

The E-reader pilot at Princeton

Fall semester, 2009

Final report, (long version)

Project web page: www.princeton.edu/ereaderpilot

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Abstract

In the Fall of 2009, the Office of Information Technology (OIT) at Princeton conducted a pilot program using the electronic readers (e-readers) in a classroom setting. The pilot was conducted with three broad goals. One was to reduce the amount of printing and photocopying done in the three pilot courses. The second was to determine if using this technology in the classroom could equal (or better) the typical classroom experience where more traditional readings were used. The third sought to explore the strengths and weaknesses of current e-reader technology to provide suggestions for future devices.

E-reader technology offered the promise of delivering a large number of digitized documents on a lightweight device with a long battery life, and a display that mimicked the reflective qualities of actual paper. The consumer market in e-readers had already proved it was possible to read on these devices; we sought to see if they could be useful in higher education by conducting a pilot using e-readers in several courses.

Three courses were selected for the pilot, involving 3 faculty members, and 51 students. The e-reader used in the pilot was the Amazon Kindle DX.

The goal of printing less in the pilot courses was achieved: pilot participants printed just over half the amount of sheets than control groups who did not use e-readers. The classroom experience was somewhat worsened by using e-readers, as study and reference habits of a lifetime were challenged by device limitations. Future e-book manufacturers may wish to pay more attention to annotation tools, pagination, content organization, and in achieving a more natural “paper-like” user experience. In summary, although most users of the Kindle DX were very pleased with their “reading” experiences with the Kindle, they felt that the “writing” tools fell short of expectations, and prevented them from doing things easily accomplished with paper.

History

Impetus for the pilot

With the advent of more course readings at Princeton being provided in digital format, paper usage in printing clusters at Princeton has increased by 20% per year since 2001. One reason for this is the increased use of “reserve readings”¹ in digital format. Reserve readings are those readings that are parts of

books or journals that are required for a course, but which are not required for purchase by students. Rather, they are provided in digital or paper format by the library instead.

The process of capturing reserve reading includes presenting the material in a way that makes it accessible for students – for example, gathering the readings together at a library desk where they can be borrowed for a limited period of time – in buying multiple copies of, or clearing rights to, the assigned reserve readings, and perhaps providing some readings in facsimile by photocopying several pages from a book or a single article from a volume of bound journals so that the larger work remains in open circulation for other library patrons.

In 2001, the university library began to experiment with offering readings of this type in an electronic format. Electronic reserves, or e-reserves are prepared by librarians in much the same way as analog reserves – gathering them together from a list supplied by the course’s instructor, clearing rights or buying copies for the number of students in the class, and capturing the text in digital facsimile – but the digitized files are additionally put on a password-protected website rather than on a shelf or in a folder. At this time, 38% of all reserve readings at Princeton are placed on reserve as hard copies, and 62% are e-reserves. The e-reserve format quickly dominated the percentage of reserve offerings because it was equally popular with faculty members and students.²

E-reserves are typically delivered via a file type developed by Adobe Systems called the “portable document format” or PDF. PDFs preserve the quality of the original exactly, so that a journal article would also contain the pagination and other formatting of the print edition. Adobe’s free PDF reader is commonly included with web browsers, or easily downloaded, and the reader is supported in a manner independent of operating system, software or hardware—making it nearly universal. While the PDF format presents a perfect facsimile of printed original, the relationship between e-book formats and the PDF format presented some unique challenges to this pilot. Those will be discussed below. The dramatic increase of printing that accompanied the adoption of the PDF as a delivery format for e-reserves was a major impetus to pilot a paperless technology such as an e-reader at Princeton.

Paper use at Princeton:

In the fiscal year of 2008-2009, 50 million sheets of paper were printed at Princeton. More than one-fifth of these were printed in student computing clusters, and overall, the total amount of printing was

more than 20% higher than it had been in the previous fiscal year. In more concrete terms, the amount of paper expended was in excess of 100,000 reams, 5 million dollars worth of paper, or the equivalent of 5,000 trees.

There is no charge for student printing at Princeton, although printing is monitored, and each user has a quota.³ Logins are required to release a print job at a public printer, and pages printed are tracked by an individual's account. In observing the printer traffic in the student clusters, it seemed clear that the primary file type being printed in the computing clusters was PDF documents.

As has already been mentioned, e-reserves are commonly delivered in the PDF format to preserve the appearance of the original. Because of the nature of these documents (scholarly articles, fairly dense or complex readings requiring extended concentration) they are often printed by students, rather than being read on the computer screen. The reasons for printing these documents are many: they are often lengthy, require close reading, and their comprehension is increased and value added by the student's marginal notes, highlighting and other annotations. Although the Adobe Acrobat PDF readers installed on some student cluster machines at Princeton⁴ offer a wealth of annotation tools, students find that it is both physically uncomfortable and less productive to read these documents on a typical computer monitor, and much prefer to print them out and make annotations directly on the paper. (The free version of the Adobe Reader that most students have on their personal computers does not offer annotation tools.⁵) For various reasons, the printing of a single e-reserve document tends to take place multiple times, per user, per semester, as there is an endless supply of copies provided by delivering the file on a course website. If technology were to provide a viable alternative to the reasons for printing, the solution needed would provide a digital analog of the experience of reading and making notes on paper.

With the explosion of popularity among e-readers in the consumer market, it seemed possible that this successful new way of delivering lengthy readings for personal consumption might have an application in higher education.

Funding for the pilot

Because the one of the primary aims of the pilot was to see if printing of reserve readings might be reduced, a grant was submitted to a campus funding agency that supports projects to make Princeton

more environmentally conscious. Among the goals of the grant proposed to the High Meadows Foundation⁶, was the desire

to gain a better understanding of the ways in which we can act to reduce student printing, to respond to [students'] academic needs, and to provide them with an environment that supports their academic needs as well as their desire for convenient and efficient approaches to their life and work at Princeton.

OIT was awarded \$30,000 by the High Meadows Foundation to help defray costs in carrying out the pilot. If printing on campus was reduced by even 1% as a result of the pilot, the cost of the experiment would be recouped. Considering the magnitude of the problem, it was worth the exploration.

Assessment of e-readers for the pilot

Although the e-reader market has changed dramatically since the inception of the e-reader pilot at Princeton, it was obvious even before the pilot began that the development of e-readers features were just beginning to be explored, and that the landscape of available devices would evolve rapidly. At that time, current e-readers on the market had several features in common that made them different than other forms of electronic reading tools, including computers and other mobile devices such as phones and PDAs. These characteristics included:

- E-paper technology: E-paper allows for dark text to be displayed on an almost white background with no backlighting. This reduces eye strain associated with reading lengthy texts on a standard computer monitor. You need a light source to see the page, because the screen does not emit light.
- Long battery life: Because it needs no backlight, E-paper only consumes power when a page is turned, and its content refreshed. A charged battery can last more than a week with hours of daily reading.
- Substantial storage capacity: Most e-readers have the capacity to hold hundreds of books. Some models have memory that can be expanded; others have internal, non-expandable storage. All have some interface that connects to a personal computer to allow one's electronic "library" to be organized, and for files to be moved on and off the reading device. Some have software that enables the e-books in the device's library to be read on the computer as well as on the e-reader.

- Formatted content: There are both proprietary and open-source sites that provide reading material prepared for e-readers. Media is formatted so that it will scale itself to the dimensions of the reading screen, and repaginate. This is called “reflow.” Reflow can allow files to be read on various devices, including computers, e-readers, and smart phones, because it adjusts the text to fit the dimensions of each screen. The reader can also adjust the text size of formatted content for personal preference.

At the time the e-reader pilot was first being considered, there were four viable e-readers on the U.S. consumer market.⁷ Basic criteria for using a reader in an academic context were:

1. a device that displays books, periodicals, and RSS feeds,
2. a source of content formatted for the e-reader so that students could buy books if they wished,
3. the ability to display certain other file formats uploaded by the e-reader’s owner,
4. the ability to search, highlight and annotate contents.
5. established customer support for the reader and its content

Since the PDF file was the primary reading type targeted by the pilot, support for this file format was critical.⁸ In the end, the display of the PDF document on a 6” screen, regardless of an e-reader’s features, resulted in documents that were too small to be legible. PDF pages were shown as images on the screen, and could not be annotated, searched or reflowed. Comparisons with the same document displayed on a computer, or printed out on letter-sized paper made it clear that the 6” e-readers currently available would not be an adequate substitution for the delivery of e-reserves as they were currently being provided to students. As e-readers with larger screens with PDFs in mind were being promised by several manufacturers, it was decided to put the pilot on hold for six months to a year until a reader that would at least replicate the experience of reading a PDF on a computer screen or paper came onto the market.

The Kindle DX

When Amazon announced the new Kindle DX in the Spring of 2009, interest in the pilot was revived by the promise of a larger screen (9.7”) and native support for PDF documents. An initial survey of

faculty members indicated that while gestural navigation and freehand annotation, (i.e. being able to turn pages by touch screen, and make notes with a stylus,) would be ideal features for an e-reader, a larger screen size was essential for using the readers in a classroom setting. Several faculty members had already had some experience with 6" e-readers, and although they liked them for reading books while traveling or for pleasure reading, they thought they fell short for certain types of content, including support for images, charts, and non-western characters.

Because several faculty members expressed a willingness to experiment with a larger-format reader, OIT decided to go ahead with the pilot, using the Amazon DX reader, which was expected on the market by mid-summer of 2009.

Course selection

Criteria

The courses selected for the e-reader pilot at Princeton needed to meet several criteria:

Robust use of reserve reading materials. According to the terms of funding by the High Meadows Foundation, the purpose of this trial was to explore how printing and photocopying on campus might be reduced by a different delivery method of reserve readings. Reserve readings, whether downloaded and printed from digital sources, or photocopied from physical reserve copies, account for a large percentage of paper consumption at Princeton. Courses selected would have both reserve readings and purchased readings delivered via an e-reader when possible. Therefore, a correspondence between the readings assigned for purchase, and books available in the Amazon Kindle store were important.

Contents suited to e-reader delivery. Subject matter areas well-suited for the use of an e-reader included contemporary fiction, nonfiction, and topics discussed in recent books and periodicals. Courses that concentrate on readings published before 1923, which are now in the public domain, and freely available for e-readers are also good candidates. Books that relied upon illustrations or subject matter that needed non-western characters (generally delivered as images in books for the Kindle) were avoided.

Course size. Courses with fewer participants would allow exploration of more than one type of course in the e-reader pilot. Smaller courses and seminars would also focus more heavily on discussions of

readings, and allow us better to assess the success of the pilot program. Three different courses with a total enrollment of about 50 students were sought for the pilot.

Candidates

Approximately 20 faculty members approached OIT volunteering their courses for participation in the Kindle pilot. Some courses were too large to consider. Others did not have enough e-reserve reading to justify their inclusion. Of those that did (the Library was asked to provide a list of the top users of e-reserves for the purposes of the pilot), preference was given to those whose other assigned readings were available in e-reader format, so that students could have all readings for the pilot course presented on the Kindle.

In the end, three courses were chosen. Each had 20 students or less; each had readings that could be purchased or prepared for the Kindle, and each used a large percentage of reserve readings.

Finalists

The three courses chosen for the pilot were:

- The Woodrow Wilson School of Public and International Affairs/American studies undergraduate course WWS325, "Civil Society and Public Policy," taught by Stanley Katz, director of the University's Center for Arts and Cultural Policy Studies and lecturer with the rank of professor at the Wilson School. The readings for this course were 17 books, 7 of which were required for purchase, and 10 of which were required reserve readings kept on a reserve shelf in the Stokes Library at Princeton. Library staff reported that past offerings of this course occasioned a lot of photocopying from the books kept on reserve.
- The Wilson School graduate-level course WWS555a "U.S. Policy and Diplomacy in the Middle East," taught by Daniel Kurtzer, former U.S. ambassador to Israel and Egypt and a visiting professor in the Wilson School. Readings for this course were a combination of purchased books, case studies purchased in PDF format from various online sources, and a number of PDF readings prepared by the Library.
- The classics graduate-level course CLA546 "Religion and Magic in Ancient Rome," taught by Harriet Flower, professor of classics. This course had four books assigned for purchase, and PDF files prepared by the Library.⁹

Design of the pilot

Courses participating in the pilot were kept secret until enrollment was complete, as each course had a fixed number of spaces available, and the faculty members wanted to ensure that students enrolling in the course were primarily interested in the course subject rather than in using the Kindle. Although the undergraduate seminar had been filled and closed for enrollment before the end of the Spring semester of 2009, graduate courses at Princeton are open for enrollment the first weeks of the semester in which they occur. WWS555a had reached a maximum enrollment before its first meeting; whereas the Classics seminar's prospective students did not enroll until after first day of class. The combined enrollment in all three classes totaled 51.

Once enrollment was closed for each course, students were sent a list of guidelines that invited their participation in the Kindle pilot. It was explained that participation in the pilot was voluntary and that the student could opt out at any time and return the Kindle in exchange for paper books or printable digital files. Any student who made a serious effort to refrain from printing in the pilot course and to do as many of the readings as possible on the Kindle would be able to keep the Kindle at the end of the pilot.¹⁰

One student opted out of the pilot before receiving a Kindle; all other students signed up for Kindle training sessions and were given Kindles. No students subsequently opted out of the pilot. The pilot was also limited to students taking the course for a grade. Auditors were allowed to participate in pilot courses when auditing was allowed, but they did not receive a Kindle.

Readings

The readings for the courses selected for the pilot have already been briefly described above. They consisted of several types of readings.

- First, books purchased from Amazon, prepared by publishers specifically for the Kindle.
- Second, PDF documents that would have been purchased online from other sources.
- Third, PDF documents prepared by the Princeton Library, consisting of scholarly articles, essays, and parts of larger works, such as book chapters.

OIT also experimented with making some PDF documents more readable on the Kindle by transforming them from PDFs to an e-book format that the Kindle could understand.

The Woodrow Wilson School courses selected for the pilot already had a high number of assigned books published for the Kindle. Amazon worked with various publishers to get other course titles into Kindle format. In the end, WWS325 had 100% of its content available in e-books prepared by publishers. WWS555a had a mixture of publisher-prepared books; PDFs transformed into e-books by OIT; and purchased case studies in PDF format. CLA525 had two books in Kindle format, and the rest of the readings supplied as PDF documents. This was not only because of the high volume of reading and the difficulty of translating PDF files into e-books, but also by the inclusion of illustrations, Greek language quotations and other character sets that were difficult to render in e-book format. Of the four books required for the course, two were available in Kindle format; students either purchased the others, or read the assigned sections in PDF.

The prevalence of the PDF format remained a challenge throughout the pilot. Not only were files difficult to transform into legible e-books, but one of the chief reasons for using PDFs – retaining the original formatting of the source document – was destroyed by its conversion to an e-book. The loss of the original pagination created a lot of uncertainty about the value of citations among the students and faculty. Kindle books have an Amazon-specific “location” number that can be used to reference locations in the Kindle edition, but this location number is not translatable into a format that would be discoverable by other scholars who did not have Kindles.

Presenting unconverted PDFs on the Kindle made several features of the e-reader unavailable. First, it was impossible to make notes in the text. PDFs were presented as images of the original pages, and could not be highlighted or annotated, although bookmarks were allowed. PDFs were also the only type of document on the Kindle with pagination. Upon opening a PDF file, the Kindle informs the reader of his or her location in the larger document, for example, indicating that the reader is on “page 3 of 65 pages” – but the only way for that reader to get to page 34 of the document is to push the “next page” button on the Kindle 31 times. Although this caused the students a great deal of trouble, some preferred being able to see the original page numbers to the more fluid navigation of jumping ahead by Kindle location numbers.

The delivery of PDFs as images also required some changes to the e-reserve scanning process. Readings are sometimes included two pages per scanned page – perfectly legible on paper – but scanning in this way was just too small to be readable on the Kindle screen, and some documents had to be rescanned, one page at a time. Some additional post-processing was required to crop the pages to get rid of unnecessary white space such as margins, in order to make the text as large as possible on the Kindle screen.¹¹

The issues of pagination and the limited functionality of the PDF document on the Kindle were to be common themes in the surveys and focus group, and will be discussed in more detail in the next section of this report.

Assessments:

Two surveys were conducted during the pilot; one in early November just after midterm break, and the other in the week after final exams ended in January 2010. Three focus groups were conducted after the final survey was complete.

The initial survey revealed that 95% of the survey participants had never used any sort of e-reader before this pilot. Participants also indicated that the pilot course was the course with the most demanding reading load of all of their classes that term – the average amount of reading done for the pilot course (using the Kindle) was estimated at 53% of total course readings done for the semester. 37% of participants also used the Kindle for some readings in other courses, with an equal number purchasing non-course related books for the Kindle. The majority of students tried to upload PDF documents provided by the Library to their Kindles, for readings not related to the pilot course.

Questions posed on the survey fell into five broad categories:

- First, an assessment of the Kindle DX's features and how they might be improved
- Second, issues that arose in the pilot because of decisions made by publishers of Kindle editions
- Third, the effect using the Kindle had on classroom experience, in terms of discussing readings in class, and in the reading experience outside of class with regard to comprehension, annotation, retention and speed

- Fourth, the effect of using the Kindle on the paper consumption in the pilot course, and more generally over the course of the semester
- Finally, an inquiry into what sort of features future e-readers ought to have to make them effective tools for higher education.

Kindle features:

The midterm and final surveys both asked questions about specific features of the Kindle DX. Participants were asked to rank a long list of Kindle features statistically, on a seven-point scale ranging from “A Failure” to “Delightful.” Battery life, text resolution, internal memory, screen size and physical weight were the most highly rated features, while the Kindle web browser, navigation between books and documents, highlighting text, the keyboard, and annotating text got the lowest rankings.¹² When asked to volunteer opinions about what worked best and worst for them while using the Kindles in their classes, responses included the points made by students in the following statements:

- *“It was easier on my eyes; I could read faster; it was lighter than a book, so easier to read; I used the voice system for long readings instead of skimming through it by reading; and I was just interested in using it.”*
- *“I loved how light and portable the Kindle was, and I also liked the ability to adjust the size of the text according to what worked best for me.”*
- *“It allowed for a more organized backpack and did not threaten me with all the distractions of the Internet.”*
- *“I loved the Kindle for readings that I didn't have to annotate extensively. The highlighting function was a little annoying but I got used to it quickly and used it often.”*
- *“I did not like typing notes or underlining. More options for highlights, notes, and underlines would be good. I also think you should be able to underline when in text-to-speech mode. Also, the keyboard was difficult, especially with the o and O being one key away. The location number should be easier to navigate, rather than typing all those buttons. I did not like how I had no idea how long a chapter or a book was when I started reading. I prefer to be able to gauge my time better.”*
- *“It was slow turning the pages; I could not compare documents; I could not jump quickly to footnotes or skim through the pages; I could not write in the margins”*
- *“I think it's great for pleasure reading, not good for study reading. Highlighting is not great, neither is note-taking.”*

Most student comments reinforced the statistical ratings, indicating that their favorite features of the Kindle included:

- The battery life, the wireless connection, and the portability of the Kindle.
- The fact that all the course reading was on one device
- The ability to search for content
- The legibility of the screen, and the fact it could be read in full sunlight

The least favorite features included

- Annotation tools
- The way the Kindle treated PDFs
- The lack of folders to organize readings
- Slow performance in turning pages or using the 5-way controller (the Kindle's "joystick" for navigation)
- Lack of pagination

Some features of the Kindle that did not relate directly to course reading had fewer students experiment with them. More than half of the pilot participants had not tried the text-to-speech feature of the Kindle at the time of the midterm survey, but of the 21% who had tried it and continued to use it, most used it for multitasking while exercising or driving, while some found it an effective reading tool for getting through more course readings when fatigued, and for skimming course readings. One user took advantage of the Kindle's audio book feature to listen to foreign language titles while reading their texts. Another person in the pilot experimented with uploading music files to the Kindle. Although three students were experimenting with subscribing to a newspaper or a periodical at midterm, all had cancelled their subscriptions by the time the trial ended. No one subscribed to an RSS feed.

When asked to rank improvements to the existing Kindle features, the top choices for improvement, (not surprisingly), closely followed the list of features mentioned on the list of things of things that didn't work well for students using the Kindle. On a scale between "Extremely Important" and "Not at all important" the Kindle features that would most increase the use of the Kindle in an academic setting were (most important first):

1. The ability to highlight and annotate PDF files
2. Improving the annotation tools
3. Providing a folder structure to keep similar readings together
4. Improving the highlighting function
5. Improving the navigation within and between Kindle documents

The least important improvements (least important first) for the Kindle to the pilot participants were:

1. Providing video support
2. Offering better screen resolution
3. Offering a color screen (unless it would not impact battery life, or be backlit – the reflective qualities of e-paper were highly valued by pilot participants.)

This section of the survey offered students the opportunity to comment on other features they'd like to see offered in the next version of the Kindle DX. While the ability to highlight and annotate PDFs remained the most frequently reiterated features in this section, students also repeatedly pointed out the importance of pagination – not only for citations, but for rapid navigation through readings, which the Kindle location numbers made cumbersome.

Several students remarked that the lack of pagination made it very difficult to assess how long the reading was, and how much time it would take—no one seemed able to internalize the concept of the Kindle “locations” to the same degree that they were already familiar with the concept of “pages.” On the other hand, there was a positive enforcement for completion in what one student called “the psychological effect of the percentage.” (Along with location numbers, the Kindle indicates what percentage of completion the reader has attained in the text.) A conversation between two pilot participants discusses this phenomenon:

Student A: the [location] numbers at the bottom were supposed to tell you how many pages [the reading] is. Never understood that, didn't get to that point—but in terms of the percentages, it was motivating. ... I think they should keep that. It's such a weird, mental, psychological thing.

Student B, responding: I agree. It is a very mental thing but especially when you're accomplishment-oriented you're like, "Alright 75% done, only 25% left, I can push through to the end."

Student A: Exactly. I think a lot of Princeton students and faculty and staff [have] this competitive nature. Even in terms of academics there's like this competitiveness to get it done. You have to finish it—I would never do this with a book—even if I had one more page, [I'd think] “Oh, I could read it tomorrow.” But with the Kindle it was like a game: [speaks dramatically] “I will conquer you, Kindle.”

These students, at least, concluded that the “percentage completed” feature was valuable to them, and ought to be kept.

Several felt that navigation, highlighting and annotation overall would be improved by the addition of a touch screen and stylus to replace the physical keypad and the “joystick” (Amazon calls this the “5-way controller”) used for navigating within a page, and for highlighting on the Kindle DX. Page turning, particularly on PDF files was thought to be too slow, as was the action on the 5-way controller (often overshooting the intended highlight the student was trying to capture, or failing to capture a highlight that involved turning the page).¹³ The keyboard was also cited for slowness: one student very proficient at thumb-typing remarked that that “[the keyboard needs to be fixed] *so that you can type faster without the output getting messed up.*”

More detailed discussions of annotation features emerged in the focus groups, and will be reported below.

Kindle publishers and the pilot readings:

As the semester progressed, students gained experience in reading books “purchased”¹⁴ for the Kindle. It soon became clear that some difficulties they experienced were not caused by the features of the Kindle DX, but by the relationship between the Amazon Kindle store and the works publishers make available for sale there.

The variables in the quality of the publisher-prepared books became a topic of concern to some students. Some books had internal formatting that allowed for navigation inside of a book, making it possible to jump ahead by chapter or section using the 5-way controller. Others did not even offer a table of contents (or worse, presented the table of contents as an image of the print version’s that was not navigable, and listed pages, not Kindle locations, so that it was impossible to guess where that chapter might start in the e-book). Books which in their print versions had illustrations were published with lists

of illustrations in the Kindle edition – but no illustrations were included in the e-book. For some books, the indexing was faulty, so that searching was impaired. When if publishers had affected their reading experience on the Kindle, students remarked:

- *More books need to be broken into sections. Without being able to navigate between chapters, books seem very long and formidable!*
- *Yes, especially the ability to tab through the chapters or click through the table of contents.*
- *Decisions made by publishers absolutely effected my e-reading experience. Because publishers decided the formatting, how one would be able to search the book, etc, there was no standard reading experience, and while some were great (really easy to navigate, take notes/highlight) others were noticeably more cumbersome to use.*

Some Kindle books had a high incidence of typographical errors, some artifacts of the print version, such as hyphens indicating words broken at the end of a line in the print edition, which remained mid-sentence in the electronic version. In other Kindle books, the text file was marred by more severe typographical errors, faulty optical character recognition (OCR), or lack of spacing and other formatting that caused lines and paragraphs to run together.

A more significant issue was with popular feature announced by Amazon shortly after the pilot began: all annotations and highlights made by Kindle owners to books purchased from Amazon were to be stored in the computing ‘cloud’ of the Amazon store, where they could be accessed, copied, pasted and shared.¹⁵ Because of the difficulty of typing notes, many students had resorted to highlighting with the Kindle instead, and to linking their handwritten notes to Kindle highlights that captured the relevant part of the text. They were at first delighted with the new online feature, since highlights could be printed and correlated with handwritten notes, pasted into a word processor and edited, or shared with classmates to facilitate classroom discussion. It was also a great time-saver for capturing paper citations. This feature was used heavily until students discovered that less than 10% of the book could be highlighted in this way – sometimes as little as 7% of the book’s total content. Hence, the highlights students had already made simply vanished. This caused a lot of frustration among pilot participants. Several stopped using the annotation tools completely at that point, except when they needed to grab a paper citation. Otherwise,

they felt it was time wasted to make notes that could not be retrieved, particularly since there was no indication that one had exceeded the publisher's limits on highlighting for any particular book. For those students who highlighted less extensively, the "notes-in-the-cloud" feature remained popular.

When asked to provide advice for the formatting of books and other files for the Kindle, the students ranked these suggestions for publishers in order of importance (most important first):

1. Internal formatting that aids navigation, such as chapter divisions
2. The ability to print or share notes and user-added content – without being constrained by limitations that are not typical of scholarly use
3. Keeping the e-book format simple to maximize reader battery life and storage
4. The adoption of more predictable publishers' standards for e-book creation

Things that were not particularly important to students (least important first) were:

1. Better support of charts and illustrations (although books using charts and illustrations were deliberately avoided in the pilot)
2. Enriching e-book format to add color or other media at the expense of battery life

Asked to add other suggestions, the inclusion of pagination was the most requested feature from students to book publishers. When asked what sort of pagination they'd prefer, 69% requested that it be tied to the print edition of the book that the e-book was based on, 8% requested a standardized e-book format that would be identical on all readers or computers, and 21% thought that either print-edition- or e-book-specific paginations—or both—would be an acceptable solution.

Students also noted the popularity of the \$9.99 best-seller price of the Kindle, among those students who purchased additional content for their devices. Among the 31% of students who bought books priced at \$9.99, 85% purchased them based either on price, on impulse, or because it was much easier to get the book this way, even though another option, (such as the library), would have been free. Only one student bought a \$9.99 book "*because I really wanted to read that book, and would have bought it no matter what.*"

Several students cited pricing, availability and formatting as reasons they did not buy more books for the Kindle. Some examples of their comments include these:

- *“When deciding about my books for next semester, I looked for Kindle editions for all of them. But most of the times, paper books were cheaper, so I did not buy any e-books.”*
- *“I would buy more books if the cost was lower. Academic books in particular are still expensive, which means it isn't worth the hassle of using them on the Kindle when you can get a print version for the same price.”*
- *There were at least two course books for other classes that I would have bought but which were unavailable.*
- *“The problem with Kindle books is that they won't work on other readers. I don't want to buy something I won't be able to read a few years from now — maybe I will want another brand of reader by then.”*

Surprisingly, more than half of the pilot participants agreed to the statement “I would pay an additional fee to buy a paper book that I could also load on an e-reader.” One student added:

“For books I want to have in “my library” on my shelf at home; I would love the option of getting the e-version for a lower price after buying the actual book.”

The Kindle DX in the classroom:

Students were asked several questions about their experience in using the Kindle in coursework on both midterm and final surveys. One question repeated on both the midterm and final surveys involved ranking the experience of reading — in terms of quality, quantity, speed, retention, and learning and comprehension – to how it compared to reading similar texts on paper. The vast majority of students on both surveys felt that these experiences were “about the same,” although there was a very slight drift to the “worse” end of the scale in the final survey compared to the results from the midterm.¹⁶ In the focus group discussions, some participants mentioned that not being able easily to compare documents, to flip through them or skim for review later in the semester, made their retention worse by the end of the course than they’d anticipated in the middle. The lack of flexibility and speed of navigation within readings was cited as a major factor in this.

A desire for the ability to “flip” or “skim” through Kindle content was mentioned again and again in discussions. One student said:

I feel like because you can't flip through [a reading] and see your notes. . . you don't have a real sense of the sequence of events in the things that you read. I felt like I retained more just because I was thinking about big concepts instead of details because that's basically all I was getting out of it . . . because there weren't physical pages to flip through.

Another student said much the same thing about navigation, but felt his inability to get a quick overview of the readings was detrimental to his understanding of the “big concepts.”

I have a hard time retaining information unless I see it more than once . . . for me it's really important . . . to be able to understand a broader framework of what I'm reading. For instance this was just given to me in a lecture I just went to [holds up stapled reading of about 40 pages]. So when I look at the paper initially, I'll probably read the first couple of paragraphs and then I'll just see what the layout of the paper is, so I'll kind of flip through it [flips through the pages and points out formatting on an open page]. It's really helpful for me to see subtitles and things that are set apart just so I can see where it's going, I can see how long it is. Then I'll read it and at the end I'll go back through and reference something . . . or if I don't have the leisure to read the whole document then I'll skim it . . . actually flipping not just forwards but also backwards and looking for sub headers and those kind of things and just kind of quickly underlining a couple of things here and there. When I was reading the Kindle I just kind of went from the beginning to the end and didn't do any of those other steps that I would normally do when reading a paper.

Facilitator: So it affected your reading style?

Same student: Oh, definitely.

The lack of speed in turning pages normally, let alone the ability to do a quick “flip” through content was also mentioned as hindering comprehension of course readings in the following conversation:

Student A: This is somewhat a picky comment but relating to a similar thing, in just flipping pages for some documents... lag times in [turning pages] were so slow I couldn't remember what the first half of the sentence said if it crossed over onto the next page. It took so much time to flip a page, I completely lost track of the thought and so then when you're trying to do the same thing and trying to find out okay, how does this argument on location 1,028 relate to the introduction on 1,026 and can't find it, I can't keep track.

Student B, responding: Yeah. I didn't put this in my critique but if there was a feature where you could just kind of get your finger and just push [student mimics flipping across the fore edge of pages]

using his thumb]... you know flip the page of the Kindle just like you would do with this, back and forth, that comes more naturally and if it was quick you could kind of go back and forth quickly.

A few respondents remarked in other narrative sections of the survey that they felt their reading speed was either significantly faster or slower using the Kindle— although most thought it was the same. A few students mentioned reading speed in the focus group discussion, one of them pointing out that the inability to take notes using the keyboard actually made her a faster reader. When asked how using the Kindle last semester would influence her approach to classes in the new semester (which had started two days before) she said:

. . . [A] positive thing I took out of the pilot was that because I found it difficult to underline and write, a lot of time I just wouldn't bother with it and so I would read... I would mark up less because I'm a chronic marker-upper and I do too much of that — so honestly I haven't done that much reading this [new] term yet but I anticipate that I'll try to do a little less [marking-up] just because I got through a lot more material and I think I retained a little more.

A question that asked if students wished more *course readings* were available for the Kindle, had most students responding “yes.” Oddly enough, when asked if more *courses* would use the Kindle, the response was less positive. Several students cited as a reason that actually using the Kindles in the classroom was very clumsy, particularly when the entire class was trying to get to the same location in the text for group discussions. Most said by the time they'd found the location number being cited by the faculty member, the discussion was often over.¹⁷ Three students remarking on this had the following things to say:

- *Locations were the most disturbing, the largest disturbance in class because my professor was always referring to various specific locations and none of the students in the class could ever find the location in time so he would finish talking about it and I'd just gotten to it so it was impossible to keep up, even if you're the most dexterous person.*
- *I kind of felt like we didn't [use the Kindle much in the classroom] We all had our Kindles in class but I felt like we didn't need to because, as I said, no one was referring to it but also . . . there was a lot of frustration you could see around the room as people when they did try to keep up with what he was*

doing, typing in furiously and... I would always be one step behind . . . because once I got there he would be on to another page and I couldn't just flip [the pages].

- *In the classroom I tried several times to go back and look at my highlighted notes . . . I would go to that reading and pull up my highlighted marks so I could try to remember the arguments . I tried that a few times but because I was specifically trying to remember a certain quote or a certain point that the author made, most of the time I just kind of gave up cause I got there but I didn't know what part of the document... or maybe I knew what part of the document it was in but if I didn't know if it was on page 2 or 4 out of my 5 pages of highlighted notes . . . like you'd mentioned earlier by the time that it would have been helpful to reference that material the discussion had moved on so I found myself just having to recall in my mind what I had read in class and not really use the Kindle in class as a reference.*

When asked about their experience in referring back to readings outside of the classroom, the students found the Kindle much easier to use than during class. However they pointed out that the final assessments in the pilot courses were not particularly dependent upon retaining the content of the assigned readings:

Student A: I didn't really need to refer back a lot to the readings that we had so I don't think it really affected my studying at all because if I had the same class where I used paper, I wouldn't have needed to do that either. But it helped me do more reading because I could use the voice function. If I needed to go somewhere for the weekend, I could listen to the readings and it was lighter and easier to have always in my backpack so if I had 10 minutes here or there, I could do a little bit more of the reading, so I think I might have done more of the reading than I would have if I had been doing a traditional course. But I don't think it really affected studying for me.

Student B, responding: Yeah, same for our class, I didn't really need to refer back too much because our entire grade was a term paper and the topic was of our choice. I used a couple of quotes from various sources but in general I didn't need to go back to the text the way that I would normally for an exam or regular analytical paper. If I had had to, it would have been a major problem because I tried to pull my notes up, maybe it was just me, but I couldn't get all of my notes, I think probably because I just underlined too much and I wouldn't have been able to study that. But in terms of quantity of reading, did you ask about that?

Facilitator: You can tell me about that.

Student B: Honestly I don't think I know because there aren't page numbers so I didn't get a sense of how much reading I was doing. In my mind I felt like I was reading quicker because as I said I was not annotating as much ... I felt like I was reading faster because I think when I see this chunk of 100 pages and I'm only part way through I feel like "I didn't do any of it!" On [the Kindle] I don't have that feeling of anxiety. So I feel like I did more reading on it but I don't know for sure.

A student in a different focus group considered the dichotomy between wanting more course readings on the Kindle, and fewer courses using the Kindle, and summed up her feelings in this way:

They probably mean that they want some of their course readings available but they don't want to be restricted to just using the Kindle. I do understand that sentiment to some degree because it did feel sort of limiting not being able to print out anything. To some degree there's a hierarchy of readings you know—there are the readings that end up being more essential to class and the readings that end up being less essential to class. For me reading the less essential readings on the Kindle was fine but when there were readings that I was really interested in and really wanted to retain, wanted to read over and over again [it] made it a little frustrating to be doing [them] on the Kindle and for those particular readings, it would have been nice to have printed off an electronic version ... especially when you're writing a research paper, for example. I don't know if professors could differentiate this way but if professors were able to make some readings available on the Kindle and some available via paper I think that might not be a bad thing either.

There were a small number of students who were emphatic about their desire to read foreign language books on the Kindle, for example—

I really want more books in foreign languages, with dictionaries — this would make the Kindle a WONDERFUL tool for reading literature in other languages

– and as this comment indicates, these students wished particularly for a feature that would allow them to swap the Kindle's built-in English dictionary for other kinds of dictionaries. As these comments happened on both surveys, in several places where unstructured narrative replies were encouraged, it is impossible to say how many students felt this way, only that one or more students felt particularly strongly about it. In a question that asked all surveyed if they would like to purchase and change dictionaries for foreign language and technical topics, 13 respondents indicated that it would be “very important,” while

22 said this feature would be “neither important nor unimportant” or “unimportant.” Several respondents did not answer that question at all.

Impact on paper use

When asked if using the Kindle reduced the amount of printing done in the pilot course, 94% of participants said “yes.” In other courses, 41% said using the Kindle helped them to print less. Students estimated that they printed only 15% of the readings they would normally have printed for the pilot course alone. Seventy-seven percent of respondents said that being part of the pilot made them more aware of paper consumption.

Discussing this in focus groups gave some students the opportunity to reflect on their past paper consumption and study habits:

Student A: I'll just mention that . . . over the course of 18 months now here at [Princeton] I've read many, many pages and I've printed them all out. I was just cleaning out my garage over Christmas and I had stacks of paper in my garage. I've gone back now and saved most of the documents from my courses to my hard drive so I can reference the original text but I don't have my highlights or anything. I just know from own past experience, I will never look through some stack of papers for the 5th reading of week 8 for this class and then pull it out and look at that page. I recycled all those [papers in my garage] but if I had been able to make notes on my Kindle which are somehow associated with the readings and they were saved 3 years from now when I'm doing research or teaching or whatever, I can just pull those back up and that would be great to have. I would definitely use that information.

Student B, responding: And on that note, I took all my notes on actual loose -leaf paper.

Student A: Which you're probably never going to refer to again— but if we had a chance to write it down and it's machine -readable, where you can just save the document you might refer to that kind of thing.

Student B: If you could just save it on your hard drive, then you have it for the rest of your life.

Facilitator: What did happen?

Student B: It's sitting on my desk—you're right, I'm never going to look at them again.

Student B, later in the same discussion: If [the Kindle] were more in sync with my PC in a way that I could keep my notes and my documents archived, organized, and like you mentioned,

associated with those [Kindle] files so there was a notes file that compiled all my notes—this is all based on [the Kindle] having better annotation tools— but ... yeah. That would be great.

Facilitator: But those are good things for manufacturers to know.

Student A: I mean that would be a big advantage over just printed literature.

Student B: One of the most annoying things for me about printed literature is the document loses any value [added from notes] if you have to reference it years down the road. And the other comment I'll make is all these things I've been saying about annotation. I guess it's kind of intuitive but [those suggestions are] just strictly for academic purposes. I gave the Kindle to my Mom and she's going to use it for pleasure reading and I don't think any of these changes need to be made for that. I think she's going to love it and it's going to be fine, but for classroom purposes it had lots of these kinds of flaws and room for improvement.

In another focus group two students discussed their study and printing habits with regard to course work and research, reaching some different conclusions than those represented in the previous discussion:

Facilitator: Well, let's talk a little bit about the PDF files though because . . . the reason the paper consumption was an interest in this study is that the printing and the copying has been sort of out of hand on Princeton's campus and they would like to try and see if students would adopt habits that would allow them to use something electronic to do the reading so—do you read PDFs on your computer? I mean, is that something you've ever tried to do?

Student A: I've tried definitely.

Facilitator: You've tried but it's not...

Student A: I don't have notation software, I guess that's what you call it, where you can use your computer to mark up the stuff so that's why, I think. Obviously it does bother my eyes after a while, I also wear contacts so it bothers them more than without contacts I guess but the main reason is because I can't mark up.

Facilitator: Well, what's your sense, I mean just from having been in class do you have a sense from other students, is it just that they want to have paper in front of them? Is there something about having paper or a book in front of you and studying that go together and so even if all of these things worked well and were explained and you were provided with tools, do you think people would to some degree would just kind of revert?

Student B: I just think it's... Well, I wanted to say that I actually did use my Kindle for other classes. I bought books at Amazon, Kindle editions of books for other classes, so I definitely used less paper, I might be one of the rare few but I definitely used less paper because I had other classes that

had books that were available in the Kindle edition and it was cheaper, it was cheaper than even buying a used text and most of the time I didn't look enough ahead to even get the book in time. I couldn't have even ordered in time if I wanted to so it was the day before and I realized I didn't read that section and then I got it on the Kindle in two seconds so I used it for that But if it's in a PDF and you can't even highlight it, I don't think anyone is going to use it, because if you don't go back and refer to it, it's like . . . you feel like you really just have to highlight, at least I do.

Student A: And also just in terms of having something tangible—I know people feel like they're being more organized when they have all of the readings printed out . . . Also, something about myself, in terms of paper consumption, I'm [an officer of an environmental group] on campus so it's not like I'm someone who thinks "I don't care about paper consumption" because I do. But I, and I know other environmentally conscious people like me, kind of view when I'm printing out an academic reading, "I'm not really thinking about it because I'm valuing the fact I'm learning something over the fact that I'm printing out 25 pages," and I think that if I feel that way, many people feel that way. . . So, I always feel guilty about it but even I am printing it just because I don't feel like I'm "getting it" otherwise.

Student B: And it's not trash . . . a lot of people save it.

Student A: Right. I don't print 3 times—once I have it I have it.

Student B: Plus I had another class where I had to cite some of the books on Kindle that I had [to use for] a research paper due over Christmas and I found it really frustrating trying to write a research paper with something on the Kindle. I don't know maybe another generation of students would be different but it's really difficult to write a research paper when you're doing quotations and stuff and you're swapping between like 20 different windows it's just, I don't know, it's easier to have the pages lined up here so you can just use it and pull the one out that you need.

Asking students what improvements could be made to an e-reader to facilitate effective note taking, study, and research tools, the same features mentioned in other places were again foremost – improved PDF support, improved annotation, the ability to have more than one document or book open at once, the ability to compare passages, support for skimming, or rapidly flipping through pages of a document, and had organizational tools, such as folders, so that notes and readings could be kept together.

A final question on the paper consumption portion of the final survey asked "*It is essential for me to print a document when . . . ?*" The short answers to that query echo many points touched upon in the above conversations.

Annotation:

- *I need to edit/annotate it.*
- *I need to take notes on it for a class.*

Research/writing

- *I am writing a paper and it is a key document — it is much harder to work with documents of this sort on the Kindle, which is better suited to reading something you aren't taking notes on.*
- *I'm writing a paper and need to quickly flip through to find where I marked different things. This is hard to do on a Kindle*
- *I might need it later as a reference for a research paper*
- *It is my own writing and I need to edit it*

Complexity:

- *The material is very dense and requires careful reading/physical interaction*
- *I really care about reading it. I only read course readings as PDF's on my computer when I don't care so much about the reading.*
- *I want to seriously engage with the text and I think I will use the document very frequently.*
- *It has a lot of charts that I need to highlight and have compiled for easy access.*
- *I really need to read it thoroughly.*

Skimming:

- *I need to skim it quickly*
- *I need to read it quickly(no time to take separate notes)/discuss in precept, be able to flip through and view both text and notes simultaneously*

Professional responsibilities:

- *I am giving a presentation on the subject matter or using it for writing a paper or article.*
- *I am preparing to teach a precept or really need to interact with it.*

The non-printers:

- *Almost never.*
- *I rarely print.*

And a new reason:

- *I'm taking it someplace I don't feel comfortable bringing an e-reader...i.e. the beach (lots of sand) or the subway late at night (get mugged)*

Why did no one opt out of the pilot?

In the final analysis of the e-reader pilot, each of the focus groups was asked a variation of the following question:

By all accounts, using the Kindle was frustrating for, and in some cases detrimental to, students involved in the pilot courses. But no one opted out of the pilot, even though they would have been given free books and readings to replace what was on the Kindle.

Why didn't you opt out? Was this something you ever discussed with other students taking part in the pilot?

The students were obviously taken aback by this question, but they stopped to think about it. One discussion went this way:

Student A: For me, it saved a lot of time from printing and just... if I know the [Kindle's] in my backpack I know I'm good for that class — and I can be anywhere and I know it's there so that made it really useful. Plus, I think it was kind of cool to have a Kindle so I you know, stayed with the program.

Student B: I just liked the idea of having a Kindle and participating in this program because it was sort of the cool thing to do and a nice opportunity to try something new. I don't regret [being part of it].

Facilitator: Did you hear people grumbling? Or did you remember anybody suggesting maybe they'd had enough or ...?

Student A: I heard people complain but I didn't hear anybody say "I'm done with this thing!" so... my thought is Hey, I don't want to be a caveman here and if this is the way all our readings are going to be in five or ten years from now, like I better get with it.

Student A: I think there was just general frustration but nobody was mad.

Another group had this exchange:

Student A: It was easier not to change — one. Two — just in my class ... It was a good class for this pilot because it wasn't really a problem as I said. We all knew we had to write a term paper, we all knew we didn't need to go back and study and reference everything that we couldn't mark up the way we wanted [on the Kindle] so it wasn't that big of a deal.

Facilitator: Okay.

Student A: I think that if we had thought that it would negatively impact our grade, then we would have opted out probably.

Facilitator: Okay.

Student A: And also, I know a lot of people, even though they didn't like it for academic use, afterwards, thought, "I'm still going to use it for pleasure reading."

Student B: I'm really surprised, I don't know... what it was like for the other classes but I'm surprised to hear that it was so negative because I really didn't hear anybody, not in [our graduate seminar], I didn't hear anybody complaining about it.

Student A (an undergraduate): Maybe it's a generation thing because like we're used to the really fast, beyond fast technology.

Student B: Yeah, could be. I think there was one guy in my class who I knew didn't really like it, wasn't planning on using it for personal use and was glad to be done with it, but I don't recall hearing anybody complain really. I think people thought it was neat, it was cool like a cool thing to be a part of.

Student B: Did people complain in your class about... like during... did you guys have Kindle...

Student A: It wasn't like we would have Kindle rants.

Student C: Well...

Student A: Maybe we would... Sometimes, not all the time.

Student C: And that would take sort of 15 minutes and then we'd get on with things.

Student B: But we had [a staff member expert in the Kindle] in our class every week, every week [the professor] would ask "is anybody having an issue they would like to discuss?" And no one ever raised a thing.

Student C: Even though our experience may not have been like we wanted it to be we— somebody— essentially had to do the pilot because, otherwise you could say, "oh I don't like this" and give it back but that means that you're not going to be able to give really constructive feedback. And I think also it was just easier, you know, sort of a matter of inertia, like once you had it, to have to go through the whole process of giving it back . . .

Student A: Human nature.

Student C: Yeah, that was just not going to happen.

A third focus group started out much like the others, but their conversation reached a slightly different conclusion:

Student A: I think nobody wanted to relinquish it.

Student B: Yeah, which is interesting though because if they didn't like it so much you would think they would want to get rid of it.

Student A: I think intrinsically though, people probably thought of it as like this is added value, right, even if I don't like this maybe when I'm done I could . . . do something [else] with it . . . That's my guess.

Student B: That's probably true. I mean, I think also people just maybe were at the beginning of the semester sort of focusing on struggling through it a little bit because that's what I did. I mean I didn't think that it was going to be revolutionary, change my life, I think it did add a lot, it did benefit me a lot and there were some downsides too but you know, no matter what I said, I wanted to stick with it and sort of struggle through it as much as possible to see how it was going to work. You know, I think of it like my parents and the internet . . . sooner or later you know this moment is coming, and you can either jump on the bandwagon or be left behind. I'm not saying that there won't be any books anymore but I feel like . . . especially for me, personally I know that for my job I'm going to travel a lot, so having a Kindle is going to be really useful. I don't know. Maybe the internet comparison may be a bad comparison but you know what I mean in terms of technological change so . . .

[The conversation drifted to other topics, but later Student B returned to the question of student dissatisfaction and new technologies]

Student B: . . . I think the transition to sort of this new technology which I mentioned before was maybe a little more difficult than people expected. I know in the beginning of class people were really excited and probably had very high hopes for the Kindle and how it was going to revolutionize their lives. I think that to a certain degree it didn't do that exactly. People underestimated the fact that they would have to adjust their own habits in order to compensate for having the Kindle . . . I just sort of thought "oh hey, we have this new thing to sort of try out in the class." I didn't really think too much of it but I know a lot of other people were very, very excited about it and may have been disappointed because it was such an adjustment.

Overcoming the study habits of more than a decade of formal education was something that all pilot participants had a hard time coping with. However, remarks on the exit survey as well as in the focus groups indicated that they were willing to try. As one student summarized, "*it's the way of the future, but it's not the future yet.*"¹⁸

Imagining the perfect e-reader

The e-reader market exploded during the course of the e-reader pilot at Princeton. Just before the release of the survey and the scheduled focus groups, Apple announced the iPad, and at least 24 new or emergent devices were exhibited at the Consumer Electronics Show in January of 2010.

Survey respondents were asked to rank their interest in three types of devices. First a “traditional,” e-paper-based dedicated e-reader, such as the Amazon Kindle DX; second an e-reader/ netbook hybrid; and third, a device similar to the (then) anticipated Apple iPad.

Given these choices, 38% percent thought a netbook-reader hybrid would be their top choice (mostly because of the fully functional web browser, and the ability to write using a word processor); 32% opted for the “slate” or “tablet model (because of the added functions, while retaining a format similar to the Kindle’s); and 24% named the “dedicated” e-paper reader as their first choice. However, the survey “branched” at this point, so that students saw a different list of features depending on the type of reader they had ranked first. The narrative comments suggest that several of respondents had changed their minds or not understood what sort of features each type of reader might have.

A student who opted to rank a tablet reader first, commented in the end that *“such a device would be too complicated and expensive. A simple reader would suffice.”* Students opting for the netbook options made clear that although more functionality would be desirable, particularly the ability to read and write at the same time, the reading experience would need to be as good as that of e-paper, and the battery life almost as good as the Kindle’s.

When asked to summarize their desire for the perfect e-reader, many students pointed out that they already owned computers, and that reading effectively required a different set of features. The statement “The perfect reading tool would . . .” was completed by students in the following ways:

- *Be something similar to the Kindle, but instead of having a dedicated keyboard, there would be two options: 1) it would have a virtual keyboard that would popup when you double-tapped on a place in the text, if people want to leave notes through the computer to search for later, and 2) there would also be a stylus that came with the device so that people could write notes by longhand. Also, the screen would be touch screen so that you could*

highlight/underline with your fingers or the stylus. Also, color highlighting/underlining would be crucial.

- *Be like the Kindle, but have a touch screen and easier to use annotating devices.*
- *Be similar to the Kindle but more user friendly*
- *Be something similar to the iPod Touch but bigger...I guess the iPad is the future*
- *Mimic the experience of reading a paper book, and allow me to put notes in the margins and highlight just as I would with a "normal" book.*
- *Would simply be like a conventional book, but paperless. I would prefer not even noticing that I am using an electronic device to read. Too many features simply make an e-reader a computer, which we already have. Having said that, some features, especially navigation tools, are very important just because without them, the reader cannot go through pages of a book the way one can do on a paper book. When using books as sources to write papers, navigation is extremely important. I usually take lots of notes on the books/articles that I am planning to cite. And when writing, I just go back and forth.*
- *Allow me to import books as well as upload my own relevant documents, with minimal editing capacity, and a long battery life. Ability to move easily through e-book*
- *I don't really want to carry around a second computer – I want my computer to be able to simulate e-paper technology so when I am at my desk/on my laptop, I can read for a long time without straining my eyes, and when I'm on the go I want something that I'm actually going to consider taking with me. In other words, I want something that is no bigger than the Kindle – a clamshell device is too close to another computer.*
- *I like the idea of having a device that is just for reading (email, music, etc. is not important because other devices do that, and then the e-reader becomes more like a computer). It makes commuting and traveling much easier to know that you have everything with you. I also found that it really did save paper for me.*
- *I'm not really that interested in browsing the web so I would prefer a device that focused on making reading and annotating work well rather than on other features.*

An opportunity to add final statements to the survey elicited this plea:

- *Don't attempt to turn e-readers into mini-computers. I already have a laptop that I love, and since I'm a student, I hardly do any of my course reading "on-the-go," which means that if I'm going to lug this device around with me somewhere, I do not want a second computer to lug around. 2) Touch screen is essential – for people who like to annotate with a virtual*

keyboard or by stylus for longhand. 3) Have to get color highlighting/underlining. 4) Device must be faster – turning pages took forever and I really missed being able to skim.

In short, students were very positive about the “reading” aspects of the present crop of e-readers when compared to paper, but felt that the experience of writing and studying could be vastly improved by better input tools, by having color available for highlights (but not necessarily for the page being read), and by allowing a way to skim visually or flip through the readings, in a way that was more analogous to using paper. They felt an e-reader that could accomplish these tasks would be a welcome addition to their lives as students. The administrators of the pilot would add that future devices should also have multiple accessible features to accommodate the needs of all members of the campus community, and to meet the needs of a broad range of users.

Conclusions

Do e-readers save paper?

This study has already focused on the pilot participants’ perceptions of whether or not they conserved paper by trying to do as many course readings on the Kindle as possible. Most of them (94%) said they did use less paper, reducing by as much as 85% the printing they normally would have done in the pilot course. By answering another question on the survey, the students indicated that the pilot course had more readings than their other courses, amounting to slightly over half of their total assigned readings for the semester. In reviewing the printing figures for the semester among pilot participants and other students, it would seem at first glance, that the students were quite accurate in their self-assessments.

Two of the three pilot courses, WWS325 and WWS555a had been previously offered with almost identical readings. The seminar in Roman Religion, CLA546 was a new course, with a substantial reading load, but no earlier point of comparison. Particularly in the case of the graduate seminar WWS555a, it could be assumed that students in past years would have been taking similar courses, with a similar reading load because they tended to be in the same degree programs. Although it is possible to see how many sheets of paper an individual printed over a period of time, it is impossible to know what they printed, or for what purpose, however, it was felt that general conclusions could be drawn, particularly if the amounts printed were significantly different from values extrapolated from past experience.¹⁹

For the two courses for which printing statistics were done, fairly good control groups could be established. WWS325, which had no pilot opt-outs or auditors, compared this year's printing statistics to last year's. In WWS555a, there was both an internal control group (one opt-out and 2 auditors) as well as statistics from a past offering from the course. In WWS555a, the printing statistics extrapolated from the printing done by students in the same course two years ago, would have amounted to 2185 sheets of paper. In fact, non-pilot participants in the course printed on average, 1826 sheets of paper. Pilot participants printed an average of 962.

Similarly, WWS325 students in a past semester, adjusted to the present semester, printed 1508 sheets of paper. Pilot participants printed 762.

More interesting was the accidental fact that another Woodrow Wilson School graduate-level seminar had a high percentage (24%) of students who were also participating in the e-reader pilot. Students in that course printed an average of 1508 sheets of paper. Students who had a Kindle taking the same course printed an average of 570 sheets.²⁰ This suggests that there is a cumulative effect in saving paper when e-readers are used in more than one course.

A summary of the printing statistics is illustrated in this table:

Summary:

<i>Course</i>	<i>Average paper use, Kindle owner</i>	<i>Average paper use, control group</i>	<i>Relative difference</i>
<i>WWS555a</i>	<i>962</i>	<i>1826</i>	<i>53%</i>
<i>WWS325</i>	<i>762</i>	<i>1373*</i>	<i>55%</i>
<i>WWS5xx with 24% enrollment of pilot participants</i>	<i>570</i>	<i>1508</i>	<i>38%**</i>

**extrapolated from Fall '08 usage of 1144 sheets per person, with 20% per annum increase*

*** Kindle users in this class were well below the mean of their pilot peer group in WWS555a, apparently because they used the Kindle in two classes instead of one. There is little else to account for the difference.*

There is no control group for CLA546 because the course was never offered before. The printing data for those netids was not collected.

In the focus groups, it emerged that students were influenced in their printing habits by various considerations. One was conscience. Whether as a result of the e-reader pilot or personal convictions, they had resolved that they should try to reduce their printing. The other factor was the newly imposed printing quotas, which were forcing students to become more aware of printing habits. The third factor was having agreed to try to print as little as possible in the pilot course. Many students took that agreement as a personal challenge, and didn't print at all, even though they would otherwise have thought they had a compelling reason to do so. As no final assessment in any pilot course was directly related to the readings on the Kindle, several remarked that although not printing was inconvenient at times, they knew it would do no harm to their final grade.

When asked about their future habits in printing their course readings, 44% of the participants said they would print less if they had to pay for printing; 25% said they would print up to the allotted quota (for free) but no more, (if they had to pay); 31% said they would print what they needed to print to succeed in class, no matter what the ramifications. Most students in the focus groups agreed that setting quotas on printing was both necessary and fair to other students.

While there seem to be few conclusions about the “green” aspects of e-readers among those studying them—as well as other mobile devices that use hazardous materials in their manufacture—there is a consensus that after some time, e-readers will displace enough paper to offset the carbon footprint of their manufacture and maintenance. An often-quoted report estimates that the carbon emissions caused by the Kindle are offset in a year of average use.²¹ Others have disputed this figure, and estimate rather, that a certain amount of paper books that would otherwise be physically purchased, when purchased wirelessly from a device such as the Kindle, will eventually offset the carbon emissions for manufacturing and recharging the device. The numbers vary. It may be that 30 paperbacks²² do the trick—or perhaps one might distinguish between books purchased at brick and mortar stores (30 of them?) from those ordered from online bookstores (60 of those?).²³ The data involving the component parts and manufacturing process of the Kindle are not well-documented enough to make these statements with confidence.²⁴

A final email to the Kindle pilot participants at Princeton includes a link to Amazon's program for recycling damaged and discarded devices. For our purposes, the fact that using the Kindle in one course could reduce printing for the entire semester by almost 50% (with some inconvenience and discomfort) it

seems hopeful that an e-reader with adequate annotation tools, used judiciously for certain types of course readings, could reduce the amount of paper printed by a much more comfortable margin—comfortable for students, administrators, and for the environment.

Notes:

¹ Many courses at Princeton have readings contained in books students are expected to purchase for that course, as well as other assigned readings placed “on reserve.” Reserve readings tend to be parts of larger works, such as a chapter from a book, an article from a scholarly journal, or a selection from sources that would be hard for students to obtain otherwise, such books that are no longer in print, but are still relevant to scholars.

² Faculty members continue to request reserve items during the semester, so these figures are constantly changing. This result was taken at the end of the first week of the Spring 2010 term. E-reserves typically increase at a greater percentage than paper reserves.

The advantages of e-reserves to students are many. E-reserves aren’t constrained by hours, e-reserves don’t have a line of other readers waiting to borrow them, and e-reserves aren’t dog-eared or covered in other classmates’ notes and highlights. The format also protects the originals of materials that would be difficult for the Library to replace. Since reading reserve materials on a computer screen offered not only the opportunity to read, but also (apparently) to write and annotate the files, it seemed that e-reserves might represent a significant savings in paper. In the past, a student presented with a complex reserve reading, and a two-hour loan period, often resorted to a photocopying as a way to be able to spend more time with the text, and also to capture a private copy for annotation and later reference. While the benefits of e-reserves in terms of convenience and clarity were immediately obvious to students, the assumption that e-reserves would conserve paper was proved wrong. Both paper reserves and e-reserves are among the most frequently photocopied and printed document types on campus.

³ Quotas were established in January, 2010. They are 2100 sheets of paper per fiscal year (July-June) for undergraduates and 3000 sheets per graduate. Computer clusters force duplexing at printers, and offer options to put two pages on each side of one sheet of paper.

⁴ Adobe Systems makes a professional version of Acrobat that is included with the Adobe Creative Suite licensed on many student cluster machines.

⁵ Princeton has an agreement with Adobe Systems that allows students, faculty, and staff to purchase a personal copy of the professional version of Adobe Acrobat at a greatly reduced price, but students and faculty are either unaware of this or uninterested in doing so. There are some free utilities available that allow one to make notes, highlights, and other marks on a PDF document, but they are not in wide use.

⁶ The High Meadows Foundation supports programs in environmental science and policy, environmental sustainability at various institutions and through the work of various organizations. For more information see: <http://www.highmeadowsfoundation.com/>

⁷ Sony was the market pioneer in the field of e-readers, and it had two models available, the PRS-505 and PRS-700. Both had 6" diagonal screens, simple navigation tools, and the PRS-700 had a touch-screen, a stylus for highlighting, and annotation tools via a virtual keyboard. Neither of the Sony reader had a wireless connection at that time. The first version of Amazon's Kindle was currently unavailable for purchase, having sold out in the holiday season of 2008, but the Kindle 2 was expected to be released in early spring of 2009. The Rex Iliad Digital reader had several desirable features, such as the ability to make handwritten notes with a stylus, and a larger screen (10.2" diagonal), but the comparatively short battery life, the small amount of formatted content available for purchase, and the price point of \$859, would have greatly reduced the number of participants in the pilot, as well as limiting the subject matter.

⁸ The Sony readers had native support for PDF documents. The Amazon Kindle later added this feature, but at the time, PDF documents needed to be converted to be read on the Kindle reader.

⁹ The final statistics for the courses were as follows:

WWS325: 2391 pages of purchased reading from books, 3367 pages from books on reserve. 100% were provided in Kindle format.

WWS555a: 857 pages of purchased readings from books; 223 pages of purchased readings from PDF case studies, and 1645 pages of reserve readings in PDF format. 100% were provided in Kindle format, having been converted from PDFs or presented as e-books. A few late additions were sent out as PDFs to student email accounts, and it was their decision to print them or transfer them to their Kindles.

CLA546: 1169 pages of readings from books, and 2250 pages of reserve readings in PDF format. Although only two of the four books required for the course were available in Kindle format (those unavailable owing to U.S. copyright restrictions on these particular editions: both were translations of books that had originally been published in Europe). However, the most critical passages of the unavailable books were offered in PDF format, so that students could do all the essential readings on the Kindle. In this course, most readings were presented as PDFs because of non-western characters or other formatting issues that made conversion difficult.

¹⁰ The guidelines specified the following conditions:

- There is no obligation to use the Kindle in the course. A student may also opt out of the pilot at any time and use hardcopy readings instead. If a student opts out of the pilot after accepting a Kindle, the device, its USB cord, AC converter, and protective cover must be returned.
- Auditors are not included in the pilot – the class must be taken for a grade in order for the student to be given a Kindle for course use. Auditors are welcome to participate in a pilot course using traditional readings, if auditing is allowed for that course.
- Students may keep the Kindle when they complete the course, provided they make a good-faith effort to do all digital course readings on the Kindle, and refrain from relying upon hard copies of the digitized material. (In some

cases, required readings for the course are not available in an e-reader format and will be purchased by or provided to the student in the customary way.)

- If after best efforts, a student decides that using the Kindle for course work is not in his or her best interest, he or she may opt out of the pilot. Traditional reading material will be provided for the student to complete the course. The Kindle and its accessories mentioned above must be returned.

¹¹ It is an advertised feature of the Kindle DX that it trims the margins automatically when documents are displayed, but for some reason this did not work for documents Princeton scanned for e-reserves.

¹² “A Failure, Poor, Fair, Good, Very Good, Excellent, Delightful.” Each is rated from 1 to 7, 1 being “A Failure” and 7 being “Delightful.” The top ranking score, battery life, was 5.35, which means most people thought the feature was somewhere between “Very Good” and “Excellent;” the lowest score, annotating text, was 2.35, or somewhere between “Fair” and “Good.” As the semester progressed, criticisms about annotation became more specific, but the midterm results showed the following ranking:

feature	ranking	notes
Battery life	5.35	
Text resolution for reading	5.18	
Internal memory for storing documents/books	5.13	
Screen size of the Kindle DX	5.13	
Overall weight of the Kindle	5.03	
Physical durability	5.00	
Buying books/content at the Kindle store	4.67	
Text to speech	4.44	
Dictionary function	4.29	
Transferring PDF and other documents to your Kindle	4.26	
Searching for books/content at the Kindle store	4.22	
Image resolution for data tables	4.06	
Image resolution for math/scientific formulas	4.00	Only 9 participants answered this query, as it was irrelevant to pilot courses
Image resolution for graphics/pictures	3.74	
Bookmarks	3.72	

Searching for specific content within a book/document	3.38	
Navigating between books / documents on my Kindle	3.30	
Searching my notes and bookmarks	3.18	
Footnotes	3.10	
The Kindle web browser	3.04	
Navigating within a book / document	2.92	
Highlighting text	2.84	
The Kindle keyboard	2.64	
Annotating text	2.31	

¹³ According to one student:

I thought the highlighting function was okay although I had some difficulty with it... I think sometimes it would highlight a lot more than I wanted it to — it would start to go crazy and go all over the place and that was not necessarily that useful because I'm not sure why anyone would highlight 3 pages of text. At that point why are you highlighting?

¹⁴ Rather, course books available for purchase in the Amazon store. Pilot participants were given these books for free, unless they decided to buy books for other courses or for pleasure reading.

¹⁵ This service is available at <http://kindle.amazon.com>

¹⁶ Results of the reading assessment, as it changed from the midterm to the final assessment. There were five points of comparison: “Much Worse;” “Worse;” “About the Same;” “Better;” and “Much Better.”

On this scale, “Much Worse” is equal to 1, and “Much Better” is equal to 5. “About the Same” would then be a 3. Even though most students answered “About the Same” there was a slight shift towards “Worse” by the end of the pilot.

Question: How did the Kindle change your learning experience in the pilot course?

	Midterm mean score	Final mean score
Reading quality	3.11	2.78
Reading quantity	3.16	2.81
Reading speed	2.97	2.61
Retention	2.76	2.49

Learning and comprehension	2.84	2.53
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¹⁷ The process of getting to a location in a text involves hitting the MENU button on the Kindle, navigating to the “Go to Location. . .” menu item, clicking on it, and then typing in the location number. On the Kindle DX, typing numbers also involves holding down the alt key on the Kindle because the top line of the QWERTY keyboard has number and letter keys conflated. If the numbers had their own keys, and/or the Kindle assumed that beginning to type numbers might mean that you want to jump to a location, (a similar shortcut is provided for navigating pages on the Kindle DX HOME page), the navigation within a text would be greatly improved.

¹⁸ Another downside to experimenting with very new technology was experienced by a student travelling in Israel. The security guards at the Tel Aviv airport had never seen an e-reader before and confiscated it. Since the student was in the course on the history of diplomacy in the Middle East, he assumed the content of his Kindle had aroused suspicion. Instead:

They said they needed "to run more tests" and would put it on the next flight. They sealed it in a box in front of me, which was surprising me because I expected them to copy everything on the device, but they said they didn't need access to it directly. I had to fill out a lost bag form and got to skip the check-in line. The Kindle made it [home] a few days later when Continental delivered it to my door.

The Kindles used in this particular class may have been the most-travelled and apparently, most suspicious, group of e-readers in the U.S. at that time.

¹⁹ Printing has increased steadily since 2001, at a rate of 20% per year.

²⁰ One student in this course had requested that PDF readings for this course be adapted for his Kindle. He shared the files with the fellow Kindle owners in the second class. The Kindle owners who participated in both this seminar AND the pilot seminar were among the most conservative paper users in the entire pilot.

²¹ Only members of Cleantech can read this report, but it is summarized in several places on the web. On site says:

The report indicates that, on average, the carbon emitted in the lifecycle of a Kindle is fully offset after the first year of use. The report, authored by Emma Ritch, states: "Any additional years of use result in net carbon savings, equivalent to an average of 168 kg of CO₂ per year (the emissions produced in the manufacture and distribution of 22.5 books)." Source: <http://cleantech.com/news/4867/cleantech-group-finds-positive-envi>

²² <http://autoautism.blogspot.com/2008/02/lcac-kindle-vs-pulp-army.html>

²³ <http://ecolibris.blogspot.com/2009/09/new-report-finds-kindle-greener-than.html>

²⁴ There is a lot of conjecture, but little data, about Kindle components. See:

http://blogs.hbr.org/hbr/restoring-american-competitiveness/2009/10/the-us-cant-manufacture-the-ki.html?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%253A+harvardbusiness+%28HarvardBusiness.org%29