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Usability Study for a Community College Library Website: A Methodology for Large-Scale Data Gathering

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Usability studies (UX) are increasingly common in libraries. A UX methodology is a useful tool to support librarians' decision-making processes during a website (re)design. This article describes a UX process using a custom-built usability-testing environment and a data-collection tool, written in JavaScript and Python respectively. The resulting automated approach allowed us to collect usability data from a sample of 225 students. The methodology described in this study will be of interest to those considering or planning a UX study in their libraries.

Keywords: ux; community college; quantitative methodology; website usability

Introduction

Library websites are at the core of contemporary library services. Most of our stakeholders expect to be able to access library resources online. So it is an essential gateway for many users, providing them with access to an important portion of the library's collections and services. It is a critical piece of infrastructure that should seamlessly deliver users to the resources they are seeking. As Letnikova says: "A library Web site reflects the academic library mission: it supports curriculum and research activities, provides service to students and faculty, presents available resources, and communicates guidelines on how to locate the information needed" (2008, 382).

It is hard to overstate the importance of a library's web presence as an access point for most contemporary library patrons. As King and Jannik suggest, "in many ways a library's website is the library" (2005, 1). Others emphatically insist on the central role of a library's website in outreach: "… an all-important function of the library's web site is to serve as a

communication tool for a library and its users" (Diaz 1998). Pampalonia and Bird (2014), Bird and Pampalonia (2014) and King (2009) helpfully elaborate the idea of the library's web presence as "digital branch". All of these authors emphasize that library websites should be a central concern for librarians.

However, generally speaking, websites do not usually age well. For example, a site that is unchanged from three years ago will probably look outdated today. This is in part due to the constant churn in front end web technologies, such as JavaScript frameworks or content management systems, but it is also undoubtedly due to constant changes in graphic design trends. Indeed, these two factors are closely interrelated, and not easily separated. Combined, they give a typical website a relatively short lifespan. The technical and aesthetic dynamism of contemporary web development means that our library website needs frequent updating.

To manage these lifecycle constraints, libraries need a well-planned update cycle. Prior experience in our library has taught us that making changes is not as simple as writing new code; rather, updates should include other equally important activities, such as usability testing, prototyping, soliciting feedback, interpreting feedback, making recommendations, and exploring potential new technologies.

This study provides evidence and narrative documentation of our attempts to improve one small part of the refresh cycle, usability or user experience (UX) testing. According to the International Organization for Standardization (ISO), usability is the "extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO 9241 2018). The case for UX testing has been well stated elsewhere (Jordan 1998; Nielsen 2000; Nielsen and Tahir 2000). This paper will focus on a testing methodology we developed for the Kingsborough Library

website. Our approach is not typical of the scholarly literature. The typical study compares the existing website with prototypes in an environment that includes observing, recording and measuring users' experiences with the website. We take a different approach.

This paper will focus on the benefits and shortcomings of this methodological approach, rather than on the conclusions we reached from our UX testing. We built custom-made usability testing tools, and used a much larger data set than is typical of most library-based UX studies. This strategy has led this project in interesting directions. Our approach may be different, but we hope that it brings valuable insights. Perhaps it can offer other researchers and librarians an opportunity to build upon the preliminary attempts outlined here.

The Environment

Kingsborough Community College is a modern, open-admission policy community college. Located in the southern part of Brooklyn, New York, Kingsborough has a student body with large populations of immigrants and first-generation students. Kingsborough's commitment to diversity, equity, and social justice has helped many of our students succeed. The Kingsborough Library has a broad collection of books, e-books, full-text electronic databases, online government documents and other resources. The library's website provides access to these services, as well as other resources offered by the Library.

In 2009, the Kingsborough Library assigned a librarian responsible for the overall design of the website, working with a broad team of librarians from various functional roles to maintain the web content. In April 2010, the college began a web migration project, aimed at reorganizing the website. The goal was to make the web content more usable. Since then, the web liaison librarian has managed changes to the library's website. These gradual changes retained some

elements from the original design, so by 2017 it was clear that a major project to refresh the website was required.

This is especially important because many Kingsborough students access the library's electronic resources remotely. The website should be up to date and should meet contemporary students' needs and profiles. We determined that a usability study would help Kingsborough's librarians, by providing us with relevant data to support design decisions. Making changes based on users' needs will have a positive impact on the use of library resources.

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Literature Review

Some authors differentiate various approaches to web usability testing by considering whether end users are involved. For example, Jordan (1998) divides usability testing into two approaches: empirical testing (with representative users) and non-empirical testing (without representative users). From Jordan's perspective, "empirical" techniques -- such as focus groups and surveys -- usually aim to be objective by using defined metrics. On the other hand, he sees "non-empirical" testing as being more subjective. These non-empirical approaches include property checklists, task analysis, expert appraisals and cognitive walkthroughs. Jordan clearly prefers empirical testing. As he says, "There is no substitute for seeing people trying to use a product" (51). While Jordan's distinction between empirical and non-empirical testing needs elaboration – it could be situated, for example, within a much longer history of philosophical empiricism -- his point about the value of gathering data on users' interactions with a website is

well taken. UX is a hands-on discipline, and it is helpful to gather data on real users' interactions with our websites.

Similarly, Genuis (2004) argues that usability "testing methods can be divided into two main categories: those methods in which site designers or experts assess usability, and those in which real users generate data that are utilized in the evaluation of usability" (Genuis 2004, 161). It is possible for librarians to evaluate website usability themselves, and make decisions based on their knowledge and experience. However, Whang and Ring caution against relying too heavily on a "librarian knows best" (2007, 69) approach. Taken together, Jordan (1998), Genuis (2004) and Whang and Ring (2007) suggest that UX librarians can gain valuable insight from real users' experiences. The takeaway is that testing with real users allows more effective usability evaluation. Insights generated by real users should be strongly preferred to a "librarian knows best" approach.

Many methodological approaches to UX can be found in the literature. For example, the System Usability Scale (SUS) created by John Brooke is used extensively in industries to test applications and systems. Klug (2017) in his article describes how SUS is used in library website usability testing, and summarizes the benefits and challenges of using this technique. SUS offers a quick and easy source of data, so many libraries have adopted and adapted SUS to gain insights on UX, to establish baselines, communicate changes, or help in the decision making process. Alternatively, a study conducted by Alhadreti and Mayhew (2018) examines the effectiveness and efficiency of two more traditional methods. The concurrent think-aloud protocol (CTA) requires participants to verbalize their action and thoughts while interacting with the website, while the co-participation method (CP) involves two participants working together on a task and discussing the process. Their analysis shows significant differences between these two usability

evaluation techniques, and suggests that CP helps participants to have a more pleasant experience and leads to the detection of a larger number of usability problems.

Varied methodologies like these have led to many different analytical perspectives on the purposes of website usability. For example, King claims that a website is like a business, where information is the product. For him, the goal is "making sure library users can find information on your website quickly and accurately" (King 2003, 13).

All of these approaches have a common focus on the user. Indeed, there are many other examples of user-centered methodologies. Advocating a user-centered approach has been central to the UX literature since the early days of usability studies. For example, Hall (2001) points us to several early advocates of a user-centered methodology, such as Norman and Draper (1986), Norman (1988), Norman (1998), and Schneiderman (1998). As the literature continues to expand, the focus today is on knowing who the users are: their capabilities; their needs and expectations; and their goals.

User-centric tasks work best when they measure if a user achieves their goals, and how they do it. However, to complicate matters, the physical and social environments affect whether users accomplish various tasks (Hall 2001). One challenge when doing usability testing is to create a testing environment that allows for adequate evaluation of the users' behavior. Tests should situate the user's needs within the context of testable features and realistic, life-like tasks.

Genuis (2004) suggests that tasks should allow us to assess a website according to several criteria. These criteria are: (1) effectiveness or how users succeed or fail in carrying out a task correctly and completely; (2) efficiency or the amount of effort put in by users to complete a task; and (3) satisfaction or the user's attitude toward completing a task. Often, capturing all of

these factors requires more than one measurement technique. However, in some cases, it may be desirable to limit the scope of the inquiry to one or two of these usability criteria.

Measuring successfully depends on having prototypes that adequately evaluate user behavior. Having appropriate prototypes is an important consideration, and requires some advance planning. Hall considers that "low-fidelity prototypes are good for testing the cognitive aspects of the design such as the layout of controls and displays" (2001, 492). In Hall's approach, low fidelity prototypes allow for useful feedback early in the design process. This information is valuable, especially when weighed against the potentially greater cost of incorporating feedback later in the process, or of producing a product with poor design.

Many existing studies focus on usability testing for a single institution website or a particular library. Our work here continues along this path. On the other hand, some studies examined groups of public or academic libraries. This is a useful approach, because almost 50% of academic libraries do some kind of usability testing on their websites (Connell 2008). A notable study by Liu (2008) reviewed 111 academic library websites and concluded that libraries' websites tend to have sections such as: search, resources by subject, about sections, library services, and site search, ask a librarian, news events, and contact us. Liu's classificatory approach was helpful for our study, as her typology assisted us as we built our prototypes.

In recent years, advanced techniques, such as eye tracking, have been adapted to website usability studies. Usability professionals have been attempting to identify the utility of different eye-tracking inputs for website design and usability. Many of these studies consider the identification of the specific targets of the users' visual attention to different parts of the interface. The investigator can compare the data associated with each of these areas of interest along various criteria, including: order, number and duration of fixation (Russell, 2005).

However, the lesson we drew from advanced techniques such as Russell's is that they may be beyond the reach of the budgets or expertise of many academic libraries.

As we can see, the literature is broad and varied. The most obvious way that our usability test differs from those described in much of the existing literature is in the size of our sample. Library usability tests usually rely on sample sizes of five, ten, or maybe fifteen subjects (Becker and Yannotta 2013; King and Jannik 2005; Neilsen & Tahir 2000). Small sample sizes are the norm in the existing literature. They are also the norm in the academic library usability initiatives surveyed by Connell (2008). However, Alshamari and Mayhew (2009) and Lindgaard and Chattratichart (2007) suggest that very small samples are not necessarily sufficient to catch the majority of usability issues. Alshamari and Mayhew conclude their discussion of sample sizes by offering a balanced assessment: "if the website has different types of users, it is vital to consider user numbers and their characteristics seriously" by being open to various sample sizes (2009, 403). Lindgaard and Chattrarichart want to "move the discussion beyond the issue of 'optimum number of users'" (2007, 1415). Following the lead of these studies, our approach heads in a somewhat unusual direction by capturing a very large amount of usability data: we have tested 225 people.

Our intention is not to call into question the literature that advocates for small sample sizes, as it has largely demonstrated its utility. Like Lindgaard and Chattratichart, "our aim is not to reinvent the wheel in this debate" (2007, 1415). Rather, we want to explore a different approach, to see if it can also yield interesting insights. We were interested in exploring alternate ways forward for UX testing. Our study produced a dataset with different characteristics than those produced by a great number of library usability studies.

A large data set can be valuable in different ways than a small data set. While drawing conclusions from a large dataset is perhaps a slow process, it also allows more subtle conclusions to emerge. Our hope was that we could not only identify and fix usability issues, but also make broader claims about user behavior. For example, larger datasets may be generalizable in ways that small datasets are not. Fagan et al. (2012) point out that data extracted from small samples, while interesting, are often not generalizable to a larger population.

The literature on usability testing is broad and mostly recent. Taken together, the existing work on UX elaborates a sensible set of best practices. However, our readings suggest that approaches to UX have yet to coalesce into a definitive set of methodologies. For this reason, we'd like to suggest that there continues to be room to explore new approaches as the field grows. This paper's contribution is to add another methodological perspective to this developing field, while drawing and expanding upon existing studies.

Methodology

Our review of the literature suggests that usability testing should be an integral part of library website development. We concluded that formal usability testing was the most appropriate way to approach the complete overhaul of the existing site. Most importantly, UX testing can generate data that facilitates an effective redesign process. As a result, we hypothesized that conducting a systematic usability test could ultimately lead us to a more usable web interface.

Dumas and Redish suggest some important considerations that should serve as a framework to guide the usability testing process. To summarize their list of considerations: (1) "The goal is to improve the usability of a product"; (2) "Participants should represent real users";

(3) “Participants should perform real tasks”; (4) testers should observe and record what participants do; and (5) data analysis should recognize problems and suggest solutions (1993, 22). These common sense ideas provided a useful baseline for our study.

To this end, we set out to create a simple, intuitive, and unified testing environment for our participants. Our aim was to have an effective, technically sound process. We wanted the testing experience to be self-contained and self-explanatory. Because of our intention to recruit a large sample, we wanted the data-collection to be automatic. Ideally, participants would be able to complete the tasks with very little guidance. The technologies we built reflect these original intentions. We initially chose to use a subscription-based tool called Hotjar to collect our data (Hotjar 2018), but for a number of technical reasons we ultimately had to take another path. So instead, we wrote some custom software to run and measure our usability tests. These custom-built tools have allowed us to reach our usability assessment goals.

Interestingly, Fagan et al. (2012) appear to have used a testing environment with a similar objective, called the Usability Testing Environment. Unfortunately, web links to this resource no longer resolve, so we were unable to compare it to our approach. More recently, Optimal Workshop was another technology recommended to us (Herrera 2018). However, the cost of Optimal Workshop was beyond the scope of our grant funding.

In contrast, we built a web-based testing environment at minimal expense. The result was a testing workflow that was entirely contained within the browser. There was no paper list of questions, no talk-aloud tasks, no card sorting, no forms to fill out. The data gathering was fully automated, and integrated into the web-based testing apparatus itself.

Within this context, we did “first-click testing”, as described by Mitchell and West (2016) and Bailey (2013). This means that we tracked where users first clicked to solve a task,

but did not track any further user actions. This is very different than, say, the "close reading" approach advocated by Baird & Soares (2018, paragraph 21). Our approach simplified the users' interactions with the testing apparatus. It also made it easier to explain the testing process to participants. First-click testing simplified our data analysis as well, as each user task had an unambiguous first-click "answer" from which we could draw conclusions.

Using an automated approach had some obvious benefits. With 225 participants, manually recorded measurements would have been prohibitively time-consuming, not to mention tedious. Quantitative, software-based data-gathering methods, and a large sample group, allowed us to do statistical analyses with a much larger dataset than would have otherwise been feasible. The following section will describe the tools we built to make this approach possible.

Apparatus

Our testing apparatus involved several interconnected components. This section will discuss each of those components, and will describe how they contributed to the project as a whole.

Prototypes

Developing testable prototypes is a key part of many UX testing initiatives. Well-designed prototypes allow designers to test effectively how a proposed solution is going to work. They also give the designer something to show users and colleagues, in order to get feedback. In other words, the goal of a prototype is to evaluate usability ideas. Prototypes allow us to gather data that will lead to actionable conclusions.

Our prototyping was a multi-step process, and it was constrained by several factors. Our grant application and Institutional Review Board (IRB) process pre-determined many of the parameters of this project. Practically, this meant that we had flexibility on the design and layout of our prototypes, but far fewer options on the technical aspects of data collection, since the grant application and IRB approval already specified these in some detail. These limiting factors shaped our process from the start.

With that in mind, we used the following steps to build our prototypes:

(1) Sketch the prototypes: We mapped patrons' goals and use cases with specific elements of the existing library homepage. With these goals and use cases in mind, we sketched out many prototypes on paper. We drew prototypes that we felt would address the main use cases for the library website. These draft prototypes served as a set of design ideas that we could subsequently build upon and test.

(2) Build the prototypes: We built preliminary prototypes to reflect our sketches. We differentiated each prototype by picking one or two features to test. Our intention was to evaluate how well the prototypes facilitated patrons in meeting their goals.

(3) Discuss the prototypes: We had several rounds of review and discussion to improve the prototypes before we finalized the layouts.

(4) Create the tasks: We developed a list of tasks for participants to complete using the prototypes.

(5) Deploy the tests: We put the prototypes in front of live participants. As participants worked through the tasks using the prototypes, they generated data that we ultimately used to evaluate the prototypes across various use cases.

LibGuides

We built our prototypes with LibGuides CMS, which is a popular, library-oriented content management system. Our LibGuides prototypes tested several different "tools" we built, which are visual and functional elements that the user could interact with on the page. We classified these tools into a number categories that subsequently helped us evaluate what types of interface were most conducive to student success.

LibGuides CMS has two obvious advantages for our project: First, it is in line with our library's strategic agenda. For a number of reasons, we want to move more of our library content over to LibGuides. For example, LibGuides makes it easy for content creators (usually librarians) to create and modify web pages without needing advanced technical skills. In this respect, it democratizes the process of making changes to our website by providing an easily understood interface, where librarians can make edits independently. Importantly, most of the Kingsborough librarians like LibGuides. Lastly, LibGuides provides pre-built styles that structure and visually unify content. While it is possible to chafe at the constraints of these pre-made styles, it is nonetheless hard to deny that they make creating and editing content both easy and quick. This was particularly useful for our prototyping process.

Because LibGuides CMS allowed us to build out new ideas rapidly, it allowed us to produce a large number of working prototypes quickly and easily. We put these in front of participants during our UX tests, which allowed us to gather data on each prototype with minimal lead-time. LibGuides default styles handled the heavy lifting of styling the prototypes. This meant that we could focus our efforts on the visual structure of the prototypes and on how best to deliver them to users. Ultimately, this allowed us to iterate through multiple sets of

prototypes. An iterative approach is recommended by others, such as Becker and Yannotta (2013); Nuccilli, Polak and Binno (2018); and Battleson, Booth and Weintrop (2001).

JavaScript application

We also needed a testing environment that would allow participants to interact with the prototypes. These interactions needed to be easily repeatable, efficient, self-explanatory and intuitive. With these goals in mind, we wanted to deliver the entirety of our testing process through the browser. Because JavaScript is the *de facto* browser-based programming language, we created our own JavaScript-based application to deliver our usability tests (Eaton 2017b). We structured and styled our interface by using Bootstrap as a framework (Otto and Thornton 2018).

The purpose of the JavaScript application was to walk the participants through the usability tests. Our goal was to make the process sufficiently intuitive that participants could complete the tests with minimal guidance. In this respect, the interface was largely successful. For the most part, our participants understood the interface and were able to work with it effectively. We provided guidance to individuals who asked for help during testing, however, but usually no intervention was needed on our part. This speaks to the effectiveness of the interface.

The JavaScript application did a couple of things:

(1) It gave participants a testing environment to work in. Each activity opened a small window describing the task to complete, and a much larger window with a prototype to work with. Users could work through the assigned task, and when it was completed, could close the window. This would return them to the landing page, where the task was marked complete, and they could move on to the next activity.

(2) The application also automatically mapped specific prototypes with specific tasks. Initially, we trialed a purely random sampling of tasks to prototypes, but ultimately a managed sample proved more useful for our purposes. Managing this with JavaScript was straightforward and reliable.

Flask application

The final piece of our apparatus was an application made in Flask, a web micro-framework written in Python (Eaton 2017a; Flask 2018). When participants completed an activity, the Flask application served up a page congratulating them on completing the activity. However, most importantly, the Flask application also harvested the data produced by the participants' interactions with our prototypes. This data was passed to Flask as parameters in the URLs that loaded the congratulations page. Our Flask application parsed these parameters and ultimately saved them in comma-separated values (CSV) format. As a result, as participants worked their way through the prototypes, their usage data accumulated in one very large server-side CSV file. CSV is a very useful data format, because it is easy to work with programmatically and with programs such as Microsoft Excel.

Recruitment

Our study targeted Kingsborough students, who are the most frequent users of the library's website. They are important stakeholders in the user population. To recruit students to our study, we approached them in the classroom. Both of us regularly teach one-time library instruction sessions for other professors' classes. When these faculty were amenable, we used a small part of our one-time sessions to recruit students. This approach reached a wide cross-

section of the student body; however, because the sampled groups were neither representative nor random, it is possible that this approach introduced some sampling error, as described by Galbraith (2017).

To recruit students, we explained our study to the class, and let them know that they would receive a $10 MetroCard as compensation for their participation. As specified in our IRB application, we obtained informed consent from participants. We had pre-installed our usability-testing environment on several computers in the back of the classroom, so that participants could complete the UX tests quickly after class. This meant that it was possible for students to take the test and still make it to their next class on time. This reduced the number of participants that were lost due to inconvenience.

Results and Discussion

Our approach provided us with a large dataset. We ultimately tracked 878 interactions with the prototypes. This represents approximately 78% of the total number of total possible trackable interactions. There are two reasons why we did not capture 100% of all interactions: First, participants did not necessarily complete every task. They had the option to move on instead of solving the task. We suspect that opting out was common. Second, participants may have come across one of the few exit points from the prototype not tracked by our Flask application. These untracked exit points were in the LibGuides header and footer. As the header and footer are standard across all of our library's LibGuides, not just the testing environment, and we did not configure them to capture usability data. These two types of data loss, while significant, did not ultimately interfere with an effective data analysis, as we still captured a very large amount of data.

While our methodological approach sidestepped some common problems with qualitative analysis -- such as those documented by Lanclos and Asher (2016) -- our methodology did fall short in some respects:

- Our quantitative data ignored users' sentiment while they were searching. We did not capture the thought processes or mental strategies that users deployed to get to their solution. In brief, our approach missed qualitative insights. A more traditional UX methodology may have captured these insights.
- We should have captured some additional quantitative data points, as they would have been interesting to analyze. Specifically, it would have been interesting to measure the amount of time spent on each task. In hindsight, it would have been possible to build this into the JavaScript application, however, we did not think of it until our data gathering was already complete.
- Thirdly, it would be interesting to have data about where the user navigated before committing to a solution. This feature is common to some subscription-based usability testing tools, such as Hotjar (Hotjar 2018). Unfortunately, building this functionality into our homemade apparatus was beyond the technical scope of this study.

The data, along with the prototypes used in the study, were analyzed and presented to the library's Website Committee by the authors. This Committee will ultimately make a decision on how to follow through on these findings, and how this information will be incorporated into an upcoming redesign of the Kingsborough library website.

Conclusion

Our approach to library web UX testing was somewhat atypical. We used home-built tools and gathered a much larger sample size than is typical of most usability studies. This had its successes and drawbacks. We found that building tools ourselves had many advantages, such cost, customizability, maintainability, ease of debugging, and the ability to focus on the data that we wanted. The downside was that this approach produced data and tools that are very specific to our study. If applicable elsewhere they would need to be modified. To this end, we have open sourced our tools (Eaton 2017a; Eaton 2017b), and we encourage others to customize them for their own purposes.

Most importantly, what we learned from this study will guide the development of our website going forward. Our approach ultimately provided practical, actionable conclusions. Data-based insights now support our decision-making process about the library's website design. This is a major victory. The UX testing process that we have described here has greatly improved one aspect of our broader website refresh cycle.

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