



An Evaluation of the Functionality and Accessibility of E-Readers for Individuals with Print Disabilities: Phase One

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Abstract:

This study explores the functionality and usability of e-readers, including the Apple iPad 2G, Amazon's Kindle Fire, and Barnes and Noble's NOOK Table. The study is being conducted in two phases to fully explore and examine accessibility features and functions of the e-reader devices and their applicability to individuals with print disabilities. Phase One established a baseline of understanding about what features are available and how the features work on the e-readers. Phase Two will analyze the same features and functions as employed by individuals with visual impairment and who use adaptive technologies to engage with written works, including books, magazines, and newspapers. Phase One concludes that in their current iterations each of the three e-readers has limitations and may not be considered universally accessible.

Introduction

In 2011, the Association of American Publishers ranked electronic books (e-books) as the top sellers among trade categories for all books.¹ In part this was due to the surge in the availability of affordable e-reader devices, including Apple's iPad, Amazon's Kindle, and Barnes and Noble's NOOK. These second generation e-readers featured E-ink, resembling print pages, along with color images, longer battery life, and some voice-over options. Magazines and illustrated books were created in electronic formats readable on the second

¹ Andi Sporkin. 2011. "Popularity of Books in Digital Platforms Continues to Grow, According to AAP Publishers February 2011 Sales Report." Association of American Publishers. Retrieved from <http://www.publishers.org/press/30/> on January 27, 2012.

generation devices, making a much wider range of print resources available in digital formats.

The third iteration of e-readers, in the form of tablets similar to the iPad, hit the consumer marketplace in late 2011 and early 2012 with better than expected sales and high visibility. Similar to earlier devices, the tablets are affordable, portable, and offer numerous applications for computing and social networking. Along with applications for e-reading, the tablets allow users to watch movies, listen to audio, and play games. The Pew Research Center reports that tablet ownership nearly doubled during the 2011 winter holiday season, and that 29% of American adults own at least one e-reader device.²

Public and academic libraries and the primary/secondary educational system in the United States hurried to embrace the new technologies, beginning in 2009 and 2010, to complement access to books and other resources and meet the demands of their constituents. Many institutions had the notion that e-books would be a low-cost solution to spiraling costs of library books, textbooks, and journals – particularly for texts that become outdated quickly – and address the increasing shortage of shelf space in physical library buildings. Several libraries and school systems, such as East Carolina University (NC), the Pasco-Hernando School District (FL), and Case Western Reserve University (OH), undertook pilot programs to test the viability of using e-readers and iPads for classroom activities.

However, numerous organizations, including the National Federation of the Blind (NFB) and the American Council of the Blind (ACB), representing individuals with print disabilities claimed that e-readers, including the third-generation devices, do not meet requirements for accessibility as defined by the Americans with Disabilities Act of 1990 and deny equitable access to digital resources.³ The U.S. Department of Justice (DOJ), on behalf of the NFB and ACB, sued four academic institutions for requiring the use of the Kindle DX as part of a pilot test for electronic textbooks, resulting in an agreement with the academic institutions to not require e-readers for students until such time as accessibility and functionality have improved for students experiencing loss of vision.⁴ As recently as May 2012, the NFB assisted public library patrons in Philadelphia to file suit against the Free Library of Philadelphia, asserting that Barnes and Noble's NOOK Simple Touch e-reader is inaccessible to blind patrons, denying these library users equal access to resources.⁵ Each of the lawsuits claims that the public institution's decision to purchase the inaccessible e-readers violates Section 504 of the Rehabilitation Act of 1973 and Title II of the Americans with Disabilities Act.

Due in part to the rapid development and deployment of the e-readers limited studies have been conducted on the usability and functionality of the devices by individuals with print disabilities (i.e., low vision, no vision, dyslexia, etc.) particularly within library and educational environments. Phase One of this study explores the functions and features of three popular e-reading devices to determine the level of accessibility for individuals with print disabilities and the viability of their use within academic settings and libraries.

² Lee Rainie. 2012. "Tablet and E-reader Ownership Nearly Doubled over the Holiday Gift-Giving Period." Pew Internet & American Life Project. Retrieved from <http://libraries.pewinternet.org/2012/01/23/tablet-and-e-book-reader-ownership-nearly-double-over-the-holiday-gift-giving-period/> on April 14, 2012.

³ See for example, Don Reisinger. 2009. "Universities Reject Kindle over Inaccessibility for the Blind." CNET. Retrieved from http://news.cnet.com/8301-17938_105-10396177-1.html on January 27, 2012.

⁴ Grant Gross. 2010. "Kindle in Classroom Hurts Blind Students, DOJ Warns." Computer World. Retrieved from http://www.computerworld.com/s/article/9144418/Kindle_in_classroom_hurts_blind_students_DOJ_warns?taxonomyId=13&pageNumber=1 on April 14, 2012.

⁵ Meredith Schwartz. (2012) "Blind Patrons Sue Philly Library for Loaning Inaccessible Nooks." Library Journal. Retrieved from <http://lj.libraryjournal.com/2012/05/industry-news/blind-patrons-sue-philly-library-for-loaning-inaccessible-nooks/> on May 14, 2012.

Literature Review

The research on the use and functionality of e-readers falls into three broad categories: product comparison between competing devices; evaluation and user preferences, including user behaviors and attitudes; and, design of e-readers and e-books. Product comparison studies examine specific features of each device. Ralph Scott (2010) examined the iPad (Apple), Kindle (Amazon.com), and the NOOK (Barnes & Noble) for consideration as part of a potential e-reader circulation program at East Carolina University. Among other features, Scott measured issues related to Wi-Fi access, availability of USB ports, price and availability. His assessment indicated that the iPad was far superior to the other products due in part to its availability of images, audio, and video despite the price of the iPad being much higher than the other devices (\$500 per unit compared to \$199 for the Kindle or the NOOK).⁶

Several studies explore user experiences and functionality of e-reader devices. Gibson and Gibb (2011), for example, found that while many of the issues related to the first-generation of e-readers were addressed, additional challenges were expressed by users, including functionality of turning electronic pages and zooming of text for ease in reading. Users also reported that learning to use the e-readers was not intuitive and involved a steep learning curve.⁷ Shelburne (2009) and Nelson (2008) both discovered that e-book usage was on the rise in academic libraries, but that functionality of e-readers was not problem-free. The users wanted greater flexibility in searching within the text of an e-book and they cited poor quality in the screen displays of text. However, both of these studies indicated that e-books and e-readers are increasing in demand among academic library users.⁸

Much of the research on e-reader devices as used by consumers with print disabilities falls into the category of product comparison. Amy Mason (2012), for example, compares several e-readers for their accessibility by individuals with sight impairments.⁹ She examined several e-readers currently available and found many lacking in accessibility due to 1) the highly visual nature of most e-reader interfaces, and 2) the limitations of digital rights management that prevents text from being read aloud. In a similar vein Petri (2012) and Burton (2011) each examine the functional criteria for accessibility of e-books and e-readers, and make recommendations for design improvements to meet the needs of individuals with vision loss.¹⁰ Petri and Burton identified many of the same types of challenges that Mason discussed. Each of these assessments point to specific features which are not accessible according to the United States Department of Education guidelines.¹¹

⁶ Ralph Scott. (2010). "An iPad, a Nook and a Kindle." *North Carolina Libraries* 68 (Summer 2010), 29-30.

⁷ Chris Gibson and Forbes Gibb. 2011. "An Evaluation of Second-generation Ebook Readers." *The Electronic Library* 29(3), 303-319.

⁸ See for example, Wendy Allen Shelburne. 2009. "E-book Usage in an Academic Library: User Attitudes and Behaviors." *Library Collections, Acquisitions, & Technical Services* 33, 59-72; or, Mark R. Nelson. 2008. "E-books in Higher Education: Nearing the End of the Era of Hype?" *Educause Review* (March/April 2008), 40-56.

⁹ Amy Mason. 2012. "Mainstream Access to E-books – What Works, What Doesn't, and What Is Still Unclear." *Braille Monitor* 55(1) (January 2012). Retrieved from <http://nfb.org/images/nfb/publications/bm/bm12/bm1201/bm120tc.htm> on April 11, 2012

¹⁰ See for example, Ken Petri. 2012. "Supplemental: Accessibility Issues in E-books and E-book Readers." In *No Shelf Required 2: Use and Management of Electronic Books*. Sue Polanka, ed. Chicago, IL: ALA Publications. Retrieved from <http://wac.osu.edu/ebooks-access-overview> on April 11, 2012; or, Darren Burton. 2011. "Product Evaluations: Kindle for PC with Accessibility Plugin." *AccessWorld* 12(5) (May 2011). Retrieved from <http://www.afb.org/afbpress/pub.asp?DocID=aw120506> on April 11, 2012.

¹¹ United States Department of Education. "Frequently Asked Questions about the June 29, 2010, Dear Colleague Letter." Retrieved from <http://www2.ed.gov/about/offices/list/ocr/docs/dcl-ebook-faq-201105.html> on May 14, 2012.

Definitions

As e-book readers began emerging, Wilson (2001) identified three distinct types of e-readers available in the consumer marketplace designed to allow users to read books in formats other than bound print:

1. Dedicated e-book readers, such as the Rocket eBook Reader (NuvoMedia) and the SoftBook (SoftBook Press);
2. PDAs and Pocket PCs with software for downloading and reading books; and,
3. Hybrid devices, such as the eBookMan (Franklin) which combined some functions of PDAs and Pocket PCs with dedicated e-reader functions.¹²

With the launching of Amazon's Kindle and similar products, such as the Sony Reader, and the ongoing development of hardware and software, e-books and e-readers are now readily available on a more extensive range of products, including desktop PCs, laptops, smart phones and iPhones, as well as dedicated and hybrid devices. Further complicating the issue are the numerous applications which can be downloaded to devices, allowing the user to access books across multiple devices (i.e., ability to pick up and read a single book on one's Kindle Fire, iPad Kindle application, and Android's Kindle application as well as a laptop or desktop computer).

The issue at hand is less about what an e-reader is, and more about what it means for an e-reader to be accessible to an individual who is blind, has low vision, or another print disability. In other words a user with visual impairments must have the ability to navigate and interact with the materials and resources, accessing the same information available to a sighted individual. The United States Department of Education Office of Civil Rights applies a functional definition of accessibility that states:

Students [who are blind or have low vision] must be afforded the same opportunity to acquire the same information, engage in the same interactions, and enjoy the same services as sighted students.¹³

The definition applies to e-readers and emerging technologies as well as more traditional print materials and textbooks. In the United States, the American Library Association (ALA) and the Institute for Museum and Library Services (IMLS) follow similar guidelines for accessibility of information.

Using a more direct definition for this study, accessibility means the ability of an individual with print disabilities to navigate and use e-reader devices through built-in universal access technologies. If the device does not include robust built-in accessibility technologies, the user must have the ability for equal access to information through modification or accommodation through adaptive technologies, such as text-to-speech screen readers or Braille translators.

¹² Ruth Wilson. (2001). "Evolution of Portable Electronic Books." *Ariadne* (29) (October 2, 2001). Retrieved from <http://ariadne.ac.uk/issue29/wilson> on May 14, 2012.

¹³ United States Department of Education. "Frequently Asked Questions about the June 29, 2010, Dear Colleague Letter," pg. 2. Retrieved from <http://www2.ed.gov/about/offices/list/ocr/docs/dcl-ebook-faq-201105.html> on May 14, 2012.

The user must be able to turn on, manipulate, locate, and understand the downloaded reading materials.

Methodology

In order to begin to address the functionality and accessibility of e-readers for use in academic institutions and libraries, this study examines the usability and universal design aspects of three popular e-readers: Apple's iPad 2, Amazon's Kindle Fire, and Barnes and Noble's NOOK Tablet. These devices were selected for their ready availability and popularity in the consumer market. Usability analysis was employed to provide opportunities for groups of users to directly interact with the e-reader devices and assess the functions and features.

Specifically the project is designed to address the following research questions:

RQ1: Which devices are preferred by users with print disabilities?

RQ2: Which devices deliver the best functionality for users with print disabilities?

RQ3: Which devices deliver the best options for adaptability and functionality for use with adaptive technologies (i.e., refreshable Braille readers, JAWS, and/or ZoomText)?

This project explores the design and functions of the e-readers for individuals with print disabilities, including assessment of built-in accessibility features, such as text zooming and voice-over. The overarching objective of the usability analysis is to gain a thorough understanding of how the devices are intended to work and to identify any possible limitations in functionality related to accessibility.

The usability analysis was conducted in two phases. Phase One established a baseline understanding of how the e-reader devices work and what types of built-in accessible features each provides to users. Phase Two, currently underway, examines the accessibility of the devices in conjunction with the use of adaptive technologies and by users with print disabilities.

Rubin and Chisnell (2008) recommend at least four or five participants per usability test in order to expose the maximum number of usability issues, but a minimum of eight in order to not overlook additional usability problems.¹⁴ Participants for Phase One of the study were drawn from two groups: 1) the general student population enrolled in classes in a school of library and information science (n = 4); and, 2) a group of students from the same LIS school enrolled in an IMLS grant-funded program in which they are learning to work with technologies and promote a philosophy of inclusivity and universal access (n = 4).¹⁵ Students were invited to participate in the usability testing and to provide feedback on the design and functionality of the devices.

The study intentionally began with sighted students in order to gain a full understanding of how each e-reader device worked. Each participant explored functions of the devices,

¹⁴ Jeffrey Rubin and Dana Chisnell. 2008. *Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests*. 2nd ed. Indianapolis, IN: Wiley Publishing.

¹⁵ Project ALFA is funded through an IMLS Laura Bush 21st Century Librarian grant. The purpose of the grant is to educate a new generation of information professionals to promote a philosophy of inclusivity through universal access. As part of their studies, the students learn how to work information and communication technologies to meet the needs of individuals with mild to moderate disabilities, who may have physiological challenges due to aging, or who may have disabilities as defined by the Americans with Disabilities Act.

including the basics of powering up the readers and navigating through the numerous screens, locating the settings for customizing the reading experience, and finding and accessing the reading materials. It was critical to identify the potential strengths and weaknesses of the equipment and what the challenges might be for individuals with print disabilities. The major issue that arose was determining whether an individual with low or no vision would be able to use the e-readers unaided.

Each e-reader was pre-loaded with the same reading materials, including a popular novel, an anthology of Jules Verne stories, and two newspapers. This provided a consistent set of resources across the three operating platforms, and enabled participants to test equivalent materials. The books and newspapers were acquired through the individual e-reader stores to ensure that they downloaded without difficulty and were compatible with the intended devices.

The usability analysis consisted of a series of tasks for exploring the e-reader devices. Each student completed an initial questionnaire to gather demographic information and to determine prior experience with e-readers and more generally with information and communication technologies (ICTs). As participants worked through the tasks they rated and ranked each e-reader on a variety of functions and features using a Likert scale (1- Highly Disagree; 2- Disagree; 3- Neither Agree Nor Disagree; 4-Agree; 5- Highly Agree) and were provided with opportunities for open-ended responses to guiding questions. The usability sessions ended with an exit interview, focusing on advantages/disadvantages of e-reader usage.

Discussion

Responses to the initial questionnaire indicated that as a whole the group of students was familiar with and owned a range of ICTs, including cell phones (100%) and iPods/mp3 players (75%). Each of the students owned a computing device – either a laptop or desktop computer. They use their ICT devices for a variety of purposes: studying/classwork (75%); research (75%); email (87.5%); and communication with family, friends, and colleagues (100%). By comparison only three of the students (37.5%) owned e-reader devices, split evenly among the three devices being analyzed (1 Kindle, 1 NOOK, and one iPad). Two students stated that they had no intention of purchasing an e-reader or downloading an e-reader application to their other ICT devices. One student clearly stated, “I prefer print to all e-readers.” Only one participant expressed a preference for reading digital or electronic texts over printed materials.

The analysis of the e-readers was broken into three distinct areas: 1) physicality of the e-reader; 2) overall functionality of the e-reader; and, 3) availability of accessibility or universal access features. Features and functions were ranked on a Likert scale: Highly Disagree (1) to Highly Agree (5).

Physicality of the e-reader. Basic features are critical to not only sighted users, but need to be comfortable to hold and manipulate unaided by individuals with disabilities in order to provide equal accessibility. The participants felt that e-readers were adequately sized for the intended purpose of reading, not much larger in dimension than a standard trade paperback book or hard cover book. They found the visual images and screens to be clear and readable. The weight of the e-readers, however, was cited as being too heavy to hold comfortably; the Kindle Fire in particular was identified by three students as being uncomfortably heavy. One participant indicated that the Kindle Fire, which weighs 14.6 ounces or 413 grams, felt

heavier than a traditional hardcover book and would be a problem to hold up for extended periods for reading. This could be a concern for individuals who have limited mobility or who may need to hold reading materials close to their line of vision.

Another concern that participants expressed was in locating the power buttons to turn the devices on/off, scoring an overall average of 3.75 on the Likert scale. The iPad ranked the lowest among the three devices with an average score of 3.25 for ease in locating the button and powering off the equipment. The button on the iPad was not immediately observable, located along an edge of the device, and lacked a strong tactile component. The NOOK Tablet was ranked the most favorably for locating and using the power switches. Being unable to see or feel power buttons inhibits an individual's ability to perform the most basic of functions with the device.

By comparison the participants found the portability of the e-readers and the ability to store large amounts of materials to be positive features of the e-readers. Both portability and storage capabilities received an average rating of 4.38. One respondent indicated that in general the devices "can store more books and you can take with you anywhere like vacation." The availability of "many different types of reading materials and music" was also a positive.

Overall functionality of e-readers. The overall functionality of the e-reader considers the ease in which the device can be navigated. The iPad, the Kindle Fire, and the NOOK Tablet use touch screen technology for accessing applications, interacting with the keyboard, and manipulating e-books. Touch is also used to change and customize settings. The participants ranked the overall touch screen experience across e-readers very highly with an average rating of 4.29. They were able to tap, slide, and touch the screen with ease to turn pages within the reading materials and to move between applications. However, they noted the highly visual nature of the screen with colors and images.

The ability to find the settings to change and customize the features of the e-readers ranked low across all devices with an average rating of 2.33, especially when attempting to locate the settings to activate the universal access functions, such as voice-over or text-zooming. Several participants commented that the link to settings was not easy to identify or locate and that it needs to be more obvious on the entry screen – larger or more centrally positioned where an individual who needs the functions can find them quickly and easily. The NOOK Tablet received the lowest ranking for the ability to locate settings (1.57 compared to 1.89 for the Kindle Fire and 3.38 for the iPad). The inability to quickly and easily locate the link to general settings where the universal accessibility functions will be found may cause significant challenges for an individual with print disabilities in successfully and satisfactorily using any of these three e-readers.

Availability of universal access or accessibility features. As part of the tasks for the usability analysis, participants were instructed to examine the built-in accessibility features included with each e-reader designed specifically for individuals with visual impairments and other print disabilities. They began by exploring the features related to text and print, such as the ability to change text size and typestyle for ease in reading. Finding the functions to work with the text on the screen appeared to be easy for the participants. They were in agreement that each of the e-readers provided options for 1) increasing the size of the font; 2) changing the typeface between serif and sans serif fonts; 3) changing the color of the font; 4) changing the page contrast (i.e., white text on dark background, dark text on light background); and 5) changing the brightness of the screen for ease in reading. The iPad, Kindle Fire, and NOOK

Tablet received equivalent ratings for their text accessibility functions with none of them standing out as being exceptional.

The three e-readers used in this study are highly visual medium, replete with color and images, creating a difficult environment for individuals with print disabilities. The stand-out was in the inclusion of voice-over feature included on the iPad that reads the screen aloud, helping an individual with print disabilities navigate through the application icons, buttons and screens. Neither the Kindle Fire nor the NOOK Tablet offered the voice-over feature, rendering the e-readers inaccessible to individuals with low or no vision. Each of the students indicated that this was a drawback for use by individuals with visual impairments with one reporting disappointment “that all this technology does little for persons with sight related disabilities.”

Conclusions

Without accessibility features, including voice-over, these e-readers are rendered inaccessible for individuals with print disabilities. The Kindle Fire and the NOOK Tablet offer limited functionality for persons who have some vision and the ability to manipulate the text on the screen may aid individuals with learning disabilities or with dyslexia. However, Kindle Fire and NOOK Tablet are not accessible to individuals who are blind; these individuals would require the assistance of a sighted person to manipulate and navigate. The iPad is the one product analyzed in this study that offers a broader range of universal access features to users, but it also has limitations in locating the appropriate links to the settings to customize the accessibility preferences. The study participants concurred that e-readers offer the potential to overcome access barriers if the functionality can be improved, but in the current iterations the devices lack universal access.

Understanding the strengths and weaknesses of the three e-readers provides a baseline of knowledge in approaching the second phase of the study. The next step is to have individuals with print disabilities undergo a similar process of usability analysis to determine whether the weaknesses the sighted students identified can be overcome through the use of adaptive technologies. Each of the three e-readers has the capability to be attached to USB ports, which Braille translators and screen readers use to connect to computers and other portable devices. The e-readers will be tested with the adaptive technologies and using the same series of tasks and questionnaires employed in Phase One.

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