” wide, 7.5” tall) than the DX model, comparable to a trade paperback book. Compared to the DX, the resolution (167 ppi), screen contrast and speed of page turning is noticeably improved. Amazon claims a 50% improvement in contrast and 20% increase in page turning speed compared to the previous iteration of the Kindle. The improved speed makes the e-ink flashing less distracting. This device features page turning buttons on the left and right sides of the device and the buttons now have a slimmer profile than previous models.

Three fonts are available for reading on the third-generation Kindle: PMN Caecilia, PMN Caecilia Condensed and “Sans Serif” (Helvetica).

Barnes & Noble Nook

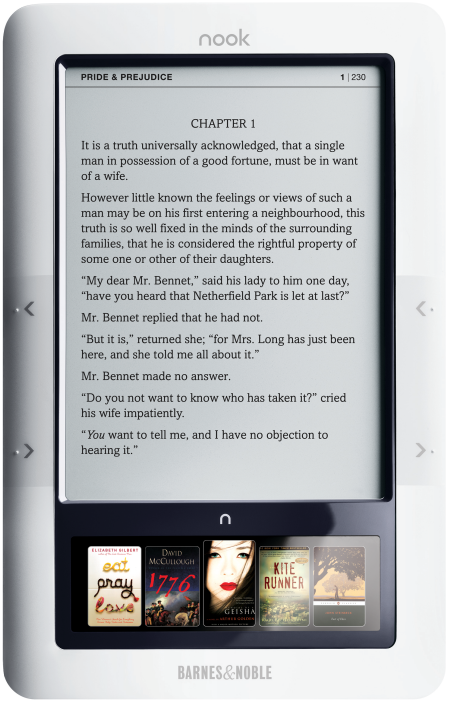

Figure 12. Barnes & Noble Nook.

A first-generation Barnes & Noble Nook (see Fig. 12) was evaluated. The overall device is slightly larger than the Kindle (4.9" wide, 7.7" tall). However, it is identical in screen size, resolution and grayscale depth to the Kindle 3 though the interface is different. There are page turning buttons on both the left and right of the device but they do not have defined edges as the Kindle does. The page turning is slower than the Kindle DX or Kindle 3.

The Nook also features a small color touch screen that is used to access the user's library and navigate the upper e-ink display. However, this color screen

was often unresponsive or slow to respond to user input. There was no immediate feedback indicating that a touch had been registered, sometimes causing the user to tap multiple times and navigate levels deeper than intended.

There are three fonts available on the device: Amasis, Helvetica Neue and “Light Classic,” a serifed face.

Apple iPad

Figure 13. Apple iPad (courtesy of Apple)

The Apple iPad (see Fig. 13) is a larger form factor (7.47” wide, 9.56” tall), similar to the Kindle DX but heavier. The device uses an LCD display (at a resolution of 132 ppi) and a touch screen, enabling full color and a larger screen. There is only

one button on the face of the device, with three buttons and a switch along the edges. Almost every interaction is made via the touch screen including page turning, highlighting and shopping.

The iPad and iPod Touch are based on the usage of “apps”, mobile applications, that function in the same way as computer applications. Apple’s iBooks app and Amazon’s Kindle app were considered for this study. The iBooks app (see Fig. 14) comes bundled on the device at purchase and uses a printed book as a visual metaphor. When reading in landscape orientation the text is presented in a virtual two-page spread. While reading vertically a single vertical page is shown. It is worth noting that the virtual fore-edge of the book is a constant thickness and does not correlate with progress in the book.

Books may be purchased through the iBook store or transferred manually from a computer via USB. iBooks can display ePub and PDF documents.

Swiping or tapping on one side or other of the screen turns to the next or previous page. There is a progress bar at the bottom of the screen and text formatting and bookmarking options in the top right corner. iBooks offers six fonts: Baskerville, Cochin, Georgia, Palatino, Times New Roman and Verdana.

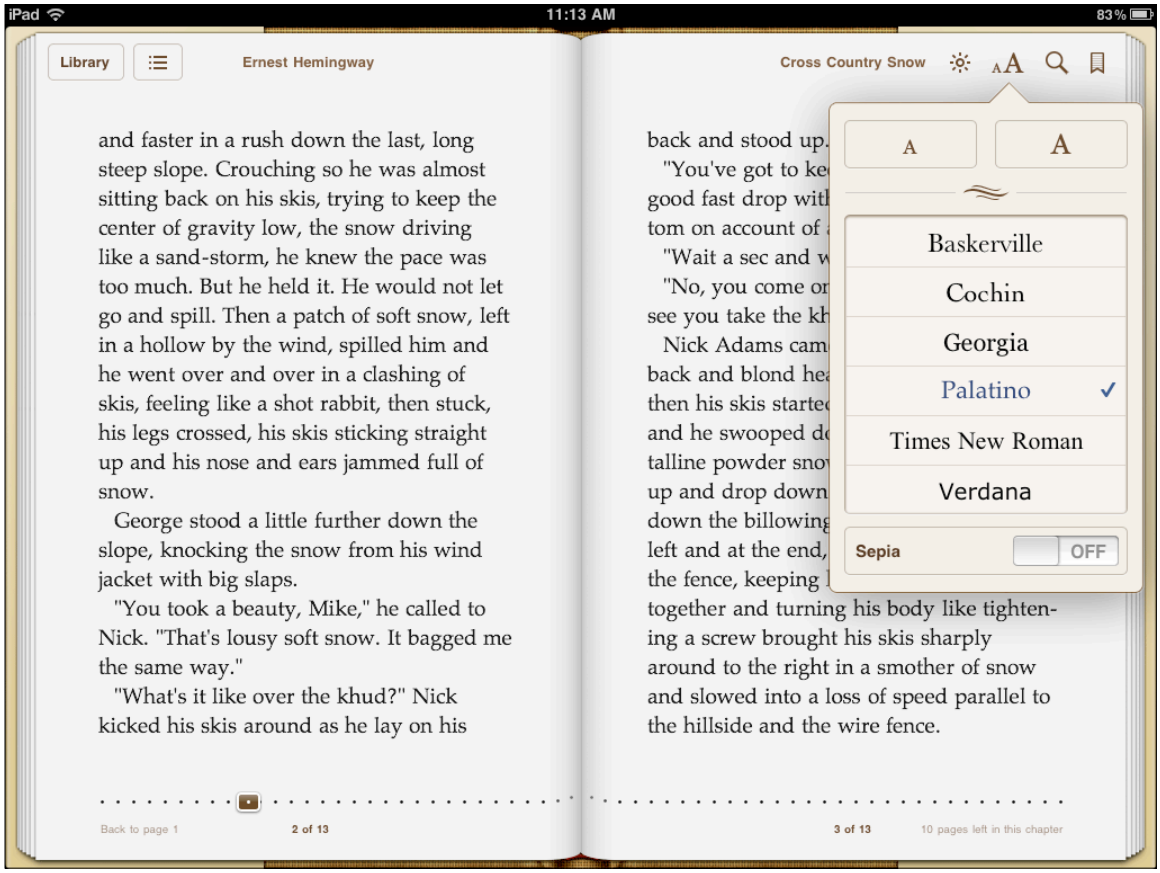

Figure 14. Screenshot of the iBooks app running on an iPad. Note that the virtual fore-edges on the left and right sides are equal regardless of the user's location in the text.

The Kindle app (see Fig. 15) has a simpler approach to presenting text than the iBooks app, utilizing a flat background. It presents text in one column by default, but when holding the device in a horizontal orientation, the app does give the user a choice between one or two columns. Books must be purchased via an Amazon account to be available for reading in the app.

As with iBooks, swiping or tapping on one side of the screen turns to the next or previous page. Text formatting options are available at the bottom of the screen, along with a progress bar. There is one font available for reading: Georgia.

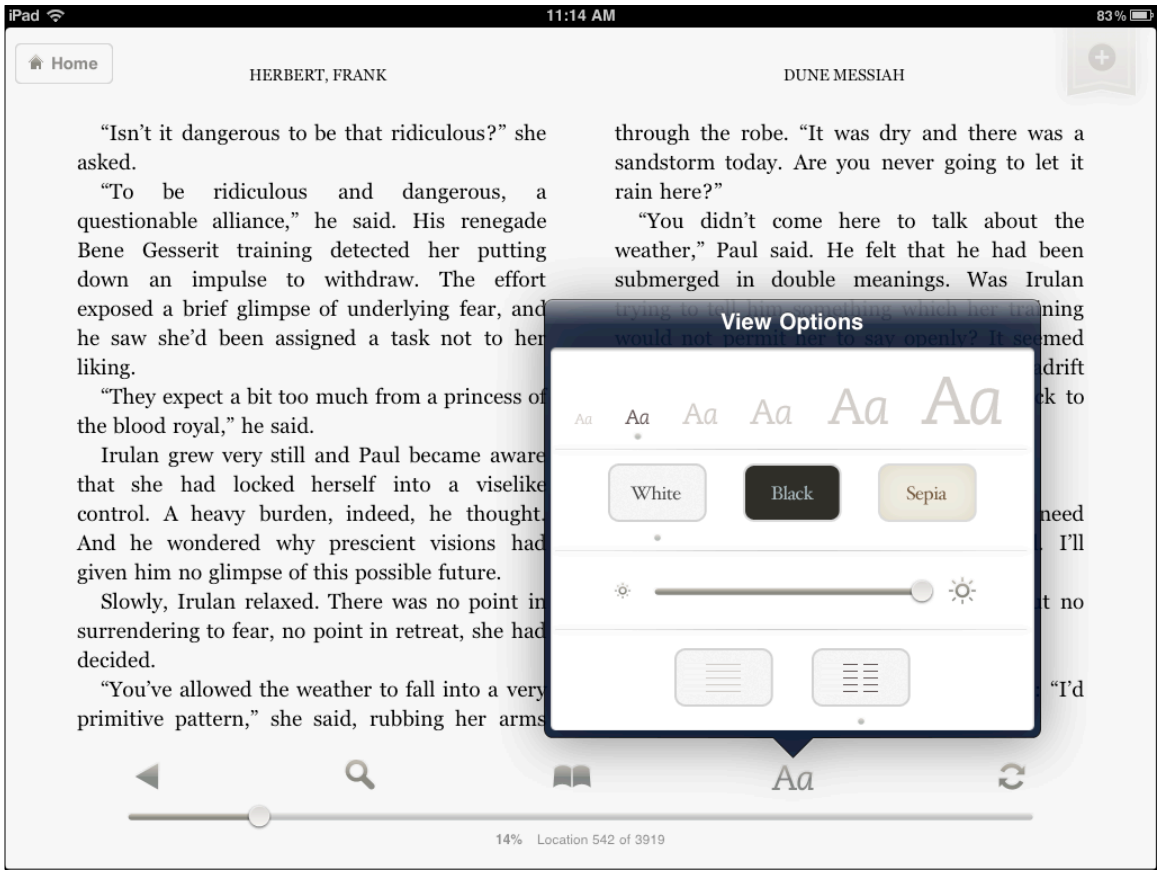

Figure 15. Screenshot of the Kindle app running on an iPad.

Apple iPod Touch

Figure 16. Apple iPod Touch (courtesy of Apple)

The iPod Touch (see Fig. 16) functions similarly to the iPad but in a smaller form factor (2.3” wide, 4.4” tall). The Apple iBooks app was used for this study. Unlike the iPad version of the app, reading in a horizontal orientation yields a single-page spread with a wider text column than the vertical orientation.

The iBooks app (see Fig. 17) uses the same visual metaphor of a printed book as the iPad app, though it is minimized due to the smaller screen of the iPod Touch. The same set of six fonts from the iBooks app on the iPad is available.

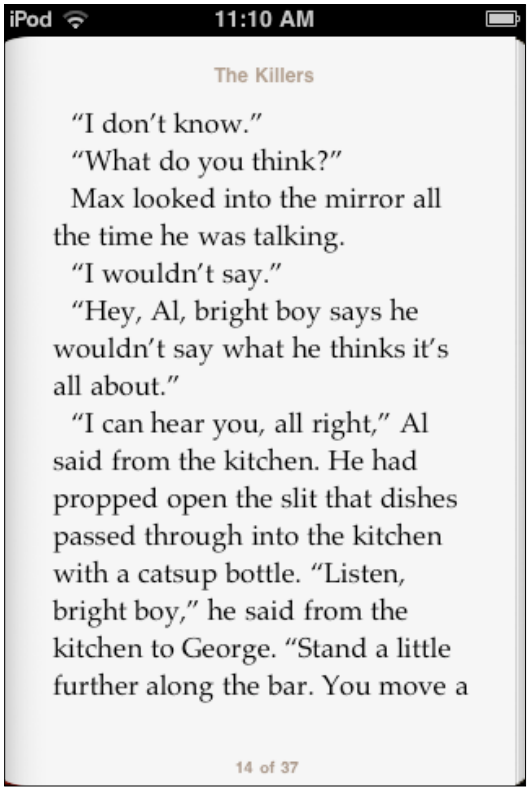

Figure 17. Screenshot of the iBooks app running on an iPod Touch.

Survey 1

Subjects ranged from age 19 to 55 with an average subject age of 30. About 63% of the subjects had used an e-reader before, but only 26% currently owned one. Among the subjects who owned an e-reader, all but one of the devices were Apple products running iOS (iPhone/iPod Touch/iPad), with the exception of a Dell Streak tablet. It is notable that none of these were dedicated reading devices, like the Kindle or Nook.

A majority of subjects (58%) were affiliated with the School of Print Media, with the remainder affiliated with graphic design, Human-Computer Interaction (HCI) and audio engineering. Seventy-nine percent (79%) of the subjects indicated the Internet as their primary news source.

Paper Booklet

The word “easy” and its derivations (“easily”, “easier”) were used repeatedly by subjects when describing the paper booklet. They noted that the booklet was “easy to hold and read,” “easier to find my place,” “I could easily flip to any page I like,” and it was “something I am familiar with.” The booklet was the most physically flexible device used in the survey, and some users took advantage of this quality, bending or folding pages while reading.

However, some subjects indicated that the booklet was too fragile or not thick enough and noted that the device itself was dependent on ambient light. Subjects commented that the “text was too glossy” or that there was a “high reflectivity of text at some angles,” a result of the shiny digital toner. This was noted as a limitation.

Apple iPad

Based on comments from the subjects, the iPad was generally liked but generated a few notable criticisms. Subjects noted that they enjoyed the fact that the text size was adjustable and that there was the “ability to change settings to fit my setting/environment.” One subject noted that the iPad felt “quick” and “seems faster than paper,” and others enjoyed the quickness of the page turning.

The most common criticisms of the iPad were its heavy weight and feeling of eye strain from the backlit screen. Some subjects found the touch screen to be too sensitive and accidentally turned pages with stray finger taps. The highly reflective glossy screen of the iPad was problematic for a number of subjects because of a light that was directly above the subject’s chair. One subject said that the “light reflection forced me to sit in an unusual position.” This difficulty was noted as a limitation, though this revealed a property of the device that might not have been noted otherwise.

Laptop

The laptop/web browser generated negative comments from subjects. The most frequent criticisms concerned the nature of scrolling to advance the text, the size of the laptop itself (too big, “can’t really hold it”) and a lack of progress indicator (the abstract indication of progress from the scroll bar was not sufficient). Two users noted that they associated work with computers, and this distracted them

from a pleasant reading experience. When asked what they liked about the device, three subjects said nothing.

One subject noted a great “opportunity for distraction” while on the Internet, though no subjects navigated to other websites during the survey. Some subjects felt “alienation/distance” from the text and didn’t like “having to look straight on” while reading. Subjects commented that it was “more difficult to find my spot if I accidentally scrolled down,” “tough to scroll through the page,” “not a lot of text on screen,” and “just not enjoyable”.

Despite the numerous complaints, several subjects stated that they did appreciate the ability to change the font (though few did) and some indicated that they enjoyed the scrolling. The adjustable brightness and familiar format were also noted as positive aspects.

Apple iPod Touch

The small form factor of the device was favored by some and disliked by more. However, subjects did like that it is lightweight and commented that it was “easy to hold” and “fit into hand easy.” One subject commented that “it made me read faster because the pages were so short.” Two other subjects made similar comments. “It was easy to accomplish reading a page” and the “limited page is

good enough to give much suspense." Some subjects indicated that they liked that the device can be operated with one hand.

Aside from its small size, some subjects felt that the line lengths were too short and that there was "too much page turning" because of the small screen. "It seemed like I read more than I did." One subject commented that it was "awkward for long reads" but "great for short bursts."

Amazon Kindle 3

Similar to the iPad, the Kindle generated largely positive feedback with a few notable criticisms. Subjects liked that the device was lightweight, had good contrast and "felt a lot like reading paper." The "text was rendered clearly," it was "easy to read," with "no eye strain."

The most frequent criticism concerned the screen refresh that happens when a page is turned. "On page turn it dipped to black and broke my concentration." This form of screen refresh is a consequence of the e-ink technology used to render any images on the screen, and it must reset whenever a page is turned. Likewise, some subjects commented that the screen was too gray and dim. This might have been due to the available light in the testing space as well. And again, the overhead light in the room caused trouble; one subject said that his/her head cast a shadow on the device "if I sat it on my leg, making it difficult."

Some subjects indicated that they had difficulty with the interface on the Kindle as well. They noted that it was a “weird interface,” had a “large unnecessary keyboard,” and didn’t like the “page turning on both sides.” One subject commented that the “interface is not as creative.” Others were confused about the pagination system used by the Kindle, which indicates a “location” in the text but not a page number. Amazon has since made real page numbers available for some of the books in their store but not all (Amazon, 2011).

Summary

The first survey provided a strong indication of which devices subjects enjoyed and which devices they found unappealing (see Table 2). When asked which non-paper device was favored, the Amazon Kindle was selected as the clear favorite (two subjects chose paper, contrary to the directions, indicating a strong preference for printed texts). The least-favorite devices were the laptop and iPod Touch, which tied.

Table 2. Favorite and least favorite devices overall.
Some subjects selected more than one device.

	Favorite	Least Favorite
Paper	2	0
iPad	3	3
Laptop	1	6
iPod Touch	4	6
Kindle	10	3

For long reading, the paper booklet and Amazon Kindle were favored (see Table 3). The laptop and iPod Touch were selected as favorites for short reading. Subjects considered short reading to include reading email and news articles.

Table 3. Favorite devices for long and short reading.
Some subjects selected more than one device.

	Long Reading	Short Reading
Paper	11	3
iPad	3	6
Laptop	0	7
iPod Touch	0	7
Kindle	10	4

When asked which features were most important, most of the features were rated about the same, but the ability to change the typeface/page layout was

ranked highest, with an average of 4.3 on a scale of 1 of 5 (see Table 4). The abilities to share texts and read on multiple devices were the least important.

Table 4. Average ratings of various e-book features (on a scale of 1 to 5).

Ability to change typeface	Ability to search text	Ability to make annotations	Ability to share texts	Ability to read on multiple devices
4.3	3.9	3.8	3.5	3.5

The reading speed results (see Table 5) across the five devices were unexpected. The fastest average words per minute was on the laptop (276 wpm), with paper a close second (273 wpm). The iPad was third (262 wpm) and the Kindle was fourth (252 wpm). The iPod Touch yielded the slowest reading speed (237 wpm). It's possible that fatigue was a factor in the slower reading speeds on the Kindle and iPod Touch. Those were the final two devices used by subjects in every survey instance.

Table 5. Average reading speed (WPM) on devices from Survey 1.

Device	AVG WPM
Laptop	276
Paper	273
iPad	262
Kindle	252
iPod Touch	237

Limitations (Survey 1)

There were some parameters in Survey 1 that may have introduced some error. The testing space included a recessed light directly above the subject's reading chair that resulted in a few subjects commenting on glare while using the Apple iPad and the paper copy. The iPad has a highly reflective glass covering on its screen and the paper booklets were printed with digital toner. The toner became reflective after being printed on the paper substrate, an uncoated text stock.

The subjects themselves were almost entirely from the College of Imaging Arts & Sciences, with a majority from within the School of Print Media. These programs often incorporate digital publishing knowledge into the curricula so many subjects had notable prior knowledge about digital reading. A broader sample of students, faculty and staff from the entire campus might have yielded different results.

In the final page of questions for the survey, some subjects selected more than one device when asked which was their favorite or least favorite. When asked which non-paper device was their favorite, two subjects chose paper, despite the instructions.

When determining reading assignments for each subject ID, a sample of 25 was assumed. Ideally, each story was to be read on each device by five different subjects. Because only 19 subjects ended up participating, there were six subject

IDs that were unused. This meant that some stories were read less frequently on some devices. Some stories were read only once on a given device or seven times on another.

Survey 2

The initial sample for this survey was larger than the first, with 52 subjects filling out the introduction page. However, only 12 of those subjects (23%) completed the entire survey. A table showing the number of subjects who completed each stage of Survey 2 is available in Appendix D.

The average age of the subjects, 30, was identical to the average from the first survey. Because the subjects were not restricted to using a particular computer for the survey, subjects were asked their location, choice of computer, operating system, and web browser.

The subjects were roughly split between taking the survey on campus and at their home (see Table 6). A majority (65.4%) took the survey on their own personal computer (see Table 7). Those who used an “Other computer” were likely in a computer lab on campus. Mac OS X was the most common operating system, used by 80.8% of subjects (see Table 8). Firefox was the most common web browser (38.5%), followed by Google Chrome (30.8%) and Safari (26.9%)

(see Table 9). Only one subject used Internet Explorer and one used an “Other” browser.

A majority of subjects (76.9%) indicated the Internet as their primary news source (see Table 10).

Table 6. Tally and percentage of survey location.

Where are you taking this survey?		
Home	23	44.2%
On Campus	23	44.2%
Other	6	11.5%

Table 7. Tally and percentage of computer used for survey.

Whose computer are you using to take this survey?		
Personal computer	34	65.4%
Other computer	18	34.6%

Table 8. Tally and percentage of operating system used for survey.

Which operating system are you using?		
Mac OS X	42	80.8%
Windows 7	8	15.4%
Windows XP	2	3.8%
Windows Vista	0	0.0%
Linux	0	0.0%

Table 9. Tally and percentage of web browser used for survey.

Which web browser are you using?		
Firefox	20	38.5%
Chrome	16	30.8%
Safari	14	26.9%
IE	1	1.9%
Other	1	1.9%

Table 10. Tally and percentage of subjects' primary news source.

What is your primary news source?		
Internet	40	76.9%
Newspaper	4	7.7%
Radio	3	5.8%
Television	3	5.8%
Other	2	3.8%

Comprehension Section

Reading 1: Spain/England (Medium size)

This text was read at an average speed of 276 words per minute, which matched the average laptop speed from Survey 1 (276 wpm). Subjects seemed divided on the size and line length. One commented that the line length was too short, another thought it was too long, and another subject said that it was a comfortable size and line length for the viewing distance.

Reading 2: Wright Brothers (Small size)

This text was read at an average speed of 239 words per minute, comparable to the average iPod Touch reading speed from Survey 1 (237 wpm). Despite the lower speed, there were many more positive comments about the format than the first. Some subjects commented that this format was a “little easier on the eyes,” it was “easier to read than the first format,” and that they “liked this format better than the first.” One subject commented, “I liked that I could fit the entire article into one screen, it made it easier for me to keep track of all the details mentally.”

Reading 3: Anastasia (Large size)

This text was read at an average speed of 245 words per minute, comparable to the average Kindle reading speed from Survey 1 (252 wpm). Subjects responded strongly to the larger text size, saying that it was “too large,” it was “a little large for the screen/viewing distance,” and the “text vibrated a lot.” Some indicated that it wasn’t bad after adjustment. “Large size was tough to read at first, ended up easier after adjusting to it,” “the big type takes some getting used to, but overall is nice to read.” One subject commented, “I felt as though I read this passage much quicker, but retained less of the information.” Also, “I found that my head was moving slightly from side to side while reading the passage due to the size of the text.”

Comprehension Summary

The range of average reading speeds for the comprehension texts, from 239 to 276 words per minute (see Table 11), was similar to the range of speeds on the devices in Survey 1 (237 to 276 words per minute). This indicates that the influence of variable text size is comparable to reading on different devices.

There was no correlation between subject's reading performance (speed) and their subjective perception of speed. The fastest measured text (Text 1) was perceived as the slowest by subjects (see Table 13). The largest size (Text 3) was perceived as the fastest. This is possibly due to the more frequent need to scroll, similar to the response some subjects had to the iPod Touch during the first survey. Because less text can fit on the screen at a given time, the user must scroll more frequently.

The second text (small size) was most favored by subjects (see Table 12). Subjects said that the "first one felt like it had weird line breaks, the last one was way too big" and "the second passage felt the most successful to me in terms of line length and font size".

Table 11. Average reading speed for the comprehension texts.

Text	Average Reading Speed (WPM)
Text 1 (Medium)	276
Text 2 (Small)	239
Text 3 (Large)	245

Table 12. Subjects' perception of most comfortable comprehension text.

Which of the texts felt most comfortable to read?	
Text 1 (Medium)	10%
Text 2 (Small)	60%
Text 3 (Large)	30%

Table 13. Subjects' perception of fastest comprehension text.

Which of the texts felt the fastest?	
Text 1 (Medium)	5%
Text 2 (Small)	30%
Text 3 (Large)	65%

Style Section

Style 1: Google Books

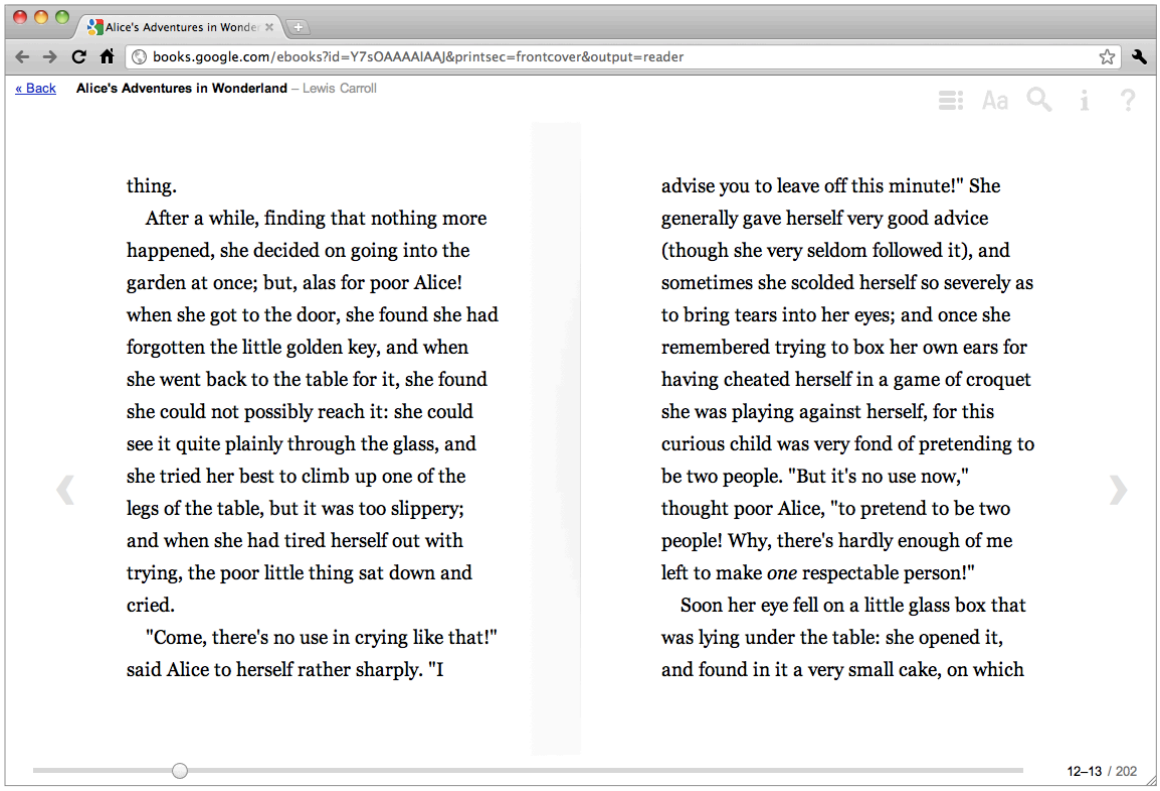

Figure 18. The Google Books reading platform interface.

The Google Books reading platform (see Fig. 18) was rated the highest of the three reading platforms in the survey, with an average of rating of 3.7 out of 5.

Only two of the subjects (14%) made any adjustments to the text in the Google Books reading platform; one changed the font and another adjusted the line spacing. One subject tried the adjustments but preferred the default settings (“default settings are good enough to not think about changing them”). Three

subjects commented specifically that they liked having the ability to make adjustments, though they did not make any.

Subjects commented that they enjoyed and appreciated the simpler interface, citing the “simple, clean navigation” and “versatility and clarity.” They were “able to click through pages quickly” and “images were included and at proper size.” They liked the two-page spread format, saying that “having two columns feels like an actual book,” and “I enjoyed that it was still in traditional ‘book form’.” “Small amount of text on the page makes for reading said text in a concise, and more thorough manner.”

Several criticisms concerned reading on screens in general: “I try to avoid reading things on screen.” The high contrast of black text on a white background bothered some subjects: “white background is harsh,” “too bright, had to turn down my monitor brightness.” There was concern about the line-height (the space between each line of text) adjustments offered: “I found both alternative line height settings absurdly useless: one too tight, the other too wide.” One subject commented that “I actually didn’t realize there were options to change styles at first.”

Several subjects expressed difficulty with the task given (to find a printed copy of Alice in Wonderland through the Google Books interface). Some were able to

find other digital copies, and some subjects said that didn't know where to look and would have likely used Amazon.com in any case.

Style 2: Treesaver

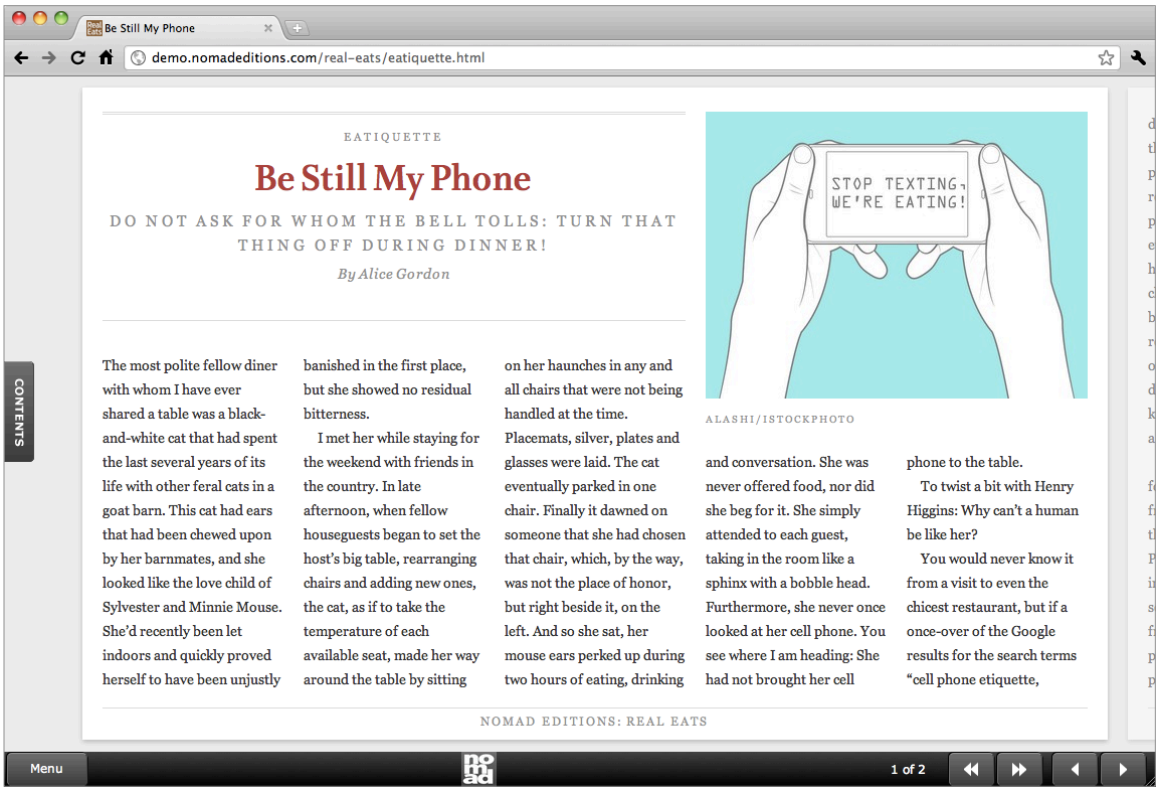

Figure 19. The Treesaver reading platform interface in a typical article.

The Treesaver reading platform (see Fig. 19) was second-highest rated, with an average rating of 3.4 out of 5. Subjects stated that it was "easy to read," "clean" and "simple." One subject liked "the fact that you could adjust the page layout by resizing the window."

The editorial-style layout was most cited by subjects who said that it was “similar to magazine,” “you can turn pages like a book/magazine” and “the columned layout works very well for magazine type articles.” The multiple forms of input (arrow keys, scroll wheel, mouse) were appreciated: “interface gave options on the way to navigate.”

However, some subjects stated that they found the interface “to be fairly confusing,” “weird” and had trouble discovering the interface initially. “The different forms of navigation are a bit confusing and scattered and take some time to figure out.” “If I didn’t accidentally scroll the wheel on my mouse, I wouldn’t have easily figured out how to move from page to page.” “Wish it would have told me somewhere about the arrow nav keys.”

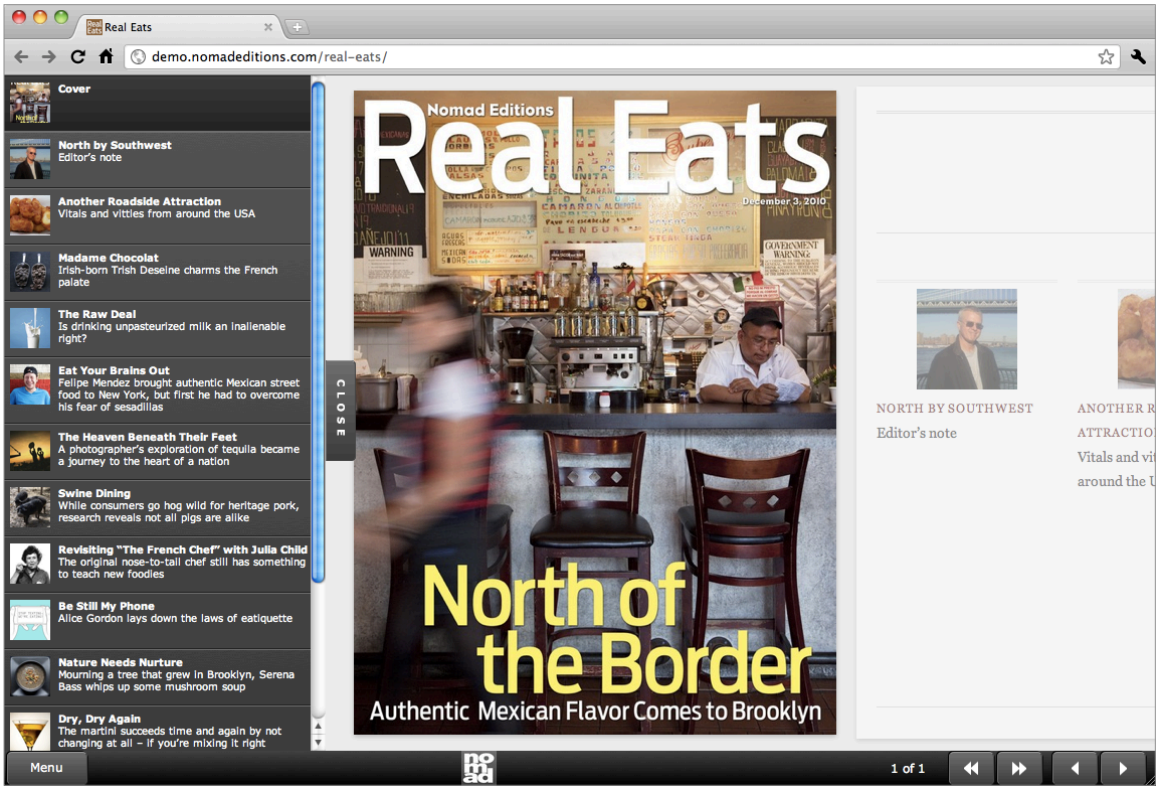

Figure 20. The Contents menu, open on the left side of the Treesaver reading platform interface.

Some subjects didn't like the use of multiple narrow columns: "the number of columns seems excessive," "real short line length makes for tiring reading," "short line length and huge line height made it impossible for me to read," it had "horribly, horribly short lines."

The designated task for this reading platform was to find a specific article. Most of the subjects were able to find the Contents menu on the left side of the screen (see Fig. 20), but some clicked all the way through other articles to get to it.

Style 3: Open Library

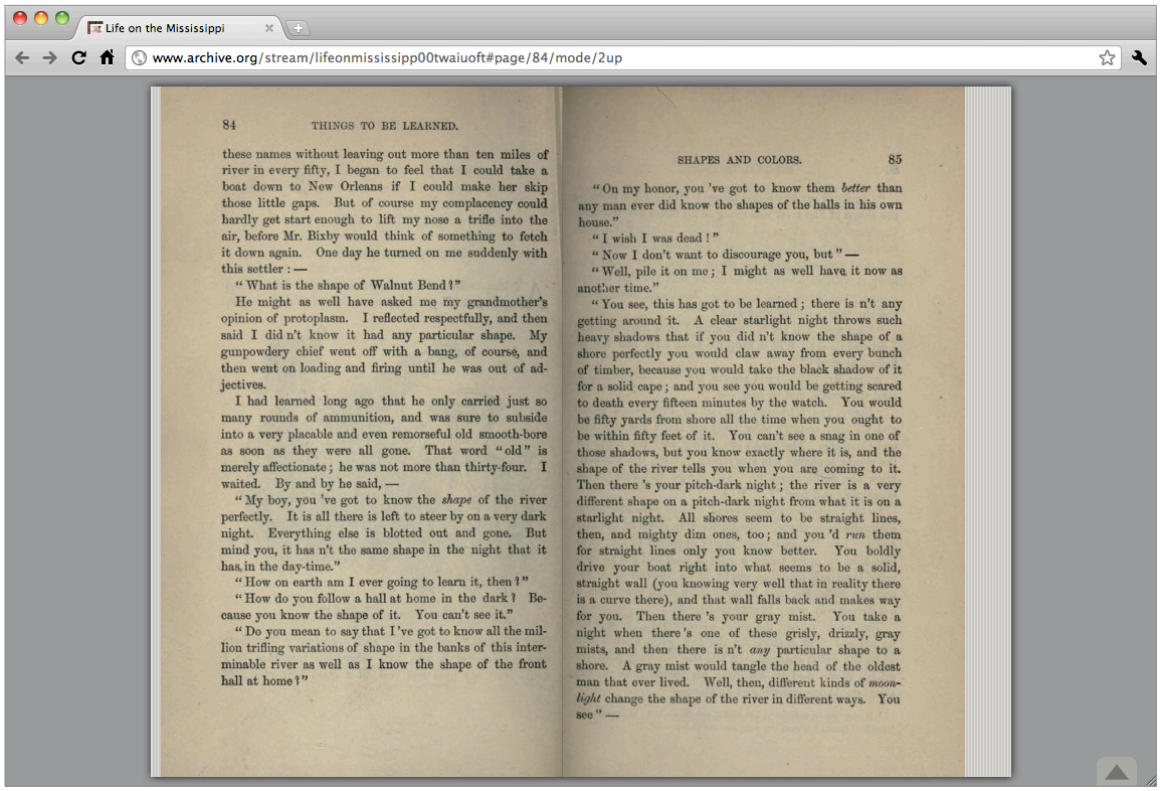

Figure 21. The Open Library reading platform interface, showing a spread from Mark Twain's *Life on the Mississippi*. Note that the virtual fore-edges vary on the left and right sides.

The Open Library reading platform (see Fig. 21) was rated the lowest, with an average rating of 2.8 out of 5. However, some subjects noted that it was "easy to use," "felt similar to reading an actual book," and "felt natural/book-like." The text used for the survey consisted of scanned pages of an edition of *Life on the Mississippi* in which the pages were significantly yellowed. This reduced contrast was actually a positive quality for some: the "color of pages is easier on the eyes," "I like that the page isn't too bright, contrast is more subtle," "I like seeing

the actual pages of the book," I like "the feeling of the real, old school printed book."

A unique feature offered by the Open Library reading platform is a representation of the user's progress through variable fore-edge thickness (see Figure 21). The user's location in the text is fairly easy to ascertain. When the fore-edges are thicker on the left side, the user has read at least half of the text. A thicker fore edge on the right indicates that the user is not yet far into the text. In other words, the stack of page edges on the left and right represents the user's progress through the text.

Some subjects criticized the quality of the digitization. Subjects noted "badly set typography," and "sometimes crumpled pages," and they commented that the "text is more difficult to see". The text size is based on the size of the browser window; the page is automatically scaled to fill the window. Because the text is presented as a flat image, and the design varies by book, it is difficult to determine the default text size. However, viewing books on smaller screens often requires "zooming and fiddling" to get a comfortable reading size (see Fig. 22). This is dependent on the condition of the original scanned book and varies between books. The fonts used were selected for a print layout and in many cases were never intended for screen use. Other layout factors, like margins and line spacing, were also designed for a printed page.

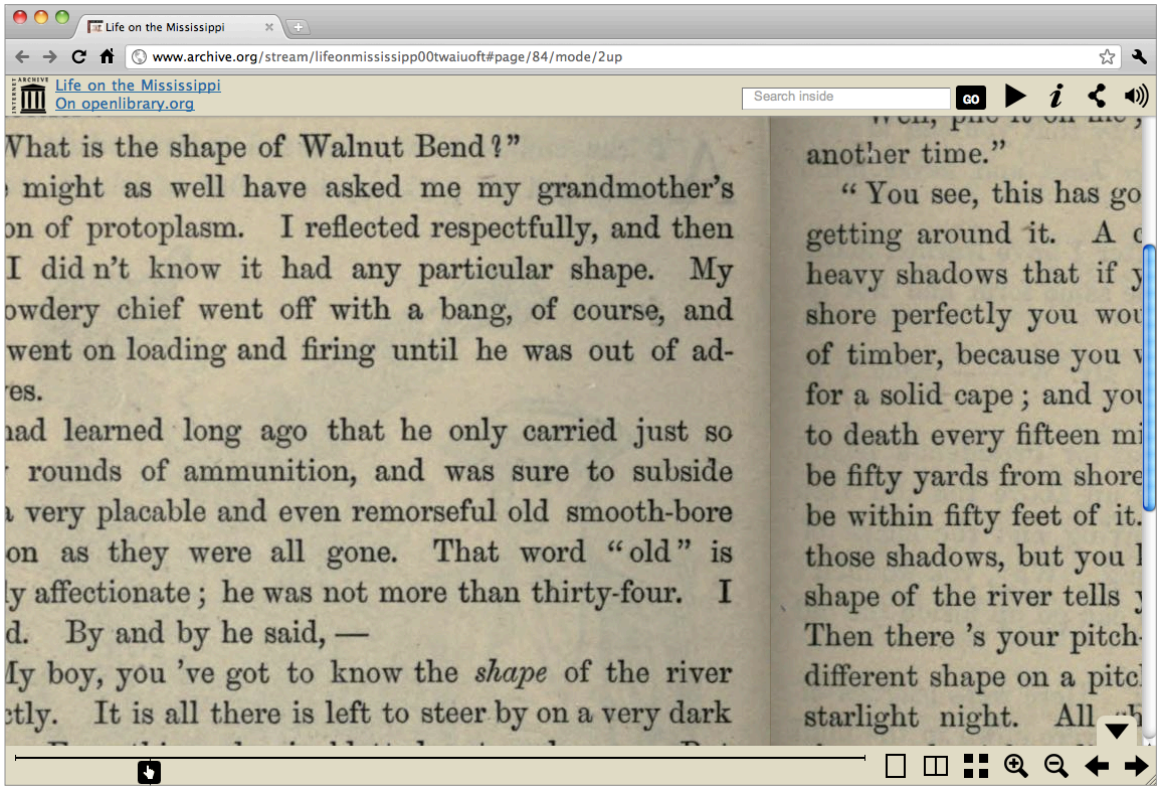

Figure 22. The Open Library reading platform interface, zoomed in on a page portion. At this magnification it is more difficult to navigate between pages/spreads.

The interface was also less refined than other reading platforms. Subjects commented that the interface is "a bit overwhelming at first" and that its "elements distract from the text." When turning the page there is often a delay while the reading platform loads the next image, another side effect of using images of scanned books instead of live text.

Some subjects appreciated the idea that a historical copy of a book could be readable on screens but felt that the process needed to be better executed.

The ability to adjust the contrast, adjust the magnification more cleanly, and load the pages more quickly would be significant improvements.

Style Summary

The Google Books reading platform was favored by half of the subjects, with the Treesaver reading platform favored second (35.7%). The Open Library reading platform was chosen as least favorite by 71.43% of the subjects. It is worth noting that subjects formed a stronger opinion about their least favorite reading platform (see Tables 14–15). Subjects were less articulate about reading platforms they favored. This lack of detail is attributed to subjects having stronger feelings about how to improve the least favorite reading platforms than detailing feedback on the devices they favored.

Tables 14 & 15. Subject preferences of reading platforms.

Which reading platform was your favorite?	
Reader 1 (Google)	50%
Reader 2 (Treesaver)	35.7%
Reader 3 (Open Library)	14.3%

Which reading platform was your least favorite?	
Reader 1 (Google)	7.14%
Reader 2 (Treesaver)	21.43%
Reader 3 (Open Library)	71.43%

Wrap-up Section

When trying the various reading platforms, most subjects (57%) indicated that they turned the page by clicking a button in the platform's interface. A surprising minority (21%) used the arrow keys on their keyboard. One user noted that "some indication of easier ways to scroll pages might be needed," since each interface presented things differently.

When evaluating the importance of features offered by web-based reading platforms (see Table 16), the ability to adjust the type size was the most important (4.3 out of 5). The ability to copy/paste text (4.1 out of 5) and change type style (4.0 out of 5) were of moderate importance. The ability to make annotations (3.2 out of 5) and share content (3.1 out of 5) were of least importance. The low priority given to annotation makes sense; annotation is more relevant to academic texts, and the texts used in the survey were non-academic.

Table 16. Average ratings of features offered by web-based reading platforms.

	Ability to change size	Ability to copy/ paste text	Ability to change type style	Ability to make annotations	Ability to share texts
Average Rating (out of 5)	4.3	4.1	4.0	3.2	3.1

In their final comments, some users indicated that they were unfamiliar with many, or all, of the reading platforms before the survey. Some downloaded the

Google Books reading platform for their iPhone or iPad after completing the survey. One subject made an interesting comment, “the biggest problem I’ve encountered is being distracted by interface elements.” There were similar comments throughout that the interface was sometimes a distraction while reading.

Limitations (Survey 2)

The online survey format introduced a number of limitations. All subjects took the survey at their own pace, on their computer of choice, without being observed. This meant their reading context may have varied dramatically, and that ambient distraction may have been a factor in their reading speed or level of comprehension.

Though the survey was tested extensively on different operating systems and browsers for consistency, different browsers and operating systems render text differently (see Fig. 23). These differences are primarily in the crispness of the letterforms. A computer running Firefox in Windows XP will display the text differently from a computer running Google Chrome in Mac OS X.

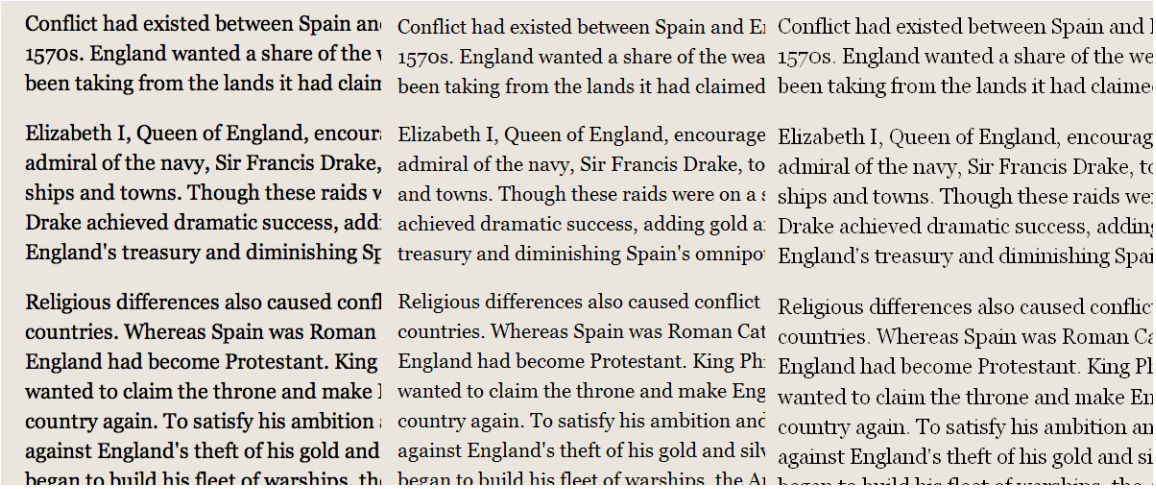

Figure 23. Screenshots of the first comprehension text, as rendered by Google Chrome on OS X (left), Internet Explorer on Windows XP (middle), and Firefox on Windows XP.

The computers chosen by subjects for the survey may have varied in screen size and screen resolution, which would influence the appearance of the type for each subject. The subject's distance from the screen might also vary depending on whether the computer is a laptop or desktop; an average reading distance of 20 inches was assumed for the survey (Shieh & Lee, 2006).

Without direct observation, the subjects were able to spend as much time as desired to complete the survey. However, in one case a subject appeared to spend over 29 hours reading one of the comprehension texts. This was likely due to the browser being left open on the page after the subject clicked the "start reading" button and returned to the text the following day. In other instances very brief reading times (under 10 seconds) were recorded, but none of the

subsequent comprehension questions were answered. These anomalous entries were discarded.

Some subjects commented that the wording of the comprehension questions was often confusing or misleading. One subject said that “it felt like some of them were a bit incomplete and could be answered multiple ways.” Another said that “although I felt that I read and understood most of the material, I felt that I got the majority of the answers wrong.” Responses from the subjects confirmed this in a number of cases, where a majority selected an incorrect response that was very similar to the correct answer.

After the survey was completed, some subjects commented that the process “took annoyingly much time.” Reducing the survey to either the comprehension section or the style section would alleviate some of this frustration. Assigning subjects to one section or the other could be another alternative. Though this survey averaged about half the duration of the first survey, asking a subject’s attention for over 30 minutes on a computer while unobserved inevitably leads to distractions. There was no reinforcement to encourage subjects to stick to the survey as there might be in a supervised physical space.

Summary

The device evaluations and surveys provided strong indicators of the strengths and weaknesses of digital reading platforms. Common strengths included the ability to adjust text size and style, available access to libraries of books, portability and freedom from physical limitations of printed books. Device-specific strengths often concerned the interface (physical and virtual) and the screen technology used (e-ink or LCD). Eighty-nine percent (89%) of subjects from the first survey indicated that they would read again on the iPad, and 84% said the same about the Kindle. Subjects from the second survey indicated that they planned to read more on platforms they tried in the survey.

The most effective interfaces were unobtrusive during reading and offered a smaller palette of options. However, the available options seemed to be thoughtfully selected.

The most common weaknesses in digital reading were distraction/confusion caused by the user interface, typographic factors, and discomfort caused by device ergonomics. Many of the weaknesses indicated in the surveys were related to a specific device as well. For example, the iPad's backlit screen allegedly caused eye strain and the laptop's bulk and weight made it too unwieldy to hold comfortably like a book.

Design aspects evidently have a strong effect on the digital reading experience. Subjects in the surveys formed and expressed strong opinions about the design features of various devices and platforms. There were notable differences in average reading speed across both the devices from Survey 1 and the comprehension texts in Survey 2.

There was also consistency in the reading performance across both surveys. The range of average reading speeds on the devices from Survey 1 closely matched the range of average speeds for the various text sizes in Survey 2. This suggests that varying the size of a reading text may have the same effect as reading on different devices. The device with the best average performance from Survey 1 was the laptop (279 wpm) and that performance exactly matched the average performance of the medium sized comprehension text from Survey 2. The device with the lowest average performance from Survey 1 was the iPod Touch (237 wpm) was comparable to the average performance of the small sized comprehension text (239 wpm) from Survey 2.

Chapter 6

Summary and Conclusions

This study asked the following questions of digital reading:

- What are the strengths and weaknesses of current digital reading platforms?
- Can design improve, enhance or aid the congeniality of digital reading?

The challenges and difficulties associated with reading scanned print book pages on a digital reading platforms, and different performance results for different scanned page platforms, indicated that large-scale book scanning projects may not provide the most congenial reading experiences. Though there are benefits to cataloguing and indexing book content for search purposes, the digital reading experience appear at this time to be be inferior to reading original printed copies. In many cases the typography and layout of the scanned pages were designed before digital books were conceived and apparently are less suitable for reading on screens. Typographic details and arrangements that traditionally rendered printed texts congenial may achieve opposite effects on digital reading devices, distracting and slowing readers by forcing them to zoom and pan across the image to see full texts in context.

Results from the second survey indicated that a majority of subjects disliked reading images of scanned pages in web browsers. The Open Library reading platform was lowest rated and generated negative comments from subjects. The Google Books reading platform, which presented texts in a minimal two-column format, was most favored by subjects.

The second survey also revealed the phenomenon that subject perception did not correlate with performance. The text size perceived as the fastest was timed to be the slowest. The opposite was true; the text that read most quickly was perceived as being read slowest. To the degree that the larger text size was felt to be congenial, this indicates that more congenial experiences are felt to be faster by the reader, even if the reality is different.

Future Research

The samples in both surveys were smaller than hoped, especially in Survey 2. A larger sample could help to determine whether the apparent consistencies between devices and size adjustment on screens are significant.

When conducting a survey in a physical space, the lighting conditions should be carefully considered. As the first survey showed, glare from overhead lighting can be a distracting factor when reading on digital devices like the iPad and even on digital toner-based prints. Subjects should also be given a period of time to

acclimate to each device and have the opportunity to ask questions about each interface.

The difficulties in keeping subjects engaged with an online survey indicate that a shorter survey might yield a higher retention rate. Limiting the scope of the survey could also aid this.

Because typographic factors were cited by subjects and the adjustment of typographic variables produced noticeable differences, further research in type and layout preferences for browser-based reading is warranted. This should include a greater variety of page layouts and type sizes. In particular, because of current large investments in book scanning, further investigation of congeniality and performance in the reading of scanned book pages it warranted, to identify and calibrate the factors that subjects found problematic or uncongenial.

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Appendix A:

Device Evaluation Table

Device	Device Size (W x H x D)	Screen Size (Inches)	Screen Size (Pixels)	Resolution	Color	Storage Capacity	Connectivity	Price
Amazon Kindle DX (1st Generation)	10.4" x 7.2" x 0.38"	9.7" diagonal	1200 x 824	150 ppi	16-level grayscale	4 GB	3G, USB	$359
Amazon Kindle (2nd Generation)	8.0" x 5.3" x 0.36"	6.0" diagonal	800 x 600	167 ppi	16-level grayscale	2 GB	3G, USB	$189
Amazon Kindle (3rd Generation)	7.5" x 4.8" x 0.335"	6.0" diagonal	800 x 600	167 ppi	16-level grayscale	4 GB	Wi-Fi, USB, 3G (optional)	$139 (Wi-fi), $189 (3G)
Barnes & Noble Nook	7.7" x 4.9" x .5"	6.0" diagonal	800 x 600	167 ppi	16-level grayscale	2 GB	Wi-Fi, USB, 3G (optional)	$149
Borders Kobo	7.24" x 4.72" x .39"	6.0" diagonal	800 x 600	167 ppi	8-level grayscale	1 GB	USB, Bluetooth	$149
Apple iPad (1st Generation)	9.56" x 7.47" x .5"	9.7" diagonal	1024 x 768	132 ppi	32-bit color depth	16 GB (up to 32 GB)	Wi-Fi, USB, 3G (optional)	$499 (Wi-fi, 16 GB)
Apple iPod Touch (3rd Generation)	4.3" x 2.4" x .33"	3.5" diagonal	480 x 320	163 ppi	32-bit color depth	64 GB	Wi-Fi, USB	$399 (64 GB)

Appendix B:

Survey 1 Forms

The Digital Reading Experience

OFFICIAL TESTING BOOKLET

Thank you for taking the time to help with this survey.
Your feedback will be valuable in determining direction
for the remainder of my thesis project.

YOUR BOOKLET ID

AGE ..... AREA OF STUDY .....

FAVORITE BOOK GENRE .....

WHAT IS YOUR PRIMARY SOURCE OF NEWS? .....

HAVE YOU USED AN E-READER BEFORE? ..... IF SO, WHICH? .....

DO YOU OWN AN E-READER? ..... IF SO, WHICH? .....

DO YOU PLAN TO BUY AN E-READER IN THE NEXT SIX MONTHS? .....

HOW MUCH SHOULD A DIGITAL BOOK COST? .....

WOULD YOU PAY FOR A SUBSCRIPTION SERVICE FOR DIGITAL BOOKS? .....

HOW MUCH WOULD YOU PAY MONTHLY FOR SUCH A SERVICE? .....

Informed Consent

This study seeks to identify advantages and disadvantages of the contemporary digital reading experience. It is a research study conducted in my pursuit of an MS degree in Print Media at the Rochester Institute of Technology.

You will be expected to participate for about an hour, though this may vary depending on your reading speed. You'll be reading five short texts on five different devices. You will fill out a paper survey evaluating the experience after reading.

There are no foreseeable risks in this survey. All of the devices used in the survey are consumer products and are used by millions of people regularly. You will gain the benefit of trying new reading technologies and considering their value.

You will be assigned a unique ID number to be used on all survey materials. No names will be associated with any of the responses provided on the survey. Participation is voluntary; participation may be discontinued at any time; there is no penalty or loss of benefits for refusing to participate or discontinuing participation. By signing this form you consent to these terms.

SIGNATURE .....

NAME (PRINT) .....

DATE ..... ID NUMBER .....

Questions about the survey and research can be directed to Garret Voorhees:
garretvoorhees@gmail.com
(609) 649-8615

Questions about the rights of research subjects can be directed to Heather Foti:
hmfsrs@rit.edu
(585) 475-7673

The Killers

ERNEST HEMINGWAY

BOOKLET ID DEVICE USED

THE STORY

Who is the target of the killers?

Where does the story take place?

Who is bright boy?

What time does the Swede typically eat at the diner?

On a scale of 1 to 10 (10 being best), how would you rate this story?

Would you recommend this story to a friend?

THE DEVICE

What was your favorite aspect of this device?

What was your least favorite aspect of this device?

Did you have any difficulties with the device interface?

Would you read again on this device?

The Battler

ERNEST HEMINGWAY

BOOKLET ID DEVICE USED

THE STORY

How did Nick fall off the train?

Who is Adolph Francis?

How fast does Ad's heart beat?

What does the "negro" do to Ad?

On a scale of 1 to 10 (10 being best), how would you rate this story?

Would you recommend this story to a friend?

THE DEVICE

What was your favorite aspect of this device?

What was your least favorite aspect of this device?

Did you have any difficulties with the device interface?

Would you read again on this device?

Soldier's Home

ERNEST HEMINGWAY

BOOKLET ID DEVICE USED

THE STORY

Who is Krebs?

What does his father do for a living?

What is "indoor"?

Why does Krebs tell his mother that he doesn't love her?

On a scale of 1 to 10 (10 being best), how would you rate this story?

Would you recommend this story to a friend?

THE DEVICE

What was your favorite aspect of this device?

What was your least favorite aspect of this device?

Did you have any difficulties with the device interface?

Would you read again on this device?

Cross Country Snow

ERNEST HEMINGWAY

BOOKLET ID DEVICE USED

THE STORY

What are the names of the two protagonists?

What do they eat at the inn?

In which country does the story take place?

Why can't they make a promise to go skiing again?

On a scale of 1 to 10 (10 being best), how would you rate this story?

Would you recommend this story to a friend?

THE DEVICE

What was your favorite aspect of this device?

What was your least favorite aspect of this device?

Did you have any difficulties with the device interface?

Would you read again on this device?

Che Ti Dice La Patria?

ERNEST HEMINGWAY

BOOKLET ID DEVICE USED

THE STORY

How does the stranger travel with the protagonists?

In what town do they eat lunch?

Why do the protagonists get fined by the Fascist?

How much are they fined?

On a scale of 1 to 10 (10 being best), how would you rate this story?

Would you recommend this story to a friend?

THE DEVICE

What was your favorite aspect of this device?

What was your least favorite aspect of this device?

Did you have any difficulties with the device interface?

Would you read again on this device?

Wrap-up

Which non-paper device was your favorite? Why?

Which device was your least favorite? Why?

Which would you choose for long reading (novel)?

Which would you choose for short reading (news)?

USE THE FOLLOWING SCALE:

1	2	3	4	5
DON'T CARE	UNIMPORTANT	INDIFFERENT	IMPORTANT	CRUCIAL

When using a digital book, how important is it to be able to...

SHARE YOUR E-BOOKS?
1 2 3 4 5

READ ON MULTIPLE DEVICES?
1 2 3 4 5

SEARCH TEXT WITHIN THE BOOK?
1 2 3 4 5

MAKE ANNOTATIONS IN THE TEXT?
1 2 3 4 5

CHANGE THE TYPEFACE/PAGE LAYOUT?
1 2 3 4 5

What features are lacking in the devices you tried?

What is your favorite part of reading digital texts?

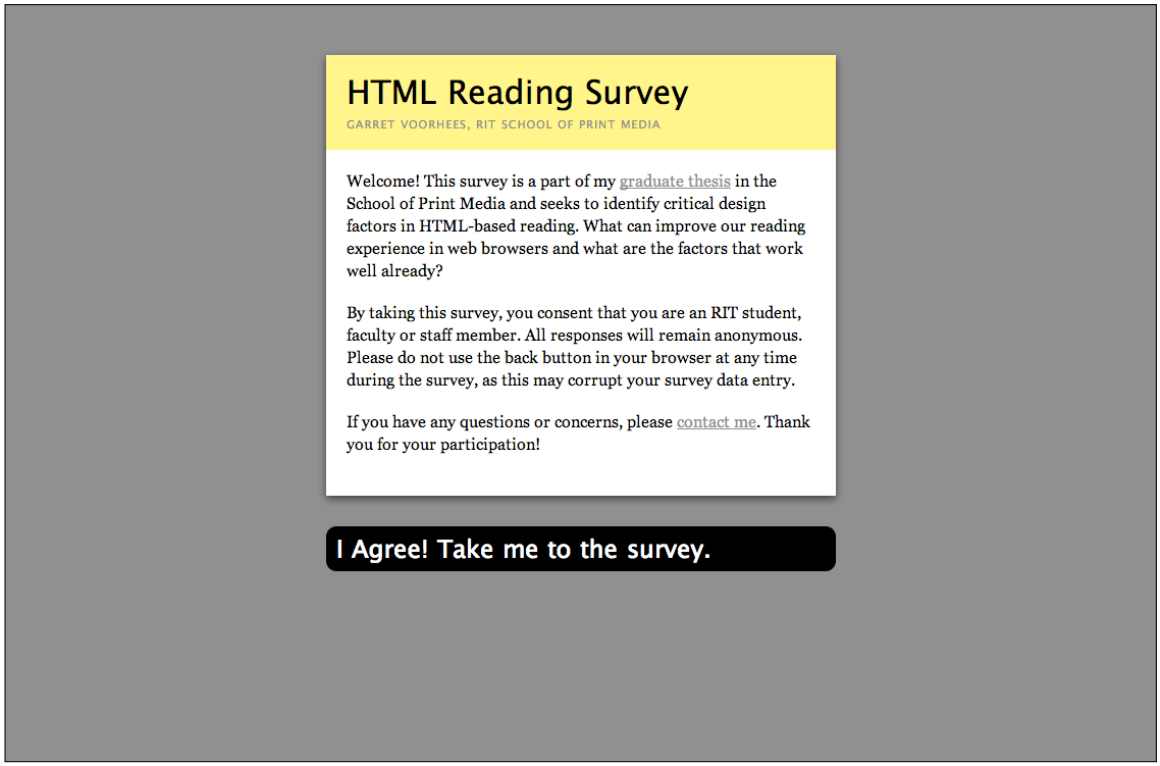
If you were skeptical about digital reading, did trying some devices change your mind?

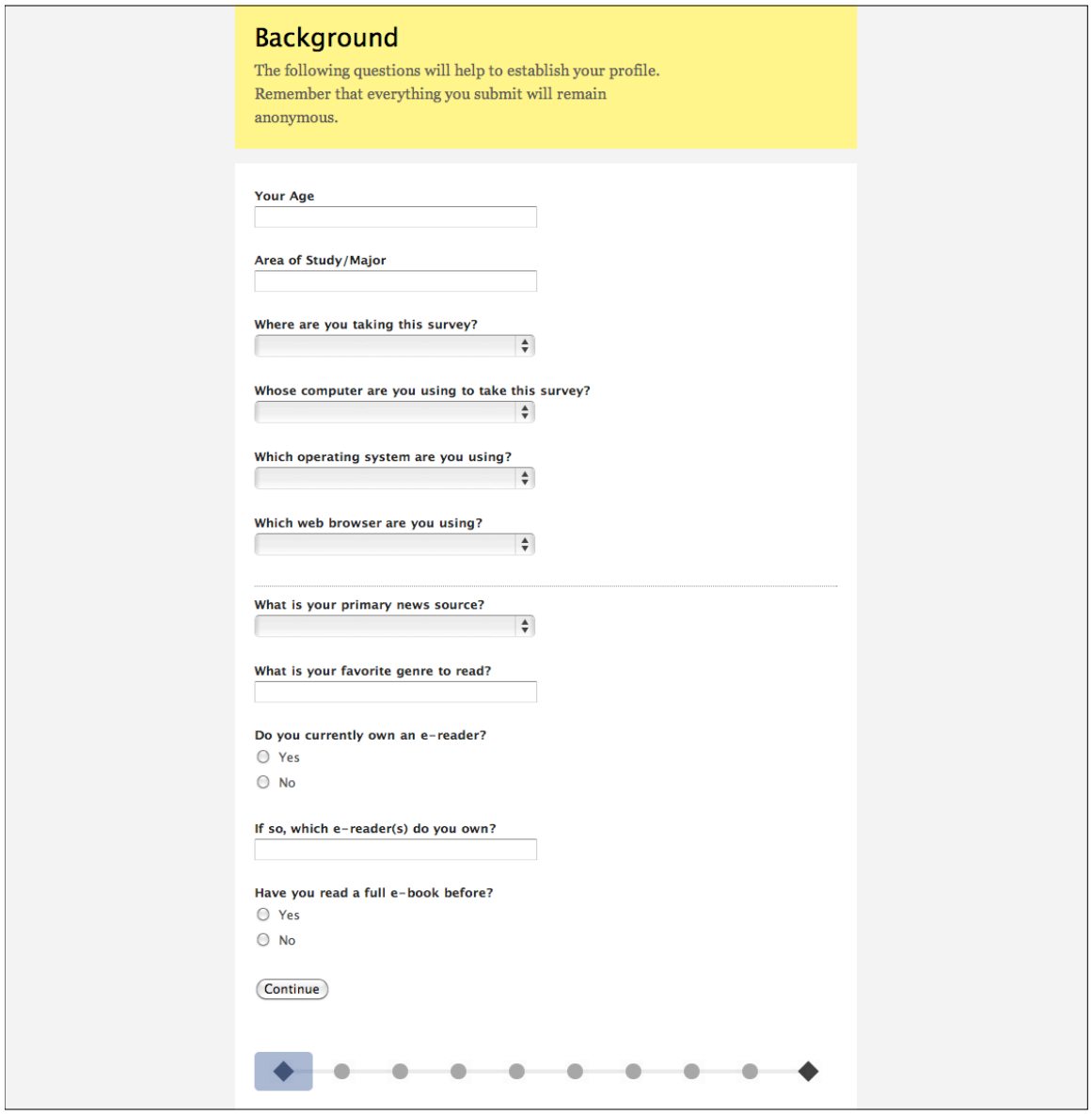
If so, how?

THANK YOU AGAIN FOR YOUR PARTICIPATION! ADDITONAL FEEDBACK & QUESTIONS CAN BE DIRECTED TO GARRET VOORHEES: *garretvoorhees@gmail.com*

Appendix C:

Survey 2 Form Screenshots





Background

The following questions will help to establish your profile. Remember that everything you submit will remain anonymous.

Your Age

Area of Study/Major

Where are you taking this survey?

Whose computer are you using to take this survey?

Which operating system are you using?

Which web browser are you using?

What is your primary news source?

What is your favorite genre to read?

Do you currently own an e-reader?

- Yes
- No

If so, which e-reader(s) do you own?

Have you read a full e-book before?

- Yes
- No

Continue

Comprehension 1: Spain and England

Please answer the following questions about the text you just read. Do not click the back button or refer to the text.

Sir Francis Drake added wealth to the treasury and diminished Spain's ___.

- unlimited power
- unrestricted growth
- territory
- treaties
- answer not available in article

Philip recruited many ___ soldiers and sailors.

- warlike
- strong
- accomplished
- timid
- non-experienced

The ___ Armada set sail on May 9, 1588.

- complete
- warlike
- independent
- isolated
- answer not available

The two battles left the Spanish fleet ___.

- open to change
- triumphant
- open to attack
- defeated
- discouraged

The armada was ___ on one side.

- closed off
- damaged
- alone
- circled
- answer not available in this article

Do you want to read more about this subject?

- Yes
- No

Comments about this format:

Continue

Comprehension 2: Wright Brothers

Please answer the following questions about the text you just read. Do not click the back button or refer to the text.

The idea of flying an aircraft was _____ to some people.

- boring
- distasteful
- exciting
- needless
- answer not available

People thought that the Wright brothers had _____ .

- acted without thinking
- been negatively influenced
- been too cautious
- had not given enough thought
- acted in a negative way

The Wright's interest in flight grew into a _____ .

- financial empire
- plan
- need to act
- foolish thought
- answer not in article

Lilenthal's idea about controlling airborne vehicles was _____ the Wrights.

- proven wrong by
- opposite to the ideas of
- disliked by
- accepted by
- opposed by

The old tables were _____ and replaced by the first reliable figures for air pressure on curved surfaces.

- destroyed
- canceled
- multiplied
- discarded
- not used

Do you want to read more about this subject?

- Yes
- No

Comments about this format:

Continue

Comprehension 3: Anastasia

Please answer the following questions about the text you just read. Do not click the back button or refer to the text.

Some Russian peasants and workers _____ for social reform.

- ○ longed
- ○ cried out
- ○ begged
- ○ hoped
- ○ thought much

Witnesses _____ that all members of the Czar's family had been executed.

- ○ gave assurance
- ○ thought
- ○ hoped
- ○ convinced some
- ○ answer not stated

Tschaikovsky _____ any connection with the Czar's family.

- ○ denied
- ○ stopped
- ○ noted
- ○ justified
- ○ answer not stated

She was unable to _____ the aid of her relative.

- ○ locate
- ○ speak about
- ○ call upon
- ○ identify
- ○ know

In court she _____ maintaining that she was Anastasia and deserved her inheritance.

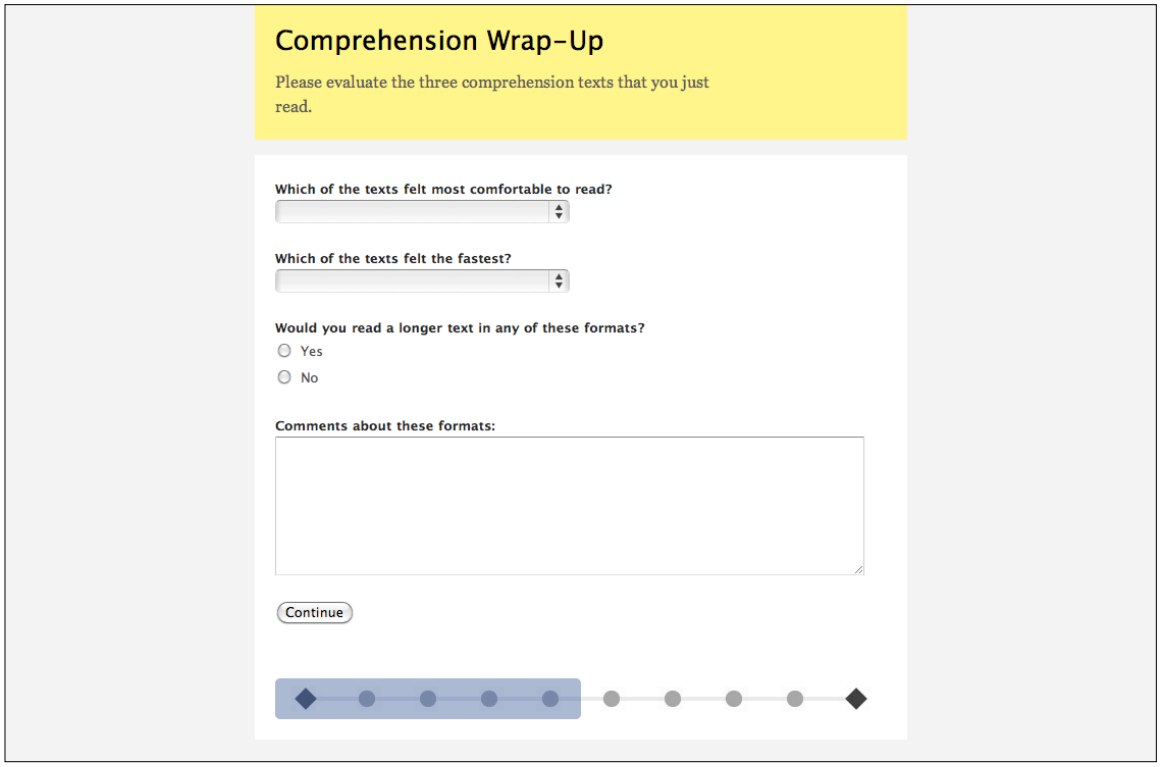
- ○ finally appeared
- ○ spoke forcefully
- ○ testified
- ○ gave evidence
- ○ answer not stated

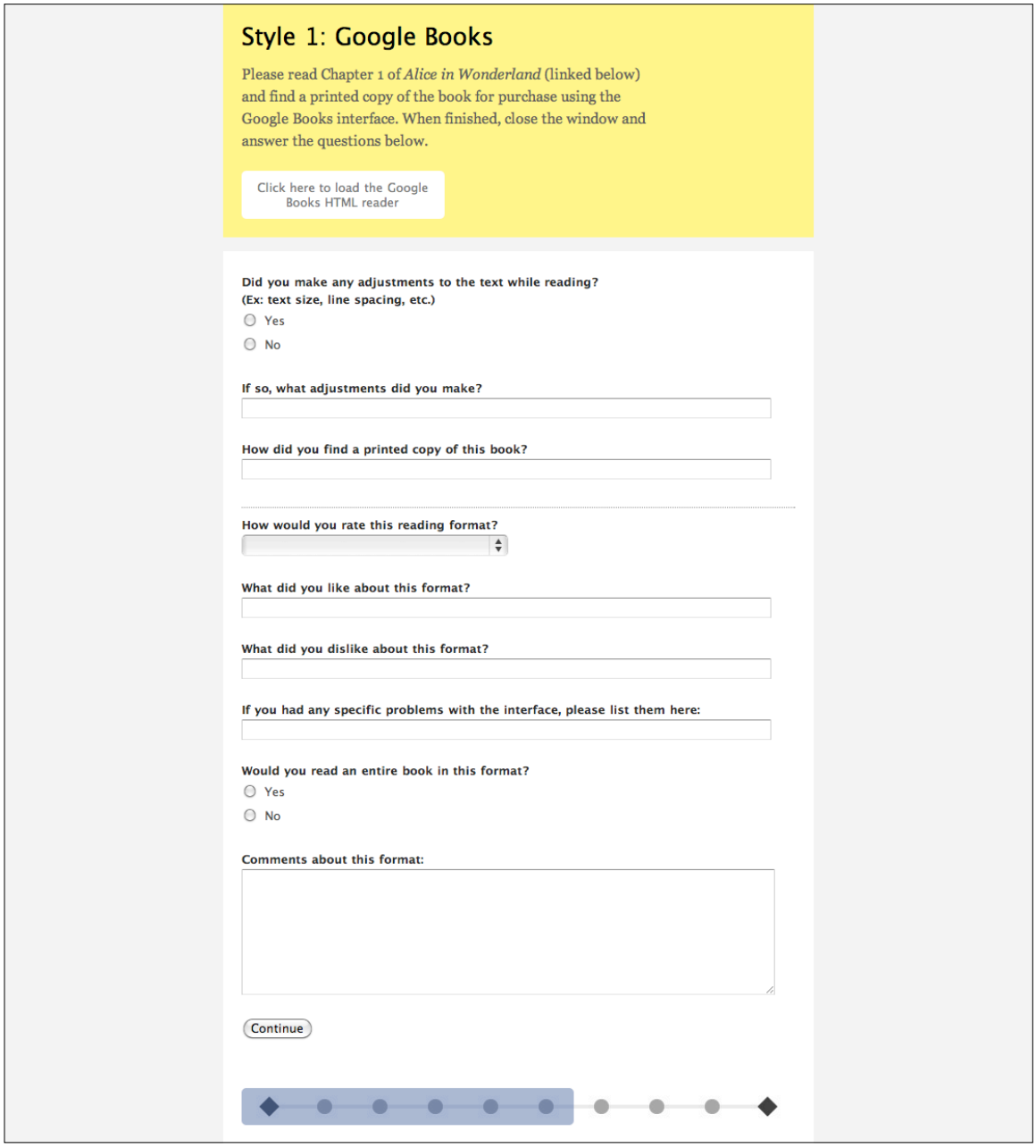
Do you want to read more about this subject?

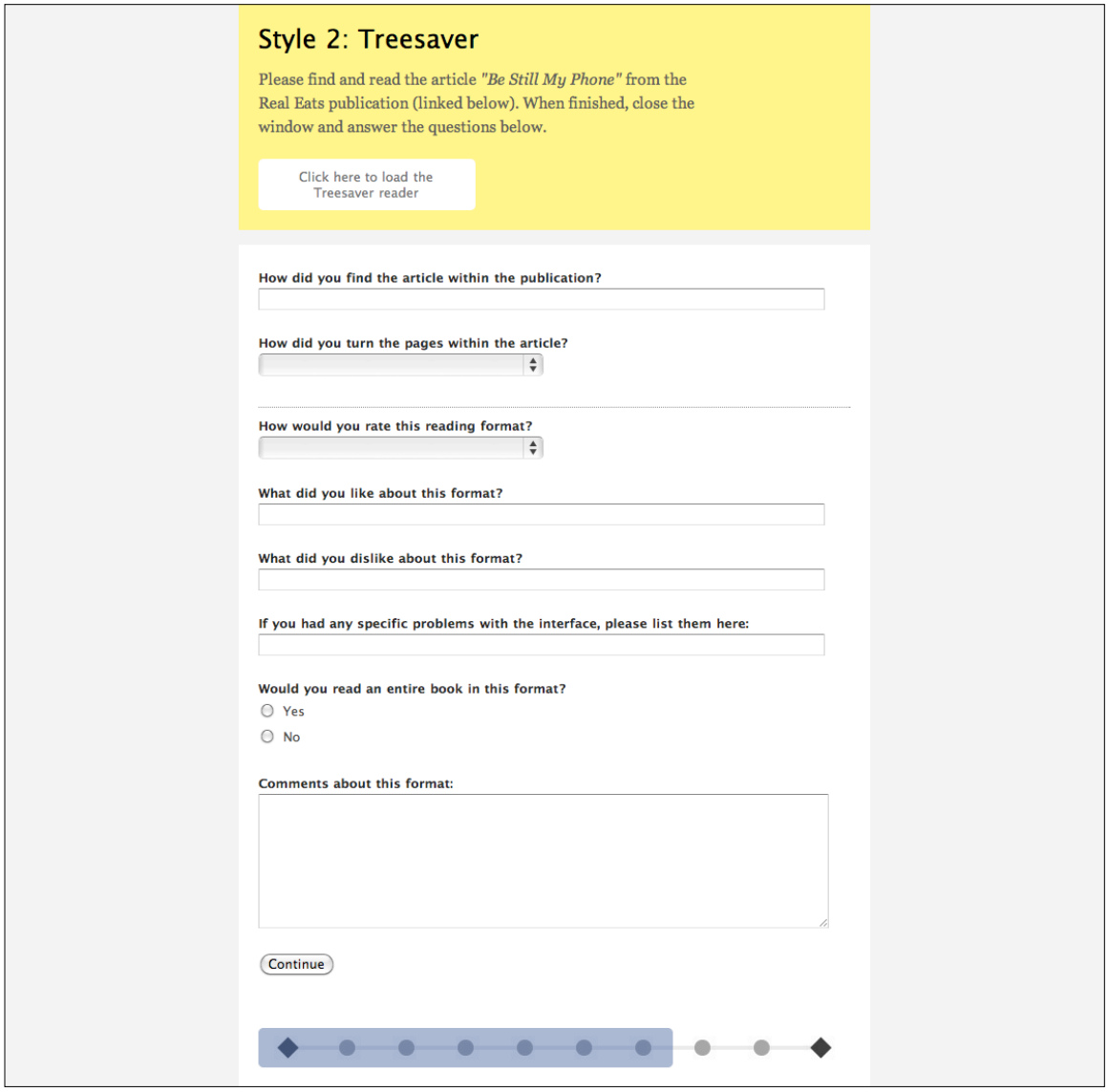
- ○ Yes
- ○ No

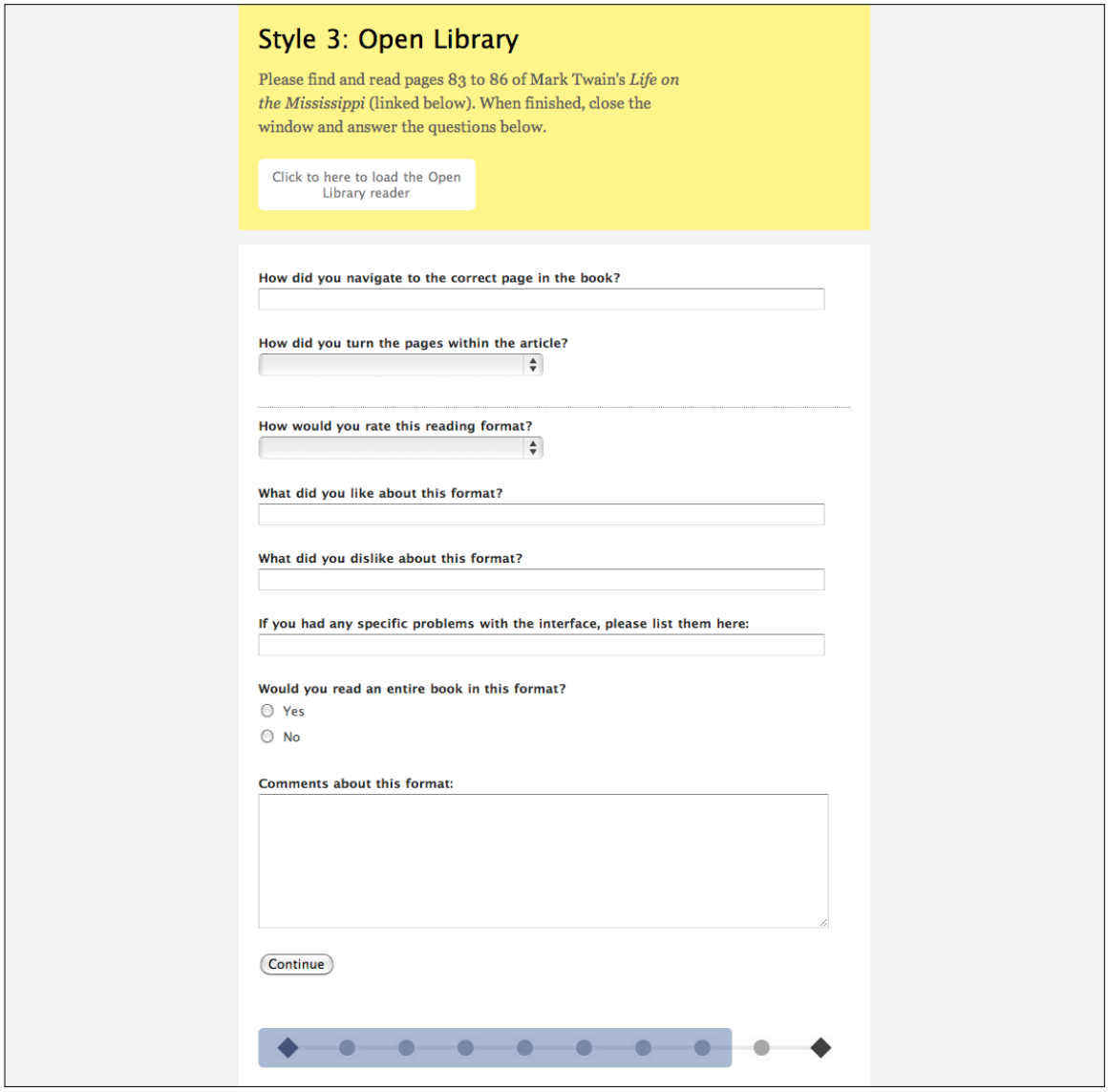
Comments about this format:

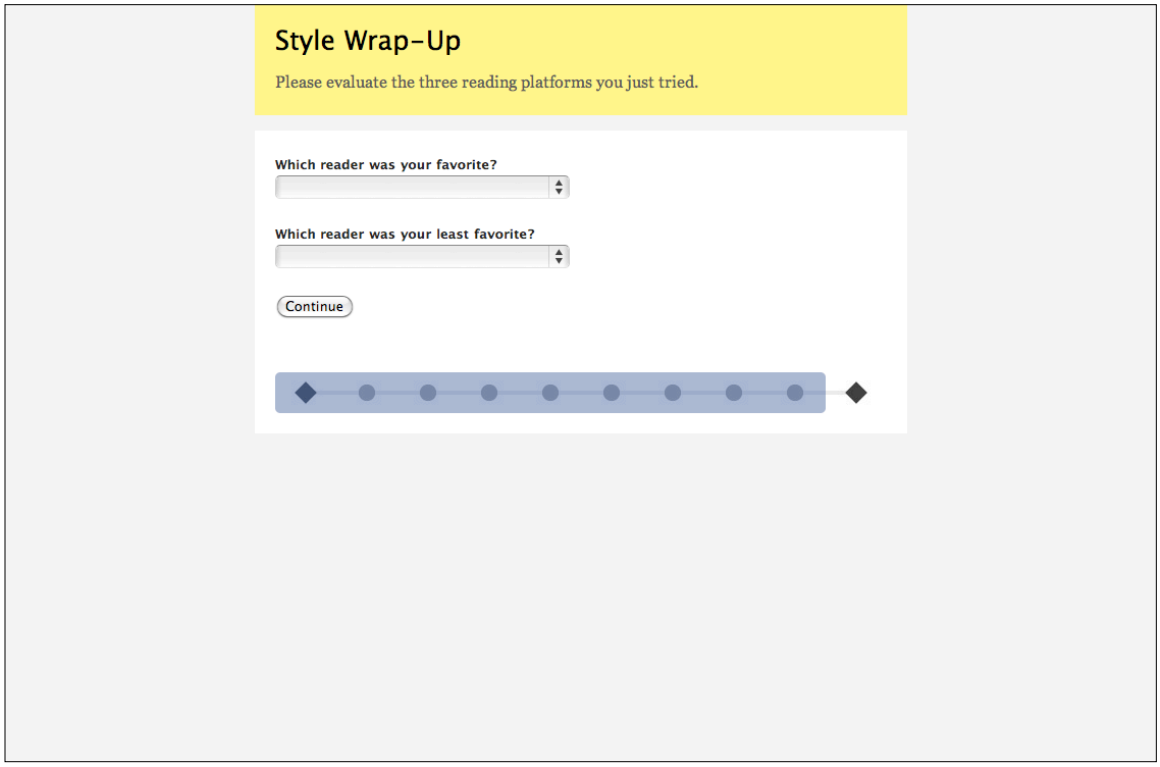
Continue

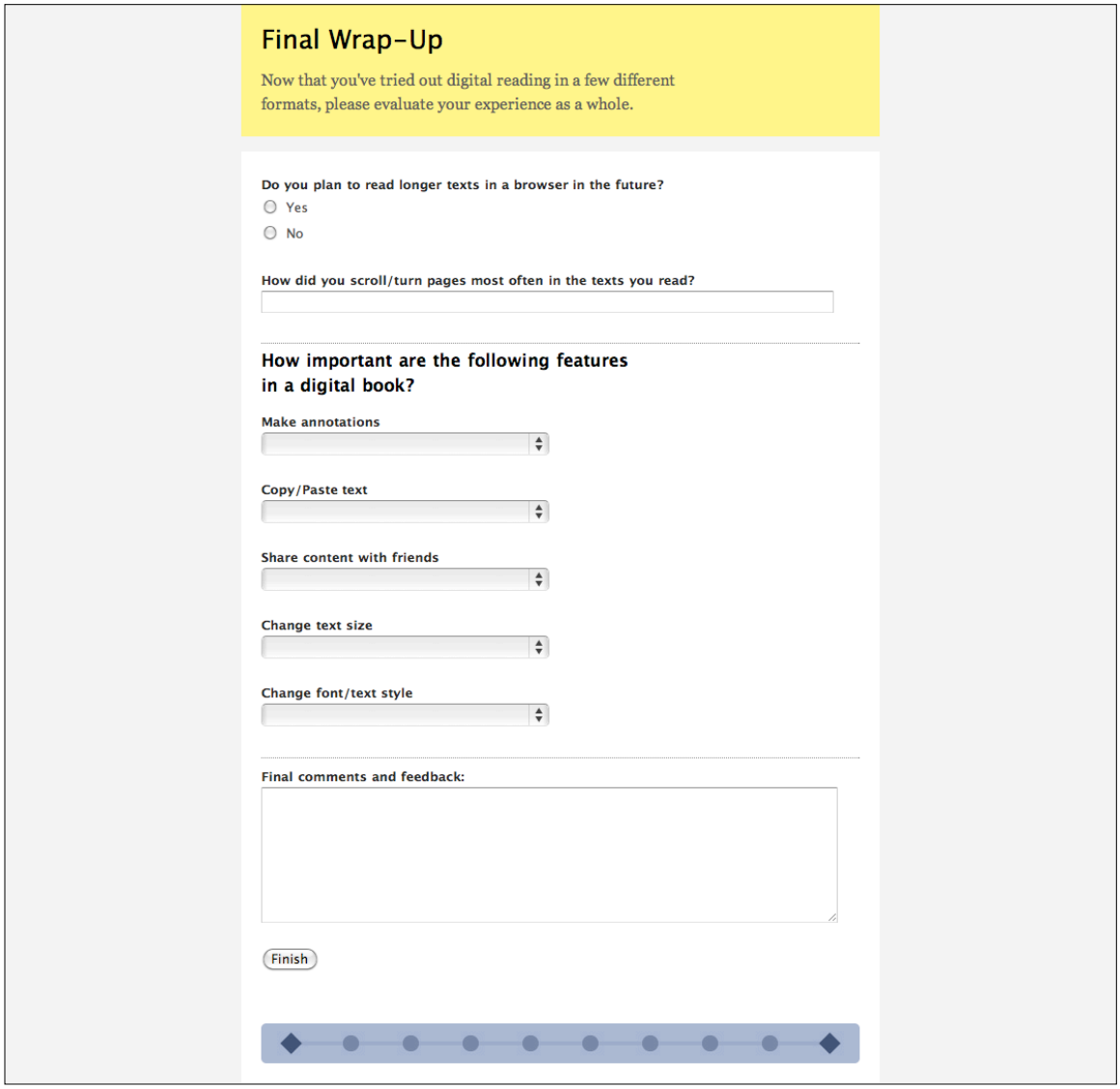

Comprehension Wrap-Up
Please evaluate the three comprehension texts that you just read.
Which of the texts felt most comfortable to read?
Which of the texts felt the fastest?
Would you read a longer text in any of these formats?
Yes
No
Comments about these formats:
Continue


Style 1: Google Books
Please read Chapter 1 of *Alice in Wonderland* (linked below) and find a printed copy of the book for purchase using the Google Books interface. When finished, close the window and answer the questions below.
Click here to load the Google Books HTML reader
Did you make any adjustments to the text while reading? (Ex: text size, line spacing, etc.)
Yes
No
If so, what adjustments did you make?
How did you find a printed copy of this book?
How would you rate this reading format?
What did you like about this format?
What did you dislike about this format?
If you had any specific problems with the interface, please list them here:
Would you read an entire book in this format?
Yes
No
Comments about this format:
Continue


Style 2: Treesaver
Please find and read the article "Be Still My Phone" from the Real Eats publication (linked below). When finished, close the window and answer the questions below.
Click here to load the Treesaver reader
How did you find the article within the publication?
How did you turn the pages within the article?
How would you rate this reading format?
What did you like about this format?
What did you dislike about this format?
If you had any specific problems with the interface, please list them here:
Would you read an entire book in this format?
Yes
No
Comments about this format:
Continue


Style 3: Open Library
Please find and read pages 83 to 86 of Mark Twain's *Life on the Mississippi* (linked below). When finished, close the window and answer the questions below.
Click to here to load the Open Library reader
How did you navigate to the correct page in the book?
How did you turn the pages within the article?
How would you rate this reading format?
What did you like about this format?
What did you dislike about this format?
If you had any specific problems with the interface, please list them here:
Would you read an entire book in this format?
Yes
No
Comments about this format:
Continue


Style Wrap-Up
Please evaluate the three reading platforms you just tried.
Which reader was your favorite?
Which reader was your least favorite?
Continue


Final Wrap-Up
Now that you've tried out digital reading in a few different formats, please evaluate your experience as a whole.
Do you plan to read longer texts in a browser in the future?
Yes
No
How did you scroll/turn pages most often in the texts you read?
How important are the following features in a digital book?
Make annotations
Copy/Paste text
Share content with friends
Change text size
Change font/text style
Final comments and feedback:
Finish

Appendix D:

Survey 2 Section Completions

	Started Survey	Finished Comp 1	Finished Comp 2	Finished Comp 3	Finished Comp Wrap-up	Finished Style 1	Finished Style 2	Finished Style 3	Finished Style Wrap-up	Finished Survey
Number of Subjects	52	28	22	20	20	14	14	14	14	12
Percentage of Total Subjects	100%	53.85%	42.31%	38.46%	38.46%	26.92%	26.92%	26.92%	26.92%	23.08%