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Junior Tidal

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ARTICLE

One Site to Rule Them All, Redux: The Second Round of Usability Testing of a Responsively Designed Web Site

Junior Tidal

Ursula C. Schwerin Library, New York City College of Technology, City University of New York, Brooklyn, New York, USA

ABSTRACT

This article examines the usability testing of a responsively redesigned library Web site. Responsive design provides a unified user experience regardless of the device used to view a site. The study's aim is twofold: to determine if the responsively designed site and its external online services support users' information seeking needs, and to discover if there is a singular experience across different devices. A cognitive walkthrough was the main testing instrument used in gathering input. Over two rounds of testing, students of various class years and technological skill from the New York City of Technology (City Tech), CUNY participated in the study. The first round of testing for this usability study on the library Web site was previously documented (Tidal 2015). This article presents the findings and comparisons between the first and second round of usability testing. The study found not only numerous improvements that could enhance the library Web site, but also the lack of a unified experience between tablet, smartphone, and desktop users, despite using a responsive design. Smartphone users were at a disadvantage in utilizing library resources. The study also found there was a significant usability impact in using a mobile-optimized discovery tool among users in comparison to its Web OPAC predecessor.

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Introduction

Based on an examination of analytics data and technological trends, there has been an increase in the number of users visiting the Ursula C. Schwerin Library's Web site using mobile devices. These devices include smartphones, tablet computers, and e-readers. In order to accommodate these users, a responsively designed Web site was developed in-house. A usability test was then conducted to specifically look at how users with different types of devices utilize the library's Web site.

CONTACT Junior Tidal jtidal@citytech.cuny.edu Ursula C. Schwerin Library, New York City College of Technology, City University of New York, 300 Jay St., Brooklyn, NY 11201, USA.

Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/wjwl.

The Ursula C. Schwerin Library serves City Tech's community of 1,700 full- and part-time faculty along with over 17,000 students. According to a study by the Pew Internet Research Center, young adults, minorities, and low-income Americans are more likely to be dependent on their smartphone for Internet access (Anderson 2015). Students at City Tech match these demographics, as 43 percent of students were born outside of the United States, more than 30 percent identify as either African-American or Hispanic, and 58 percent of students are from a household where the income is less than $30,000.

Before this study, the library's online presence was maintained using the Drupal 6 (D6) content management system (CMS), a modular, open source system where content is directly edited through the browser. The site gave users access to the library's CUNY-wide catalog as well as access to numerous electronic databases. The site also contained research guides housed on an installation of MediaWiki CMS, and the library's blog and newsletter powered by WordPress.

A working prototype of the site was hosted on an Amazon cloud server. This prototype employed an upgraded CMS utilizing Drupal 7 (D7) paired with a Bootstrap theme. Bootstrap is a popular Web framework. Created by two developers from Twitter, it was selected due to its rapid deployment, expansive library of form interface widgets, and out-of-the-box responsive design.

Responsive design is a Web design philosophy in which Web page layouts adapt to the width of the screen viewing the site. This is accomplished through cascading style sheets (CSS) declarations and JavaScript, which are provided in the Bootstrap library. In essence, the Web page "responds" to the size of a user's screen, where content either expands or narrows.

One feature of responsive design is the inclusion of a "hamburger" menu, in which navigation is collapsed into a single button identified by three horizontal parallel lines. This hides the menu so the screen is not filled with numerous menu items and places visual emphasis on the content of the page. This solution is ideal for mobile devices as screen real estate is limited, and navigation menus can clutter smaller screens.

Responsive design also utilizes a "grid" system, where a Web page is divided up by a number of invisible columns (Bootstrap uses twelve). Content is stacked vertically and horizontally, so that content is pushed at the top depending on the screen width, or viewport, of the device rending the Web page. Screens with a smaller viewport, such as a smartphone, will show only a few columns, whereas the larger screen size of a workstation will show all columns.

Many academic libraries have adopted responsive design to support increasing numbers of mobile users. Not only are responsive sites useful for a variety of users, developers can easily update a single site to meet accessibility criteria instead of multiple ones (Rempel and Bridges 2013). Responsive design also opens the opportunity to promote mobile services and offerings (Kim 2013).

The previous D6 installation was not mobile optimized and was supplemented with a separate D7 mobile site. The first round of testing using the prototype was

conducted in fall 2014 (Tidal 2015). After testing, a working Web site (https://library.citytech.cuny.edu) went live in spring 2015. This Web site incorporated modifications based on this first round of testing. A second round of testing was conducted during fall 2015. Since the redesigned site went live and incorporated responsive design, the existing separate mobile site was decommissioned. An image of the library's homepage view from a desktop and smartphone can be seen in Figures 1 and 2, respectively.

There were two objectives in this research project. The first objective was to determine if a responsively designed library Web site and its online services could support students' research needs. The second was to examine if there was a consistent user experience when visiting the library's redesigned Web site across different device types. Different measurement tools were used to evaluate these objectives, including a pretesting screening survey, a task-oriented usability test, and a post-testing survey.

Literature review

Usability testing is not new to libraries. Everything from discovery tools (Emanuel 2011; Fagan et al. 2012), LibGuides (Sonsteby and DeJonghe 2013), site redesigns (Becker and Yanotta 2013), and electronic resources (Fry and Rich 2011) have been evaluated through usability testing. This type of testing can be used to

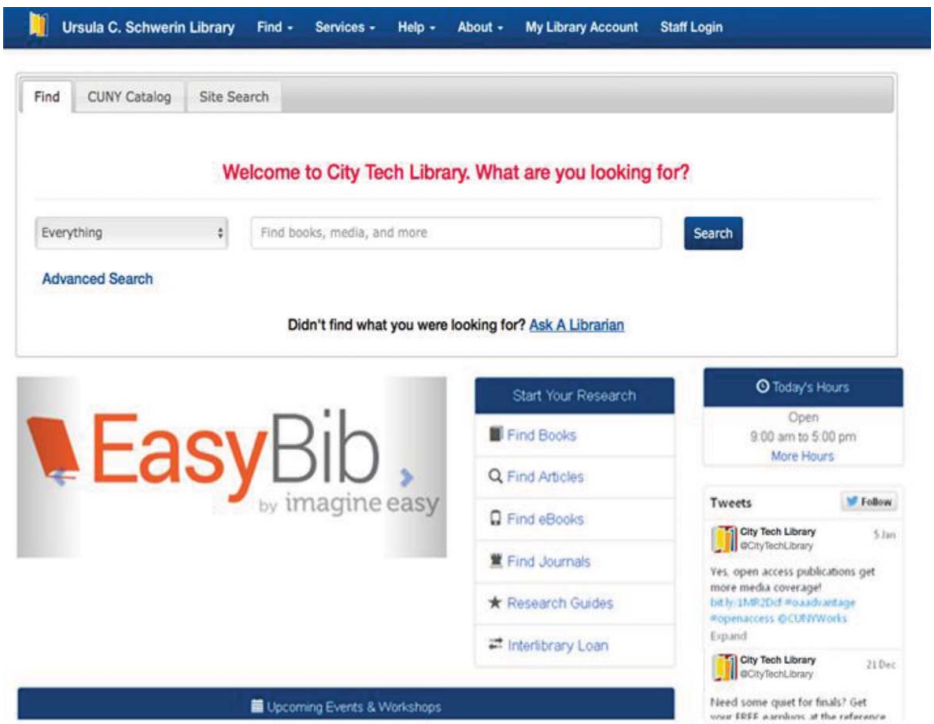

Figure 1. The Ursula C. Schwerin Library homepage, desktop view.

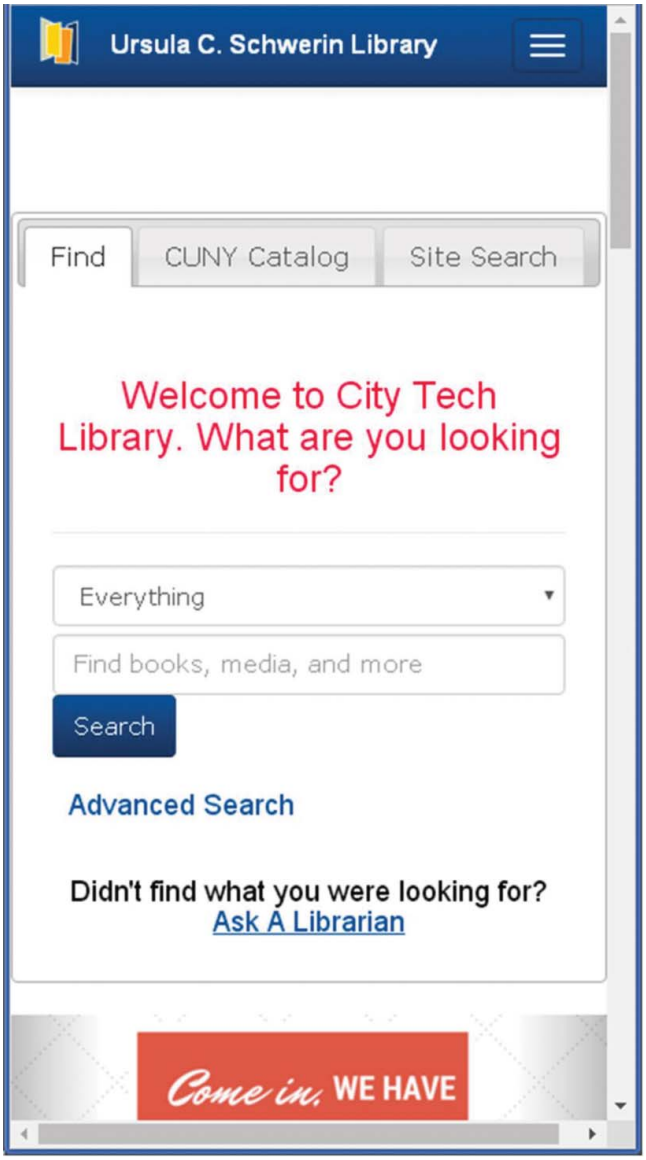

Figure 2. Library homepage responsively designed to fit on a smartphone viewport. Note the hamburger menu in the corner.

pinpoint differences among users. For example, Turner (2011) examined the differences of librarians' and students' mental models and how this impacts their interaction with online library tools. As useful as usability testing can be to improve library online services, it can be difficult to sustain. Unfortunately, not many libraries can commit to frequent usability studies due to the significant amount of time required (Chow, Bridges, and Commander 2014).

Studies of library Web site mobile usability testing are emerging, stressing important factors that benefit library patrons. Mobile usability testing is important,

since "mobile layouts may not fit the needs of your users" (Travis 2011). Users find library Web sites more usable when optimized for mobile devices in comparison to non-optimized sites (Yeh and Fontenelle 2012). Smaller screens can contribute to usability problems, since there are more ways for users to fail a task (Budiu 2014). Simplicity, satisfaction, and trust can be earned when users interact with mobile interface with high usability (Lee et al. 2015). In evaluating the library Web sites of the Orbis Cascade Alliance, Evelhoch noted that mobile library Web sites should scale to "a user-friendly view on mobile devices" (2016, 116).

The process of conducting a test must be considered when evaluating a library Web site's usability. Unlike desktop machines, there are numerous devices that can support the mobile Web, including handheld gaming consoles, e-readers, tablet computers, and smartphones. Griggs, Bridges, and Rempel (2009) noted that identifying device families of users narrows the range of testing devices required in a study. Mobile testing also presents the challenge of where to conduct a test. Mobile devices can access the Internet anywhere and at any time, so long as there is a cellular or wireless network to connect to. Network availability can create obstacles for conducting an accurate usability test. Environmental factors, such as auditory, social, and visual distractions, can impact the test (Tsiaousis and Giaglis 2008).

Mobile usability has also spurred discussions on how mobile services are evaluated. Various models have been constructed to acknowledge cognitive load (Harrison, Flood, and Duce 2013), age (Wagner, Hassanein, and Head 2014), contextual factors (Baharuddin, Singh, and Razali 2013), and learning (Taharim et al. 2013). Usability models have also been proposed specifically for mobile gaming (Engl and Nacke 2013; Hussain et al. 2015). Despite these recent models, heuristic evaluations of Web sites, or cognitive walkthroughs, are still commonly used in evaluating mobile library Web sites.

Methods

Participant and device selection

Participants were recruited using social media, paper flyers, e-mail, and announcements on electronic displays within the library. Participation was open to all City Tech students and faculty, yet only students responded. As an incentive, students were given $5 Amazon gift cards. Equipment and subject fees were acquired through a PSC-CUNY grant. All testing procedures were approved through the City Tech Institutional Review Board (IRB). The first round of testing was conducted during the fall 2014 semester, and the second round was conducted during the spring 2015 semester.

This usability study consisted of a screening survey, a task analysis, and a post-test survey (Tidal 2015). The online screening survey was distributed to the 90 potential participants who initially expressed interest in the research study. The screening survey was used to determine what devices participants were familiar

with. It was essential for participants to use devices they were accustomed to, so as not to taint the usability of the Web site with the experience of using an unknown tablet or phone. Not only were the results of the screening tool used to pair users with their preferred device, but also contact information was collected to set up research appointments.

Despite social media efforts, in-class announcements, mass e-mails, and a $5-dollar gift certificate for Amazon.com enticing users, it was difficult to find 90 participants for the usability test. Only twenty students responded to the call for participants after taking the screening survey. Other problems arose that hindered testing. Students would schedule a time to conduct the research study and would either not show up or cancel at the last minute. Similar to the protocol study that Pendell and Bowman (2012) conducted, if a participant did not respond or show up to a research appointment request, the next available participant with the same device preference was contacted.

This low participation rate reframed the test such that users were divided by device type rather than a specific model. Initially, the participant pool was made up of five participants using nine different devices, for a total of twenty users (see Table 1). It is common in usability testing to use a sample size of five users, so this number of users per device type provided sufficient baseline observations (Nielsen 2000). The goal had been to have a total of 90 participants involved over two rounds of testing. For this second round of testing, however, only twenty participants took part in the second round of usability testing.

Participants had varied levels of experience in using the library Web site. Most were either freshman or transfer students who either did not use the library's physical space or the library's Web site. Other participants were more experienced students who had used the library in the past, either as a study area or as a student taking a one-short library instruction workshop. One participant could be noted as a power user, and used advanced search techniques and multiple browser tabs to complete many of the tasks presented to her. Participants were not asked directly about their level of experience using the specific device; it was assumed that because they owned the particular device they had some level of familiarity with it.

Devices were selected based on the usage statistics collected through Piwik and Google Analytics; the devices used most frequently to access the library's Web site were included in the sample. The devices preferred by users closely reflected the preferences of users in the first round of testing and the distributions found in

Table 1. Devices used in the study.

Workstations Round 2: 8 users	Tablets Round 2: 5 users	Smartphones Round 2: 7 users
Windows 8 Dell Laptop (5 users) 2014 MacBook Pro Laptop (3 users)	Apple iPad 2 (2 users) Apple iPad Mini (1 user) Google Nexus Tablet (1 user) Microsoft Surface (1 user) Samsung Galaxy Tablet (0 users)	iPod Touch (to simulate iPhone 5) (4 users) Galaxy S4 (3 users)

Note. The Galaxy tablet was used by Web site visitors but was not selected for this study.

the library Web site's analytics of mobile devices. There were several other modifications pertaining to the device usage of the test. Users were given a choice of what size iPad to use, either the larger iPad 2 or the smaller iPad Mini. An Apple iPod Touch device was used to mimic the iPhone 5, since it was more economical, and has a comparable screen size and similar functionality.

Testing setup

The testing setup of this second round was similar to the first round described previously in the literature. See Tidal (2015) for more detailed information on how participants were recorded and what software was available to them. A brief summary of the recording set up is provided here. Participants were recorded using a variety of equipment. For users on the Windows PC laptop, the Camtasia® video recording program was installed to record screencasts of users undergoing the study. Camtasia has the ability to simultaneously record the desktop and Webcam, so users' expressions and Web site actions can be recorded during testing. Windows users had the option of using Internet Explorer, Chrome, or Firefox browsers. Users on the MacBook Pro laptop were recorded using the built-in QuickTime Pro player application to record screencasts, as well as the included Photobooth software to record Webcam video of the users. Users had the option of using Safari, Chrome, or Firefox Web browsers on the MacBook. The screening room's plasma screen was connected to both the PC and MacBook Pro laptops displaying the user's screen to the testing proctor. This allowed the participant to be free of a proctor hovering above them as they conducted the test.

For tablet computers and smartphones, recording screencasts proved more challenging than documenting laptop workstations. Before testing, various open source tools were evaluated to screencast Android devices. These tools would exploit the Android's maintenance kit to provide a feed from the device into a computer. This approach proved cumbersome, as the device required a constant USB connection, which could interfere with participants' comfort. Also, data transfers via USB are slow, so there was significant lag from video coming from the device into the computer. iOS devices, such as the iPhone and iPad, did not have any native screen recording capabilities. Apps are available to record screencasts but were prohibitively expensive at the time. Another idea was to have an iPod touch mounted to record users, but this took time to setup. As a work-around, an IPEVO document camera was used to record mobile user's device interactions. The camera was placed so it would be unobtrusive to users working with testing devices.

The MacBook Pro had multiple purposes for the test. Not only was it a testing device, but it also stored the recordings of the other testing devices. The MacBook Pro can create a WiFi network from its wired connection, which was used as a network bridge to connect the other mobile devices, providing a router/gateway to the

Internet. This was a technical necessity since the City Tech Institution WiFi is typically slow during the regular semester.

Usability test

This usability test was conducted in two rounds. The first round, reported on earlier (Tidal 2015), identified usability obstacles from the user's perspective. As a response, modifications were made to the site to repair these obstacles. To test how well these modifications achieved their intended purpose, a second round of testing was conducted.

Analytics data were utilized to determine the most used pages on the library Web site. Data were collected using Google Analytics and Piwik data, an open source alternative to Google Analytics. The most used functions and pages of the site were selected to pinpoint what usability goals to test. These data revealed that finding books, e-books, articles, library hours, and directions were some of the most sought information on the library site.

There are different types of usability tests, but for this particular study, a task analysis was used. During this type of testing, a user is given a specific task to complete. Tasks are written and presented to the user in the form of task scenarios. These scenarios provide a realistic context to put the user in an appropriate mindset to complete the task. For instance, instead of asking a user to "find a book," a task scenario provides contextual information, such as finding a book for an English class assignment. A good task scenario does not reveal the steps required to accomplish the task (Dumas and Redish 1999).

A testing proctor read these task scenarios aloud to participants. Participants then used the Web site to accomplish the task. To avoid confusion, a printed sheet of tasks was given to participants in case they misheard the proctor speak. Participants were encouraged to "think-aloud," a process known as the think aloud protocol (TAP), as they navigated the site and attempted the task. This technique is an extremely useful qualitative measurement that goes beyond quantitative metrics and gives observers insight into the participant's thought process. These data are especially useful, as they can highlight usability merits and obstacles that designers may not have thought of.

Various quantitative metrics were also recorded during the test. Users rated how easy or difficult the task was upon completion using a 5-point Likert scale. The success or failure of a task was recorded, and some were considered as "partial successes." These were tasks or solutions that were not necessarily complete failures or successes. Each task had an end goal and a method to reach it, yet users may have found other alternate processes to achieve it. Specific tasks are further explored in the task section below.

Analyses of these metrics were used to determine which patterns emerged from the data. One such pattern was consistent success or failure for a given task. Based on these patterns, modifications were made to the prototype. These modifications

resulted in the current live responsive site, which was used for the second round of testing.

Web site modifications between testing rounds

There were numerous modifications to the library Web site in between the first and second rounds of testing. These changes included revamping the electronic database page, the adoption of two responsive designed discovery tools, and updating the navigation on the site.

The electronics database A to Z page was altered from a long list of electronic resources, to a landing page that sorted resources by subject. McMullen (2014, 3) noted that "there's just nothing to defy usability quite like a 200-item long list composed largely of links that offer no clues as to what they might lead to." To better serve our user population, our Web site was restructured to organize article database resources into subjects, rather than a long list.

The other modification was the adoption of a new discovery tool. First-round users searched the CUNY Catalog, an Aleph-based Web OPAC, which provides records to both local City Tech resources and CUNY-wide resources. In summer 2014, City Tech, along with a few other campuses within CUNY, implemented Ex Libris's Primo discovery tool. Marketed as "OneSearch," this discovery tool incorporated responsive design. It allows users to search the library collection, electronic resources, and research articles through a drop-down menu to narrow the search to a specified format, such as articles, books, e-books, or media.

In addition to the adoption of OneSearch, the LibGuides 2.0 CMS (http://libguides.citytech.cuny.edu) was also implemented. Like the library Web site, LibGuides is inherently responsive, since it is built using Bootstrap. Research guides housed in our MediaWiki installation were migrated to LibGuides. The system was modified to mirror the appearance of the library Web site, by customizing CSS code and JavaScript markup. This customization was intended to present users with a seamless transition between the research guides and the library Web site.

As noted, the OneSearch and LibGuides products incorporate responsive design techniques out of the box. Much like the Ursula C. Schwerin Library's current Web site and unlike their predecessors, these tools conform to various screen sizes. In addition to the adoption of the responsive discovery tool and research guide management system, other changes to the library Web site include adding a responsive class to the "Borrowing Policies" HTML table using Bootstrap's inherent CSS modifiers.

Task analysis: Finding information on the library's Web site

There were several goals for this usability test. The most prominent goal was to determine how well users could find library resources using a site built with responsive design. First-round users searched the CUNY Catalog, which is neither mobile optimized or responsively designed, to retrieve call numbers. In

comparison, second-round users had a different experience finding books using OneSearch, the discovery tool implemented between the two rounds. Users were asked to complete twelve different tasks, from finding library materials of various formats to finding research guides and library contact information. Only tasks that directly address responsive design will be reported in this article.

Successes and failures of finding materials were recorded in the study, as they could be used to compare results between the two rounds of testing. Partial successes include situations where the correct information was found, but the user was not satisfied with the result. For example, a user finds the correct record for an e-book, video, citation resource, tutorial, research guide, or other type of library information, but does not open it.

Findings

Usability task results

Finding library resources on the library Web site is not a unified experience across device types despite the implementation of a responsively designed site. Workstation and tablet computer users had the opportunity to filter search results for specific formats, as search facets were present at the top of the screen. Facets in the discovery tool were missing for users viewing the site with a smartphone, since responsive design pushes these facets to the bottom of the page (see Figure 3). It was observed that smartphone users typically did not scroll down far enough to use them. This was interesting, as tablet and mobile participants of the first round of testing stated that they did not mind scrolling on long pages (Tidal 2015). This lack of facet transparency effected tasks that centered on searching for books, e-books, films, and articles.

The catalog used in the first round of testing was not optimized for mobile devices. Tablet and smartphone users during the first round found the catalog easier to use compared to users of similar devices in round two doing searches in OneSearch (see Tables 2 and 3). First-round users were more successful in retrieving call numbers than second-round users, despite the fact that the catalog did not employ responsive design or was mobile optimized.

A problem that second-round users encountered with OneSearch was the search field displayed on the results page. The search field at the top of the page allows the user to search the local holdings of a specific CUNY campus or holdings for all of CUNY. The button that switches these functions was compressed when viewed on a smaller screen, causing the button label to visibly block the search field on the page (see Figure 4). This caused problems, as mobile device users were not able to tap and edit their search since the button blocked their view of the field.

Users were given the task of finding e-books, videos, and electronic databases on the Web site. For the task of finding electronic database resources, some participants did not use the Web site's "hamburger" navigation menu, opting for the discovery tool. This menu was more prevalent on screens for smartphone users.

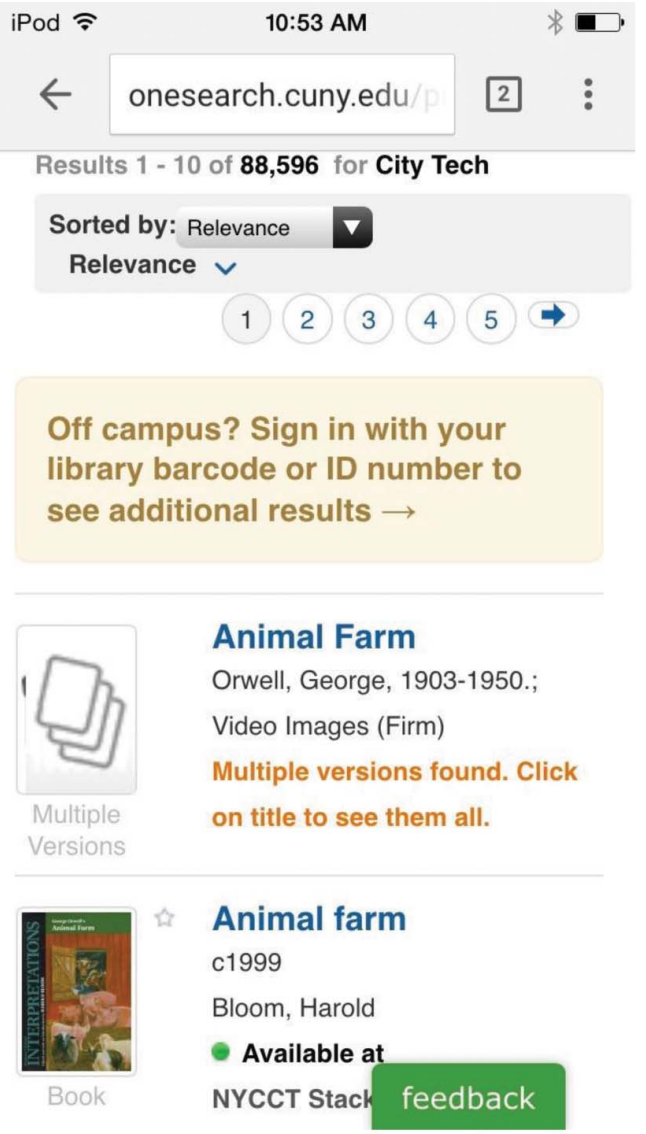

Figure 3. Hidden facets in the smartphone view of OneSearch.

Smartphone users had similar success rates to those of tablet users, but could not filter e-books since the responsive design hid the search facets within the discovery tool. This was also true when these users tried to find videos. Tablet users were more successful and found it slightly easier to find resources using OneSearch in comparison to participants who used the catalog in round 1.

This task scenario required users to find an article from the *New York Times*. Most workstation users utilized OneSearch to find newspaper articles during the second round of testing. Since OneSearch has indexed some of the library's electronic resources, many users were able to find a newspaper article

Table 2. Round 1 results from the usability test.

	Round 1 results					
	Windows and Mac desktop machines		Tablets		Smartphones	
	Success rate (%)	Avg. ease of use (1–5)	Success rate (%)	Avg. ease of use (1–5)	Success rate (%)	Avg. ease of use (1–5)
Find a book	85	2.14	80	1.60	87.5	1.88
Find an e-book	71	2.71	80	3.00	75	2.88
Find a film	100	2.14	80	3.60	37.5	3.75
Find a specific database	71	2.00	60	3.40	75	2.38
Find a newspaper article	14	2.71	60	2.40	50	2.38
Find a research guide	0	1.57	20	1.80	25	1.75
Find a citation resource	14	0.86	20	2.00	25	2.38
Find a tutorial	43	1.86	80	2.20	50	2.25
Ask a Librarian	85	1.57	80	1.60	100	1.13
Find the subject librarian for your department	28	1.29	60	1.80	37.5	1.63
Find how long you can check out a book	57	1.43	100	1.60	87.5	1.63
Find the library's hours	85	1.43	100	1.20	87.5	1.75

using the discovery tool. This is evident in the increased success rate among users between the first and second rounds of the usability test. First-round users did not use the catalog to find newspaper articles. This task demonstrated that the transition to OneSearch as the default search made an impact on how users navigated the site. Workstation and tablet users were more successful finding a newspaper article using OneSearch, due to visible search facets. Similar to previous tasks, smartphone users were not as successful because of the low visibility of the facets on their devices.

Table 3. Round 2 results from the usability test.

	Round 2 results					
	Windows and Mac desktop machines		Tablets		Smartphones	
	Success rate (%)	Avg. ease of use (1–5)	Success rate (%)	Avg. ease of use (1–5)	Success rate (%)	Avg. ease of use (1–5)
Find a book	85	2.14	40	2.20	43	2.29
Find an e-book	75	1.50	60	2.6	71	2.43
Find a film	75	2.00	80	2.20	86	1.43
Find a specific database	63	2.50	80	2.40	43	2.29
Find a newspaper article	88	2.20	80	2.40	43	2.71
Find a research guide	63	2.00	20	2.20	14	1.57
Find a citation resource	88	1.60	60	2.20	43	1.86
Find a tutorial	75	2.10	80	2.60	43	2.00
Ask a Librarian	100	1.00	100	1.00	86	1.29
Find the subject librarian for your department	50	1.50	60	2.40	29	1.86
Find how long you can check out a book	75	1.50	80	1.20	57	2.29
Find the library's hours	100	1.00	100	1.00	86	1.00

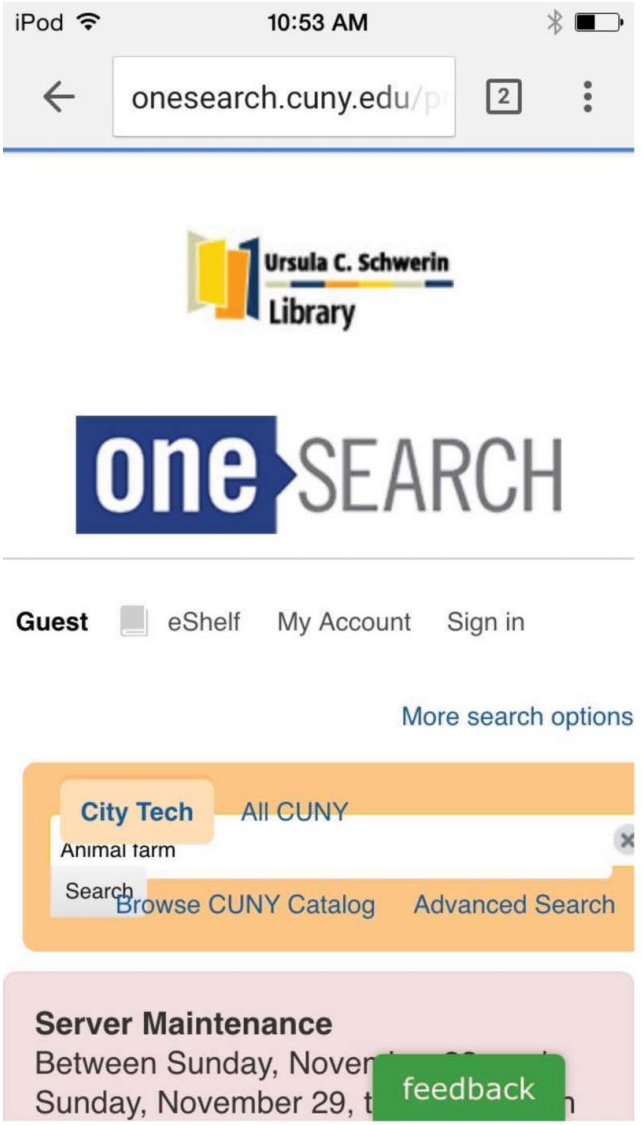

Figure 4. The search type selector obscures the search field.

Moving the citation resource link from the second-to-last entry up to the second option on the "Help" menu on the site's main navigation between rounds 1 and 2 had an apparent impact with participants. This is evident in both think-aloud responses and in the higher success rates of second-round workstation and tablet users. Success rates for smartphone users did not change despite the menu modification, but users of those devices rarely used the minimized "hamburger" navigation menu to reach the citation guide.

In this task scenario, the context given was to find a library subject specialist to set up an appointment for a one-on-one research consultation. Many users in the first round of testing sought this information on the research appointments page, which

did not contain that information. As a result, a link to the subject specialist directory page was added to the sidebar of that page for the second round of testing. Unfortunately, similar to the problems encountered with OneSearch's responsive design hiding facets, this change impacted users viewing the site with smaller screens. The sidebar link was pushed to the bottom of the page where users could not find it.

Users were asked to find out how long they could borrow books from the library. Unlike first-round participants, second-round participants searched for borrowing policies through the discovery search tool. TAP responses indicated that participants were expecting borrowing information to be found within the catalog records of the discovery tool. For instance, if a user found a book record, they were expecting borrowing policies to be there along with other pieces of bibliographic information.

Tablet users had the most success in finding borrowing information among the three test groups. This is evident in their 100-percent success rate and ease of use ratings. Smartphone users had similar rates of success and perceived ease as workstation users. It seems that adding the responsive class to the HTML table that contains borrowing information made very little impact on mobile users.

Post-test survey findings

Immediately after the usability test, post-surveys were conducted. These were distributed using hard copies rather than online surveys. It made sense for users to fill out this information while the usability test was fresh on their mind. Overall, survey results indicate users' perceptions changed slightly after the Web site was modified between rounds. Participants in the second round of the study found the site to be slightly easier to use in the categories of finding information and navigation, and were slightly more pleased with the visual design (see Table 4). Workstation users in the second round found the Web site more usable compared to first-round workstation users.

Second-round tablet users indicated that the site was not as usable compared to first-round tablet user respondents. Second-round tablet users felt that the site was

Table 4. Post-testing survey results for rounds 1 and 2. On the rating scale 1 (*Easy/Good*) – 5 (*Difficult/Bad*).

	Workstations		Tablets		Smartphones	
	R1	R2	R1	R2	R1	R2
Q1. The library Web site is easy to use on this device.	1.71	1.75	1.40	1.75	2.25	1.57
Q2. Headings on the Web site are easy to understand.	1.14	1.75	1.20	2.00	1.62	1.71
Q3. Finding information on the library Web site is … .	2.14	1.75	2.20	2.25	2.50	2.00
Q4. I would rate the library's Web site navigation as ___ to use.	2.29	1.87	1.80	2.25	1.75	1.57
Q5. Have you used the library Web site before?	100% yes	50% yes	100% yes	40% yes	50% yes	71% yes
Q6. Have you used a mobile device or smartphone to access the library Web site?	14% yes	13% yes	60% yes	20% yes	37.5% yes	29% yes
Q7. On a scale of 1–5, how would you rate the library Web site visual design?	2.43	1.87	2.00	2.00	2.12	2.13

not as easy to understand, finding information was more difficult, and the site was harder to navigate. Among smartphone users, survey results between the two rounds of testing were not that different. Second-round smartphone users found the site and headings to be slightly more difficult to use and understand, yet they expressed that the aesthetics of the Web site were pleasing.

The last question of the survey was open-ended and asked participants to give any other comments regarding the library Web site. Generally, most of the comments regarding the Web site's redesign were positive. Workstation users gave the most positive feedback. Tablet user feedback was mixed, with one commenting that the site was a "10/10," and another noting that the site would be easier to use if the search brought up more useful results. Feedback from smartphone users was critical of the site's search functions and indicated that homepage content was "a lot on one page."

Discussion

Responsive design is a useful solution for library Web sites, but it is not perfect. It is evident that there is not a singular experience among users of various devices. Responsive design brings functionality to Web sites, but it is not equal across all devices. It is apparent that smartphone users are at a disadvantage in comparison to those visiting the site via a tablet or workstation. Not only do smartphone users have a smaller screen size and a touchscreen interface, but they also encounter specific problems with responsive design including its grid system, form functionality, and navigation.

The grid system of responsive design worked as intended, but this caused problems for smartphone users. Users had problems finding sidebar content if they did not scroll down far enough. Important library information such as library hours and library subject specialists were obstructed. The same can be said of the search facets within the discovery tool. As seen from the tasks above, these participants had problems filtering media formats as they navigated the site.

Responsive design also impacts form input. When the search field OneSearch is viewed through a small viewport, the option to search for local results or CUNY-wide results obstructs the search field. Users found it difficult to enter information into the field because of this flaw, as the touch interface could not distinguish a tap between the CUNY-wide button and the search field.

Even though OneSearch is a mobile optimized Web site, smartphone users had the least success in using it. It is notable that no participants explored the site or utilized the hamburger navigation menu. Instead, participants used the discovery tool to search the site mirroring similar usability test findings of discovery tool use in general (Fagan et al. 2012). This was problematic, as much of the Web site content was not indexed in OneSearch. If it could be, overall functionality of the site may be improved. A bento-box-style search apparatus that utilizes the discovery tool's APIs could be a potential solution to display search results among different online tools a

library employs. A number of libraries have implemented this type of search system into their sites (Beatty, Jones, and Koltutsky 2014; Darrington 2014; Tay and Yikang 2015). In relation to responsive design, bento box searches should be displayed with priority for the format of the initial search. For instance, if a mobile user is searching the catalog, results should be displayed at the top of the grid system.

Recommendations

A solution is needed to improve the library Web site specifically for smartphone users. As explained above, there are many technical reasons why they are at a disadvantage, but it is also important to revisit the user base of the site. According to a report by the Pew Internet Research Center, lower-income, minority, young people are more likely to be smartphone dependent, and it is their only point of online access (Smith 2015). These are the same users that City Tech serves, and it is important to acknowledge the shortcomings of responsive design on smaller screens.

Sidebar links may require reevaluation. Sidebar links were helpful for users to complete tasks, but smartphone users had an obvious disadvantage since these links were pushed to the bottom of the page. With Bootstrap, it is possible to declare CSS classes to offset, push, or pull tags to prioritize what gets pushed. It may also be a good idea to determine what and how much content should go on each page. Fox (2012) noted that by shifting the focus on content first, we put the patron first. Incorporating these links into the main content rather than using the sidebar may also be a viable solution. Users may not necessarily understand library jargon when evaluating Web site content, so usability testing should be done to ensure users understand the language used on the site.

Some suggestions for improving the usability of the Ursula C. Schwerin Library's Web site are outside of the library's control. This scenario is common among libraries when providing access to electronic databases, external/proprietary CMS, or other tools. Echoing the findings of a usability study on discovery tools, this study examines more closely the role of the discovery tool in tandem with other online services in a way that is beneficial to users (Fagan et al. 2012). From this usability test, there are a number of recommendations for the OneSearch discovery layer, which include improving how users see search facets. The study has revealed that this makes an impact on finding resources based on a specific format. Users with touch-based interfaces may also have problems editing terms in the search field because the field shrinks to conform to the viewport, causing the submit button to block the field. Since this is a CUNY-wide tool, it is unknown if these changes can be made specifically for only City Tech users, as not to affect the other campuses within the university system.

Future considerations

This study shows that when conducting a usability test on a responsive site, it is unnecessary to test on every type of device. Having the top three or four devices

was sufficient to determine usability problems with the library Web site. It may not even be necessary to distinguish between PC and Macintosh laptops, since the browsers work similarly. In future rounds, testing a variety of screen sizes rather than device types would provide more useful information. There is the potential that this choice may affect power users, who are used to particular operating systems' keyboard shortcuts.

For future testing, there could be considerable improvements with the testing instruments. The focus of this usability study was to determine how well responsive design meets our users' needs. Some tasks could be reworded into a scenario, or even rewritten for specific device types. For more realistic applications, more data could be gathered when tested in the field. For instance, the cellular network or WiFi connection of a tablet or smartphone could be compared against that of a wired workstation connection. Schade (2014) mentioned that comparing these varied conditions can test the boundaries of access across different devices.

Conclusion

Based upon this usability test, responsive design may not necessarily equate with a singular experience across different devices. Smartphone users will continue to have a greatly different experience compared to that of tablet and workstation users. As newer mobile technologies are adopted, such as responsive design, it is important to consistently conduct usability studies on libraries' Web sites to ensure that users can find the information they seek. This test revealed a number of issues from the user's perspective. Looking at the Web site through the user's eyes can help to remove obstacles and improve the library's Web site.

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About the author

Junior Tidal is the Multimedia and Web Services Librarian and Associate Professor for the Ursula C. Schwerin Library at the New York City College of Technology, City University of New York. His research interests include mobile Web development, usability, and Web analytics.

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