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The Design Cycle and a Mixed Methods Approach for Improving Usability: A Case Study

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Abstract

This case study explores the concept of the design cycle as a guiding principle for choosing usability methods. It discusses the stages of the design cycle alongside the strengths and weaknesses of usability methods commonly used in libraries. Hollins University applied the design cycle principles to the redesign of the library's website, which involved various methods (e.g. analytics, card sorting, content audit, surveys and usability testing). This article argues that using the design cycle encourages an effective practice of mixing different usability methods, which leads to a more informed approach to improving usability. It concludes with recommendations for application of the design cycle to library projects.

Keywords: academic libraries, design cycle, mixed methods, website design, usability

Introduction

"All of us are smarter than any of us" (Brown, 2009, p. 26).

The design cycle, also known as design thinking, is a user-focused and user participatory

approach to problem-solving that can result in novel designs and a competitive advantage

(Gibbons, 2016). It places an emphasis on the stages and methods used to discover a problem,

generate solutions, test solutions, and then revisit the problem with the data acquired during the

process.

The design cycle pursues the goal of improving usability by listening to users and

observing user behavior through a variety of methods. This listening stage provides insights and

sets the goals for the usability project. The users are the primary group engaging with the website

or service so it is pragmatic that users define the problem and set the goals. Aside from defining

goals, the design cycle can allow users to participate in creating solutions. These solutions to

usability problems are tested, adjusted, and retested in the design cycle. The cycle is recursive so

stages may be revisited and repeated for the same project. The design cycle has a sequence of

stages and associated methods for each stage that provide direction, structure, and logic to any

usability project.

The library staff at Hollins University, a small women's liberal arts college, wanted to

redesign the library's website in concordance with our mission statement of "connecting our

patrons with resources that advance scholarship and creative work" as well as "teaching students

to thoughtfully engage in the discovery and use of information" ("Wyndham Robertson Library

mission," n.d.). Applying the design cycle to a website redesign project aligned with our mission

statement by striving to create a more usable website that supported our users' priorities. This

case study details the stages of a website redesign project in the context of the design cycle and

includes a discussion of design cycle principles. Included are sections for each stage of the

design cycle, which list the methods typically associated with each stage and also provides

guidance for choosing a method based on the nature of the usability project. The article

concludes with recommendations for librarians interested in applying the design cycle to their

usability project. The recommendations should scale for a usability working group or a single

librarian working on a usability project.

The design cycle as a concept

The design cycle is also described as a design map, design method, design framework, design

thinking, or development cycle. This article refers to this concept as the design cycle. There are

many versions of the design cycle. One of the most well-known models is the five-stage model

from the Hasso Plattner Institute of Design at Stanford University, whose stages are

"empathize," "define," "ideate," "prototype," and "test" (2010, pp. 2-6). Another prominent

model is the International Baccalaureate, whose four stages are "inquiring and analyzing,"

"developing ideas," "creating the solution," and "evaluating." (2014, p. 2). Despite the varying

number of stages, the principles and ingredients of all design cycles are similar and models with

fewer stages often bundle multiple processes into one stage. For instance, "empathize" and

"define" are the first two stages from the Stanford model, which considers them to be two

separate processes of understanding users in order to define a problem. These two processes are

handled in the first stage of the International Baccalaureate model named "inquiring and

analyzing." Schmidt and Etches break the design cycle into the stages "observing,"

"prototyping," "testing," and "implementing" (2014, pp. 151-153). This case study applied a

three-stage design cycle model because I was the sole researcher and dividing the process into

three stages was more efficient and streamlined the process.

This paper will use Schmidt and Etches's terms when referring to stages of the project: observing, prototyping, and testing/implementing (2014). While Schmidt and Etches define the first stage of the design cycle as "observing", Usability.gov calls it "plan" and "analyze" ("User-Centered Design Process Map," 2013) and the Nielsen Norman Group (Gibbons, 2016) uses the terms "empathize" and "define." This first stage deals with understanding users and recognizing their difficulties using a library resource (e.g. difficulty finding journals in a discovery system). This stage uses information from users to define the problem and in doing so gives direction for the project and may help to define its goals.

The second stage of the design cycle is called "prototyping" and "ideating" by Schmidt and Etches (2014) and the Nielsen Norman Group (Gibbons, 2016), while Usability.gov defines this stage as "design." This stage involves generating ideas to resolve the problem identified in the first stage. The ideas could, for instance, involve a change to a website or discovery system to decrease the difficulty of using a feature by making changes (e.g. providing a filter to restrict search results to journals). This stage is not strictly the domain of librarians or designers because users can share their design ideas for improvements to a project.

The third stage is defined as "test and refine" by Usability.gov or "testing and implementing" by Schmidt and Etches (2014) and the Nielsen Norman Group (Gibbons, 2016). In this final stage, users test the design ideas generated from the second stage. In other words, librarians test the prototypes created in the previous stage to see if they help resolve usability issues. Using the previous example of users having difficulty finding a journal, the activity in this stage might involve giving users journal-finding tasks on a prototype version of a website or discovery system. During this stage users give feedback about the prototype site designed to make finding journals easier. After this stage the design cycle practitioner modifies the prototype

based on users' reactions and actions during the test. After reviewing the findings from this

stage, the prototypes are implemented or go "live."

The design cycle is often illustrated as a wheel, circle, or a flow chart of interconnected

activities. It is illustrated this way to emphasize the concept of each stage of the design cycle

informing the next stage. Moreover, the circular nature denotes there is no finish line in the

design cycle as the "final" stage can lead back to the first stage. The design cycle is illustrated

and structured in this cyclical way to encourage practitioners to run through the process multiple

times. Repeating the cycle creates an iterative process of continually improving the user

experience. Each stage of the design cycle provides insights and possible solutions to usability

issues, so an understanding of the design cycle may help a librarian to improve the user

experience.

Improvements to a library system may be suboptimal if stages of the design cycle are

skipped. Skipping the "observing" phase means losing the opportunity to hear what users

struggle with while using a library system or what changes users want. Deciding to skip the

"testing/implementing" stage means making a change to the library system but not seeing how

users react to the change before implementation. Users are involved in every stage of the design

cycle. The beginning stage (observing) opens up communication with users about what they

need. In the middle stage (prototyping), design cycle practitioners devise solutions and can

involve the user in creating them. In the last stage (testing/implementing), users see prototypes

and have the opportunity to engage with them, while practitioners listen to their reactions.

This paper examines how libraries can use the design cycle to apply a mixed methods

approach to usability research. Usability methods may include surveys, focus groups, usability

testing, content audits. A mixed methods approach is a "class of research where the researcher

mixes or combines quantitative and qualitative research techniques, methods, approaches,

concepts or language into a single study" (Johnson & Onwuegbuzie, 2004, p. 17). This approach

can be advantageous because it harnesses the respective strengths of qualitative and quantitative

methods to gain more complex insights that single methods are unable to provide (Johnson &

Turner, 2003). Choosing combinations of methods can seem overwhelming based on the sheer

amount of methods that exist. Using familiar methods, perhaps those from previous projects, is

appealing, but this can create blind spots as each method has limitations in gathering data. This

paper argues that following the design cycle can simplify the selection process because each

stage of the cycle calls for different methods. See Table 1 for the stages of the design cycle and

methods commonly associated with each stage.

Table 1. Design cycle stages and associated methods

STAGE 1 Plan/Analyze Observing Empathize/Define	METHODS Analytics, Focus Groups, Interviews, Personas, Surveys, Task Analysis
STAGE 2 Design Prototyping Ideate	METHODS Card Sorting, Content Audit/Inventory, Parallel Design, Prototyping, Usability Testing
STAGE 3 Test and Refine Testing/Implementing	METHODS First Click Testing, Heuristic Evaluation (aka Expert Review), Usability Testing

It is common to divide methods into either a quantitative or qualitative category, but there

are additional ways to categorize usability methods. The Nielsen Norman Group categorizes

methods as attitudinal or behavioral, qualitative or quantitative, or contextual or decontextualized

(Rohrer, 2014). These categories can be a useful framework for understanding the benefits and

limitations of different methods. Seeing how different categories of methods counterbalance the

weaknesses of other methods makes selecting a mix of methods easier. This article will not attempt an exhaustive treatment of all methods, but covers common methods used in libraries, based on a review of the literature.

Surveys are common in libraries and as a method are in the attitudinal category because they gather participants' thoughts about the website and are decontextualized because the survey is not done while actively interacting with the website. Classic usability tests, whereby a user attempts tasks on a website while thinking out loud and under the observation of a facilitator, are in the behavioral and contextual categories because they collect behavioral data while a participant uses the website. Applying a small number of different methods from different categories ensures a well-informed and holistic approach to improving usability. Moreover, seeing how these methods relate to, and can supplement, one another shows the possible benefits of a mixed methods approach for improving usability. The findings from one method can inform the implementation of another method. For example, a survey about a website reveals users' difficulty with a particular feature of the website and a subsequent usability test is designed to test that particular feature.

This article aims to show how to choose different methods based on the stages of the design cycle and the needs of the project. The hope is that this enables librarians to choose a variety of methods that complement each other and produce more reliable data for defining the goals and course of action for a usability project.

Literature review

Broadly speaking, there is scant literature about libraries and the design cycle. One of the few publications available is the design thinking toolkit for libraries created by IDEO, a global design company, with the Chicago Public Library and the Aarhus Public Libraries in Denmark ("Design

Thinking for Libraries," n.d.). The toolkit covers each stage of the design cycle, as well as

pitching a project idea to administrators, managing a project, and case studies from various

settings such as dating apps, hospitals, public libraries, and school cafeterias. The case studies

touch briefly on the methods used to reach a project goal. The toolkit uses a wide approach to

project areas, which includes programs, services, space, and systems. It is helpful in unpacking

the design cycle, but there is no close examination of a library-related project and how each stage

of the design cycle guided the choice of methods for the project.

In the library literature, Manzari & Trinidad-Christensen (2006) used a combination of

heuristic evaluation and usability testing to reveal different usability problems. Heuristic

evaluation judges the library's website against a list of recognized usability principles. Rogers

and Preston took a "multilateral approach" (2009, p. 202) using surveys, focus groups, usability

tests, and card sorting. Two studies (Carter et al., 2005; Oldham, 2008) began their projects using

a combination of methods (focus groups and a usability consultant) that later informed their

design and use of classic usability testing. Zaugg, Terekhova, and Rennick (2015) conducted

three levels of assessment (focus group, survey, and usability test) and each method informed the

design and use of the subsequent method.

These papers do not mention the terms "design cycle," "design thinking," or "design

framework", but these studies do contain a semblance of the design cycle. For instance, using a

focus group and survey are forms of "observing", then using their findings to design a usability

test is a form of "prototyping", and conducting usability testing is a form of

"testing/implementing."

The greatest variety of usability of methods was used by Florida International University

(FIU) Libraries in a series of four website redesigns between 2001 and 2014 (Dominguez,

Hammill, & Brillat, 2015). Their design methods included focus groups and analytics (a form of

observing), think-aloud usability testing (testing/implementing), and content audits and card

sorting (prototyping).

This review of the literature suggests that although many libraries are using a mixed

methods approach to usability testing, which is a tenet of the design cycle, few or none are using

the design cycle as a guiding principle for selecting the methods. The cited articles answer the

question of how they gathered data for a usability project, but many do not discuss the rationale

for choosing each method. Rogers and Preston (2009) and Zaugg et al. (2015) mention user-

centered design principles, however there is no discussion of how these principles drove the

selection of methods for their projects. None of the articles, aside from the design thinking

toolkit from IDEO, discuss the design cycle as a guiding principle for choosing usability

methods to apply to a project.

Outside of libraries, there are examples of explicitly and intentionally applying design

thinking and the design cycle to usability problems. Toyota redesigned its Customer Contact

Center by using journey maps and interviews about internal processes (observing), including

Contact Center associates in the process of sandbox redesigns (prototyping), and testing the new

system with customer inquiries (testing/implementing) (Liedtka, King & Bennett, 2013). The

redesigned website enabled associates to resolve customer inquiries with fewer calls and less

time on hold, and in doing so saved money by enabling their associates to answer more customer

inquiries. Kalaichandran (2017) describes the crowding of a hospital trauma area with nurses,

physicians, and respiratory therapists, and how this high number of staff made it difficult to

determine which staff member was leading the trauma team for each patient. Through simulating

a scenario of a gunshot wound victim entering a fully staffed trauma area (observing), a nurse

came up with the idea (prototyping) that the leader of the trauma team wear an orange vest so

others can see who is in charge (2017). This simple change led to more effective communication

among staff (testing/implementing). Both of these case studies outside of libraries show the value

of observing the problem, cultivating empathy for those affected (e.g. Contact Center associates

and nurses), and allowing the affected individuals to participate as co-creators in devising a

solution.

Profile of the library

Hollins University is a small women's liberal arts college with an FTE of approximately 650

undergraduate students, 150 co-ed graduate students, and nine full-time library staff with one

staff member in charge of web services. Primary interactions between library staff and library

patrons occur during instruction sessions (averaging over 100 per year) and Reference desk

hours (roughly 450 hours per year). The library also has a Student Advisory Board, which allows

students to play a role in library operations by providing feedback about services, collections and

programs. The library's website and discovery system are common topics for the board's

discussions. Specifically, the board has provided feedback during the process of changing our

ILS providers from Millennium to Ex Libris and during the process of changing website

platforms from Dreamweaver to WordPress.

The library is dedicated to providing excellent customer service, in particular by making

an effort to listen to our users. We wanted to follow an approach to redesign that would put the

users' needs first and the design cycle provided a helpful set of principles to follow. The aim of

the project was to use the design cycle to identify problems and improve the website from a

user's perspective.

Stage 1: Observing

The observing stage gathers information about users in order to articulate goals for the project. Put simply, this stage is learning about a problem. Acknowledging previous reported problems is important in the observing stage. Known problems should be investigated in this stage, but whichever method chosen should also allow respondents to report new or unanticipated problems. For instance, a survey designed to uncover new problems could have questions about finding books and articles but also include an open-ended question prompting students to share experiences with tasks on the library's website that they find difficult. Exploring solutions to known problems may be categorized as "confirmatory" research, while deploying methods strategically to discover new problems may be categorized as "exploratory" research (Jaeger & Halliday, 1998). Regardless of the stage of the design cycle, usability methods should strive to combine elements of confirmatory and exploratory research.

Depending on the project, certain methods may be more suitable for observing users. If observing or defining a problem involves an extended conversation about a topic with unspecified problems (e.g. student attitudes to ebooks), this requires a deeper dive than a survey or an analysis of analytics data. For this kind of topic, the methods of interviewing or conducting a focus group are more appropriate, allowing a librarian to pose questions and then probe deeper with different questions based on the responses. Conversely, if the goal is narrower than the ebook topic (e.g. evaluating how users feel about one small change to the homepage, such as adding a dropdown menu to a search box), then a survey focused on that particular change may provide valuable information. In any case, the observing stage contains an empathy component, which means librarians have to step away from their perceptions of a problem and allow their approach to a problem to be shaped by the needs and preferences of users.

In the Wyndham Robertson Library observing phase, the problem was a cluttered homepage. When asked informally in instruction sessions about the library's homepage, students commented about the website being "too busy" or "crowded." Instead of removing content from the page without user input, library staff decided to survey students in the fall of 2015 about the layout of the homepage. This was "confirmatory" research because library staff were aware of the perceptions of the homepage. The survey also posed general questions about using the website, which was "exploratory" research designed to discover unknown issues.

We chose a survey as a method because it was easy to deploy to a large number of people and it allowed users to respond without the influence of a librarian who may have different rankings of importance for items on the homepage. In an interview or focus group, people "bend the truth to be closer to what they think you want to hear or what's socially acceptable" (Nielsen, 2001, para. 3). Surveys have the weakness of being a self-reporting method. In self-reporting, participants tend to over-report behaviors seen as appropriate or desirable (Donaldson & Grant-Vallone, 2002). However, we believed that our survey would be less affected by this bias than focus groups or interviews.

One goal of the homepage survey was identifying low-priority resources and links for possible removal. The library's homepage had a box at the top of the page that included tabs and search boxes for the catalog, "Articles & Databases", "eBooks", "Frequently Asked Questions", and "Reserves." Below the tabbed search box were two sets of links under the headings "FIND" and "QUICK LINKS". In the first half of the survey, we asked respondents to rank the search box tabs and links from most important to least important. Allowing users to assign rankings and values was intended to show them their point of view was important and to communicate empathy.

The second half of the survey included general open-ended prompts (e.g. "Complete the

following sentence. On the library website I can never find…"). These prompts allowed

respondents to comment on their overall experience using the site so the data we collected was

not limited to the homepage. As noted, questions for surveys, focus groups, or interviews should

give the respondent latitude to bring up problems not anticipated by the researcher. This allows

the research to be exploratory.

There were 61 respondents to the survey (95% undergraduate, 2% graduate students, and

3% faculty). 24 responded to the question "On the library website, I would like to see…." and

21% requested easier access to databases from the homepage, in the form of a clearer and more

extensive list of databases and 25% requested a layout or design that was easier to read (e.g. less

text, more noticeable font, and fewer links). Database access and homepage layout were the most

consistent themes identified in this question. There were 20 responses to the question "On the

library website, I can never find…" and 20% stated the interlibrary loan service, which was the

most consistent response. Although less significant of a trend, the My Account feature was

mentioned once in both the "I can never find…" and "I would like to see…" questions.

Naturally, there is no perfect method in the any stage of the design cycle, which is why

using multiple methods in each stage is important. Surveys, like interviews and focus groups, are

a form of qualitative and attitudinal data, describing users' self-reported behaviors. A survey

may be valuable for assessing users' needs and primary tasks, even though it does not show how

these tasks are being done, specifically where the pain points are located. Rubin and Chisnell

explain that asking people what they usually do on a website is no substitute for watching them

in a usability test, but surveys help "begin to understand the preferences of a broad base of users

about an existing or potential product" (2008, p. 17).

In this stage of the project, we supplemented the survey with analysis of web analytics, a

quantitative method. Web analytics can track and report in a limited way what users do on a

website, and so fall in the observing stage of the design cycle. Analytics have the limitation of

not explaining users' behaviors (Fagan, 2014). Nonetheless, supplementing attitudinal data, such

as the previous survey, with analytics is a good protection against the biases in self-reporting or

weaknesses in qualitative sampling. Web analytics can, for instance, control for an imbalanced

sample such as our survey, which had a 3% faculty response. Analytics data can be a supplement

to any other usability method. Analytics data will not always corroborate or contradict a trend in

surveys or findings from other tools, but it offers an additional empirical viewpoint. Similar to

surveys, analytics can help prioritize which tasks or pages to focus on during the prototyping and

testing/implementing stages of the design cycle. Goward (2012) argues that analytics data is the

most important resource for prioritizing what to test.

To supplement our survey with analytics, we used Google Analytics and Crazy Egg to

track website activity from August through November of 2015 while the survey was underway.

A tool like Google Analytics can identify which pages of a website are most popular and which

are rarely viewed. This data can be used to corroborate responses to survey questions such as

"What's the number one reason you visit the library's website?" Crazy Egg is a web analytics

tool that takes a screenshot of a web page and displays all clicks as a heat map. Crazy Egg is

priced by number of "snapshots" or pages loaded with the software. In our project, the homepage

was the only page loaded with the tracking software.

Google Analytics showed the databases page was the second-most-viewed page and this was consistent with the survey responses. The Crazy Egg snapshot of the homepage showed the "Articles & Databases" link (in a table in the center of the page) and "Articles" tab (in the tabbed search box) were the "hottest" with the highest click numbers. The click numbers for the links to "Books," "Course Guides," "Films" and "For Faculty" also showed high use of these pages. Crazy Egg revealed "cold" links in the center table that received few clicks, if any. The Crazy Egg visualization of activity on the homepage provided a strong basis for decisions about removing low-priority links.

Crazy Egg also showed the percentage of clicks for each element (e.g. image, link, text, form). This is useful data in light of the trends in survey results, which indicated certain links (e.g. Interlibrary Loan and My Account) were difficult to find. The "Interlibrary Loan" link received 1.28% of the total clicks on links from the homepage, which appeared to corroborate survey responses that it was difficult to locate. The "MyAccount" link received 8.21% of the total clicks on links from the homepage. These percentages can be used as a benchmark when checking a site after making changes.

Crazy Egg data revealed the "For Faculty" link was the fourth most popular link of the ten links in the center table and was an important link to keep on the homepage. The popularity of the "For Faculty" link was noteworthy because it exposed representational weakness in the survey. A weakness in the survey data collection was the overrepresentation of undergraduate students (95% of respondents) and underrepresentation of other user groups such as faculty (3%) and graduate students (2%). Had we relied exclusively on the survey data, we might have removed this popular link.

The results of analysis in the observing stage can inform the next stage (prototyping) of

the design cycle and allow a design cycle practitioner to make strategic decisions to address the

findings from the observing phase. It was clear from the results of our observing methods that

the next stages (prototyping and testing/implementing) needed to address access to databases and

the findability of links.

Stage 2: Prototyping

The prototyping stage entails generating ideas to solve problems that were discovered and

analyzed in the observing stage. Some design cycle models call this stage "design" or "ideate."

The ideas in the prototyping stage should not come from thin air and should flow from identified

problems in the observe stage. If the prototyping stage is not informed by the observing stage,

the new ideas will not address the problems users have and may even create new ones.

The literature on this stage of the design cycle emphasizes developing a lot of ideas for

the defined problem and not looking for one single "right" idea from one individual. The Hasso

Plattner Institute of Design at Stanford University describes this stage as a process of "going

wide in terms of concepts and outcomes" (2010, p. 4). One method that particularly illustrates

the approach and spirit of this stage is the practice of parallel design. In parallel design, members

of a team, which could comprise students and librarians, independently create their paper

prototype of a web page, addressing the problems identified in the observing stage. The team

shares its paper prototypes and then creates a new prototype with the best ideas from each

design. This approach embodies the "going wide" maxim by including many different ideas and

concepts from multiple perspectives. Typically, parallel design is followed by usability testing of

the resulting prototype. Using parallel design and usability testing in sequence is a way to

compensate for the weaknesses of each method and illustrates the strength of a mixed methods

approach. As in each stage, mixing multiple methods in the prototyping stage provides a more

holistic approach toward the problems defined in the observing stage.

One of the goals for the library's website was to remove elements with low use or user

value from the homepage and the survey results in the observing phase informed this goal. In the

prototyping phase, we could have focused on the homepage, but library staff were also interested

in broadening this goal to include the rest of the website. If users had difficulty finding certain

links on the cluttered homepage, were they also struggling with finding resources on other parts

of the website? We needed a method that would address the entirety of the website's pages. A

usability test would be too narrow to evaluate the issue of clutter on a larger scale. We therefore

conducted a content audit (also called a "content inventory"). A content audit involves itemizing

each page on a website and assessing it by asking whether the content needs to be revised,

removed, or moved to a new location ("Content inventory," 2013). In a content audit, staff may

realize that some library services or information are not included on the website. This can

generate a discussion of what services or information should be included and why. The content

audit is likely to be perceived as the most time-intensive process for improving usability, mainly

because it involves looking at everything on the website.

A content audit is appropriate for the prototyping stage of the design cycle because

practitioners can conduct content audits after information on users is collected during the

observing stage. Content audits are limited in that they do not directly ask for input from users,

aside from library staff, about how to streamline the content. However, a content audit that

integrates analytics data, gathered in the observing stage, strengthens the method by bringing

users' behavioral data into the decisions made as a result of the audit. For instance, page views

show which pages users skip over or rarely visit. For this content audit, I shared analytics data

for all pages with library staff. They then performed a content audit in their assigned sections of

the website. Sharing usage data may temper unrealistic perceptions of the importance of certain

pages. Google Analytics showed our "News" category had only eight visits in 2015-2016. The

low views did not necessarily mean we should remove the "News" category and the pages

within, but it led to a discussion of the location of the "news" pages.

One way to structure a content audit is to create a form in Google Docs and assigning

department heads a set of pages related to their department. The form serves as a springboard for

conversations about pages to edit, revise, or delete. Establishing a means for discussion as part of

a content audit is similar to parallel design because it involves people with different ideas and

perspectives, and may provide a way to synthesize the best ideas on how to proceed.

Our content audit enabled us to streamline our site. We combined two pages dealing with

government documents into one updated page. We caught outdated language about login

procedures for our Interlibrary Loan service and moved a link to an FAQ about Interlibrary Loan

to the Interlibrary Loan login page. The content audit also alerted us to a few instances of pages

linked from multiple menu categories. For example, the "Reserves" page was linked from the

"Find" and "Borrow" menu categories. Although it is common practice to have the same link in

multiple menu categories, this project aimed to involve users in the categorization of links in an

attempt to make the links easier to find.

To evaluate whether the current menu categories and placement of pages within each

category made sense to our users, we used an additional method to obtain input from our users.

Card sorting is a method that can be used to gather user input on content organization and

labeling in the user interface (Rubin & Chisnell, 2008). During a card sorting session,

participants organize topics or web pages into categories that reflect their preferences. Users have pre-existing mental models about where certain items should be located in different settings, be it links on a website or produce in a grocery store. In interface design, mental models help a user determine how to interact with a website and these models are based on previous experiences with other websites (Weinschenk, 2011). Card sorting generates data that can help reorganize a website to better fit users' expectations or mental models of how content is arranged.

There are two principal types of card sorting: "open" and "closed." In "open" card sorting, participants organize web pages into categories they think are apt, then name each category they created in a way that they think correctly describes its pages ("Card sorting," 2013). This type of card sort is appropriate when library staff do not have predetermined categories or groups for the web pages. We decided against using this kind of card sorting because library staff had already identified their preferred categories. Our 2016 site had categories for "Find," "Borrow," "Services," "News," "Contact Us," and "About Us". Many of these categories overlap and could create confusion for a user. Interlibrary Loan, for instance, is a service, but is also a form of borrowing. "News" had had only two links and low page view numbers, so this category was a candidate for elimination or combination with another category. Library staff agreed on the following categories: "Find," "Services," "About Us," and "Help." We therefore used "closed" card sorting, where participants organize website pages into previously created categories ("Card sorting," 2013). Our goals for the card sort were to get users' input on which pages should be placed in which category. We also wanted to review the categories selected by library staff, so we included the following question at the end of a questionnaire answered by the users who participated in the card sort: "Do you think there

should be a different category from the ones listed (Find, Services, About Us, Help)? If so, what

would you name this category?"

Card sorting exercises can take place in person or online. We chose the online option

because we were conducting our card sort in the summer and few students would be on campus.

Instead, the online option could reach off-campus students. We used OptimalSort from Optimal

Workshop, which required a $100/month subscription, because of the ease of set-up and the

robust reporting and analysis. Optimal Sort offers many analyses out of the box. The one that

stood out as particularly useful was the Popular Placements Matrix, which highlights the most

popular groupings. After reviewing the data, we placed our pages in the categories deemed most

popular by the most participants. Placing the pages' organization in the user's hands felt

liberating because the resulting data resulted in less disagreement between library staff about

organization than might have been expected.

When recruiting participants for the card sort, we referred to a "questionnaire" and

purposely avoided using the term "survey." We had asked users to take website surveys

previously so instead of asking them a second time to take a survey, we thought using a different

term would minimize potential fatigue or annoyance about completing a card sort. There were 35

participants, consisting of 15 faculty, 13 undergraduate students, one graduate student, and six

staff members. The card sort included 25 pages.

There were clear trends in the Popular Placement Matrix (see Figure 1). For 15 pages,

70% of more of the participants placed it in the same category. For seven other pages, the

percentage was 60%-69%. For the remaining three pages, the percentage was 49%-51%. One of

these three was the "Reserves" page, which participants placed in two categories in similar

proportions: 51% in "Find" and "46%" in "Services."

Popular Placements Matrix ⊚

	Find	Services	About Us	Help	unsorted
Journals by Title	94%	6%			
Articles and Databases	89%	11%			
Films	86%	14%			
Government Documents	86%	14%			
Music Library	74%	20%	6%		
Special Collections	71%	29%			
Course Guides	69%	20%		11%	
New and Recommended	69%	26%	6%		
Digital Commons	63%	29%	9%		
Reserves	51%	46%		3%	
FLEX Delivery		97%	3%		
Interlibrary Loan	9%	89%		3%	
Locker & Carrel Reservations	3%	74%	11%	11%	
Renew/My Library Account	14%	60%	3%	23%	
Staff and Departments	3%		91%	6%	
Library Blog	3%	9%	80%	9%	
Hours	3%	6%	74%	17%	
Library Newsletter	3%	23%	71%	3%	
Library Policies			63%	37%	
Borrowing Policies		14%	51%	34%	
Ask a Librarian		20%	3%	77%	
FAQs		3%	20%	77%	
Submit a Suggestion		14%	20%	66%	
Video Tutorials	17%	20%	3%	60%	
Library Floor Maps	17%	3%	31%	49%	

Figure 1. Optimal Workshop's Popular Placement Matrix. Percentages represent the proportion of students placing a page in the same category.

Overall, participants voiced approval of the proposed categories, deeming them comprehensive and easy to understand. After sharing the results with library staff for discussion,

the library renamed the categories and reassigned several web pages to different categories,

based on the users' responses.

Card sorting is decontextualized, which is a limitation, because the users are not using the

website as they put pages into categories. Card sorting is also a form of self-reporting, but

quantitative analysis of the data can show the most popular placements. Card sorting pairs

especially well with content audits as an audit provides an updated list of pages to use in the card

sort. This method collects feedback from users and thereby acts as a counterbalance to the library

staff-dominated input of content audits.

Usability testing can be applied as a design method in both the prototyping and the

testing/implementing stages of the design cycle, which can be confusing. There are two

processes at play with usability testing: creating the usability test and conducting the usability

test with users. Separating usability testing into two distinct stages of the design cycle

emphasizes the importance of deliberation in creating the tasks or questions for the usability test

in the prototyping phase before conducting usability testing in the testing/implementing phase.

The observing stage plays an essential role by giving a librarian a baseline to design tasks for the

usability test. How would a librarian design a usability test if they did not know users' key tasks

or difficulties they have? Without that knowledge, a usability test might include tasks that

interest librarians, but do little to explore a user's needs. For instance, pursuing an uninformed

design of a usability test guided by a librarian's interest might create a task such as performing

an advanced search for a journal using an ISSN. Such a task might be valuable and interesting to

a librarian but perhaps not to a student. This kind of uninformed task design amounts to wasted

effort because it ends up addressing an imagined need or concern instead of users' actual needs

and concerns.

In the observing stage, the Wyndham Robertson Library collected data from users that

enabled it to begin designing tasks for the usability test. The survey results in the observing stage

showed that users wanted an easier way to access databases, a less cluttered homepage, and a

more readable layout or design. We were intentional in designing tasks that would hopefully

address and tease out difficulties users had with the website. The analytics findings from the

observing stage also helped us select tasks for the usability test. The analytics showed that the

databases page was used the most, so the test design had a section of tasks dealing with

databases. Other tasks included using the catalog to find books and DVDs, and checking the

user's library account for checked-out books. Additional tasks were finding journals, finding

librarians by name or subject area, and finding hours of operation.

Three Work-Study students tested the draft of the usability tasks to make sure the

questions were clear and comprehensible. They confirmed the importance of certain tasks (e.g.

finding the "My Account" link, finding databases) by reporting a high frequency of questions

about these tasks. Being previously trained by the head of Circulation to answer basic reference

questions, the Work-Study students had little difficulty completing nearly all of the tasks in the

usability test. However, they struggled somewhat finding librarians by subject.

Going "wide" in the prototyping stage meant using a mix of methods that included ideas

and perspectives from both library staff and users. Including multiple groups in the prototyping

phase meant there was a decentralized generation of ideas. By using a content audit and card

sort, ideas did not flow from only one person or one group, and users played a role as co-creators

or co-designers. In addition to generating a broad spectrum of ideas, being intentional in the

prototyping phase entailed analyzing all the data collected in the observing phase and using the

analysis to guide the design ideas in the prototyping stage.

The appropriate method for a library in the prototyping stage depends on the goals or

domain of the project. For a broader goal such as improving the categorization or findability of

pages, a content audit followed up by a card sorting exercise for users is a suitable option. If the

usability problem is more defined (e.g. setting up a clear process on the website for scheduling

an appointment with a librarian), creating a few prototypes to test with students is more

appropriate. The prototypes can either be functioning web pages or paper mock-ups that simulate

the process of scheduling an appointment. Asking students to indicate their preference among the

prototype pages and whether anything is unclear about them drive the process of creating a better

prototype. The most-recent prototype can be tested until most users are able to use it without

difficulty. A broad goal such as findability of pages can be paired with a more refined goal such

as the library appointment scheduler by placing the page for library appointments in the card sort

to see where most users would look to find this service. Libraries should include users in the

prototyping stage so the ideas from this stage directly address users' difficulties and

acknowledge their preferences.

Stage 3: Testing/implementing

In this stage, librarians introduce prototypes to users and facilitate their interactions with each

one. The testing/implementing stage is an opportunity for learning even more about users and

developing additional empathy while watching how they interact with prototypes. Watching the

effectiveness of the prototype in resolving usability problems makes this "rubber meets the road"

stage arguably the most exciting one. It can be gratifying to see students use a newly designed

element to complete a task as intended. Another useful, and sometimes bewildering, aspect is

observing unexpected behavior and thereby learning more about users, which can lead to

developing a solution to a previously unknown problem. Above all, perhaps the biggest reward is

seeing how the design stages cascade into each other and provide valuable insights into

improving usability.

Choosing a method in this stage depends on the goal. If a library is looking for input on a

site's general design, accessibility, and usability, a heuristic evaluation is a good match.

Heuristic evaluations are typically conducted by a usability expert, broadly defined as someone

with experience of conducting UX research and observing user behavior. A heuristic evaluation

checks for adherence to usability guidelines and principles of human-computer interaction

(Harley, 2018). A heuristic evaluation analysis provides a list of potential usability issues, which

may be different from those found in usability testing, so a heuristic evaluation should not be

used as a substitute for usability testing ("Heuristic evaluations", n.d.). A few common heuristics

include remaining consistent in user interface design, minimizing the number of steps a user has

to take to complete a task, and avoiding unclear language (Douglas, 2017).

If a library wants to address a defined problem or gain insight on how users complete

specific tasks, a usability test is a better choice as it lets a librarian choose the tasks to test with

users. A usability test provides a window into the approach and thoughts of users. During

usability testing, a participant completes tasks on the website while a facilitator takes notes. Web

usability tests often follow a think-aloud protocol where participants narrate or verbalize their

thoughts while working through tasks. These tests expose the pain points a participant encounters

with key tasks and through "thinking out loud" the facilitator hears the participant's thoughts

during the task. Recording these tests via screen capture software allows librarians to review and

discuss the data.

Usability testing in the testing/implementing stage allows for a unique window into behavior otherwise not discoverable with methods such as surveys, interviews, or focus groups. It is behavioral and contextual because a practitioner observes users as they complete a task on the actual website, in contrast with other methods (e.g. surveys, interview) that are attitudinal and decontextualized because the practitioner gathers information from users about their feelings or attitudes about the website at a time when they are not using it. The testing/implementing stage generates a unique type of data and is an essential part of the design cycle.

Usability testing is a good method for addressing defined problems with specific tasks, but it can also explore other features of a site or system. For instance, library staff might know that most of their students are unaware of how to renew books by logging into the "My Account" section. The library staff might not know whether students are aware they can update their personal information in the "My Account" section. Usability testing could address the known problem of renewing books with a task and explore students' awareness of the feature by asking them to update their personal information during the test. This would be confirmatory and exploratory research.

Usability testing has the limitations of being an artificial environment and an approximation of what a user would do and how a user would behave. Also, the sampling of tests may not be representative (Rubin & Chisnell, 2008).

A variation on the classic usability testing method is guerrilla usability testing. In guerrilla usability testing, participants are not recruited in advance and the testing has fewer tasks than a classic usability test (Adiseshiah, 2018). Also, guerrilla testing can be used on more primitive prototypes. For example, a facilitator can present sketches or paper prototypes of designs to users and ask them how they would perform a task on the prototypes. Alternatively,

this shorter method can also be used with fully functioning prototypes (e.g. a developed website)

in a similar way as classic usability testing, except with fewer tasks. One advantage of guerrilla

usability testing is the ease of finding participants for testing. There is no formal recruitment

process (e.g. creating fliers, advertising incentives to participate in a test). Using the guerilla

method, a facilitator approaches a potential participant, explains their objective (e.g. testing a

feature on a website), and jumps directly into the test. With permission, they might record the

participant using the website. A limitation of guerrilla usability testing is that the facilitator

spends less time and tests fewer tasks than classic usability testing. This shorter method might be

more appropriate for a library staff with time constraints. Libraries preferring frequent and short

usability tests instead of infrequent and more extensive tests may prefer this method. Guerrilla

testing is also useful for libraries seeking users' perspective on rough layouts of web pages.

Using the survey and analytics results from the observing staging, the Wyndham

Robertson Library had a list of defined problems and a strong interest in observing users attempt

to find databases, log into their accounts, and perform other tasks. As mentioned, the data

collected from the observing stage informed our design of the usability test in the prototyping

stage, and we felt that our usability test addressed defined problems. After receiving IRB

approval to ensure the methods, format, content, and test conditions provided anonymity and

safety, the library set up individual tests through appointments and met our goal of testing 10

students in spring of 2016. This number fit with Rubin and Chisnell's (2008) recommendation to

test at least eight participants. Nielsen and others (2000; "Recruiting usability test participants,"

n.d.) estimate that the majority of usability problems are identifiable with four or five

participants, but this low number poses difficulties for obtaining a representative sample.

The 2016 usability tests had students find books and DVDs in the catalog, log into their

accounts, determine whether the library held specific journals and in which format, find specific

databases, find contact information for specific librarians, and determine the library's hours of

operation for the following week. In addition to completing tasks, we asked students to preview a

prototype databases page. This was the "A-Z" list of databases available through our subscription

to Springshare's LibGuides platform, which we considered a clean and simple alternative to the

current page. At the end of the tasks, we asked students for their impressions of the prototype

databases page, which of the database pages they preferred, and why.

Most of the participants took what we considered an "expert" path to these questions,

which involved using the fewest clicks and finding the answers quickly and on their first attempt.

The pain points during the tests echoed the responses in the homepage survey because many

students struggled with tasks involving finding articles and databases. Some users had difficulty

finding a subject-specific database and librarians with a subject specialty. A small set of users

struggled slightly determining where to start an article search.

For each task, Wyndham Robertson Library librarians had ideas about the ideal or

intended way for a participant to complete a task. We had put thought into creating elements on

different pages for quick and easy access to resources. For instance, we had a "Subject" tab on

the databases page with lists of hyperlinked subjects, each linking to a LibGuides page with a

subject-specific list of databases (see Figure 2). Despite our efforts, many of our test participants

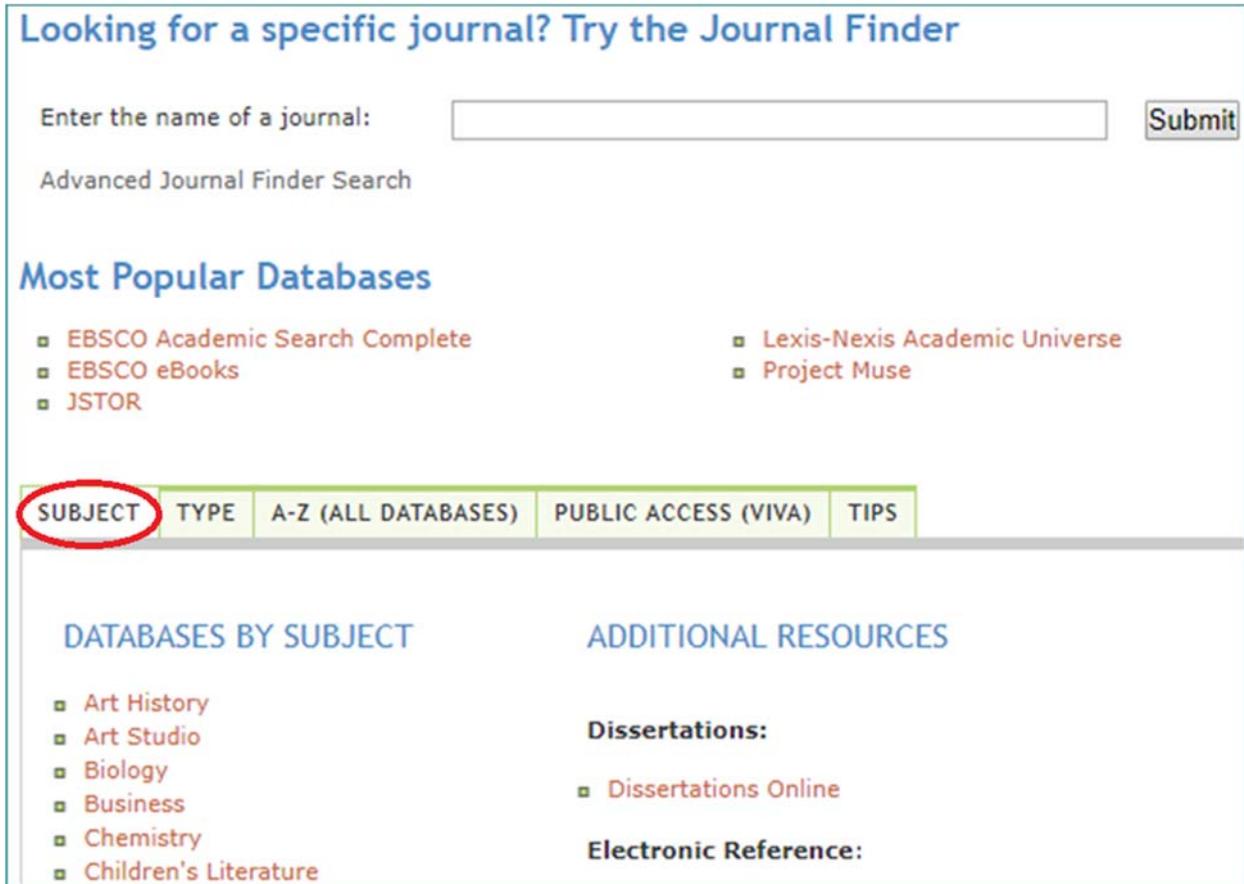did not click on this tab and looked for databases in circuitous or unexpected ways.

Figure 2. Original databases page.

After reviewing the prototype databases page (see Figure 3), participants commented on

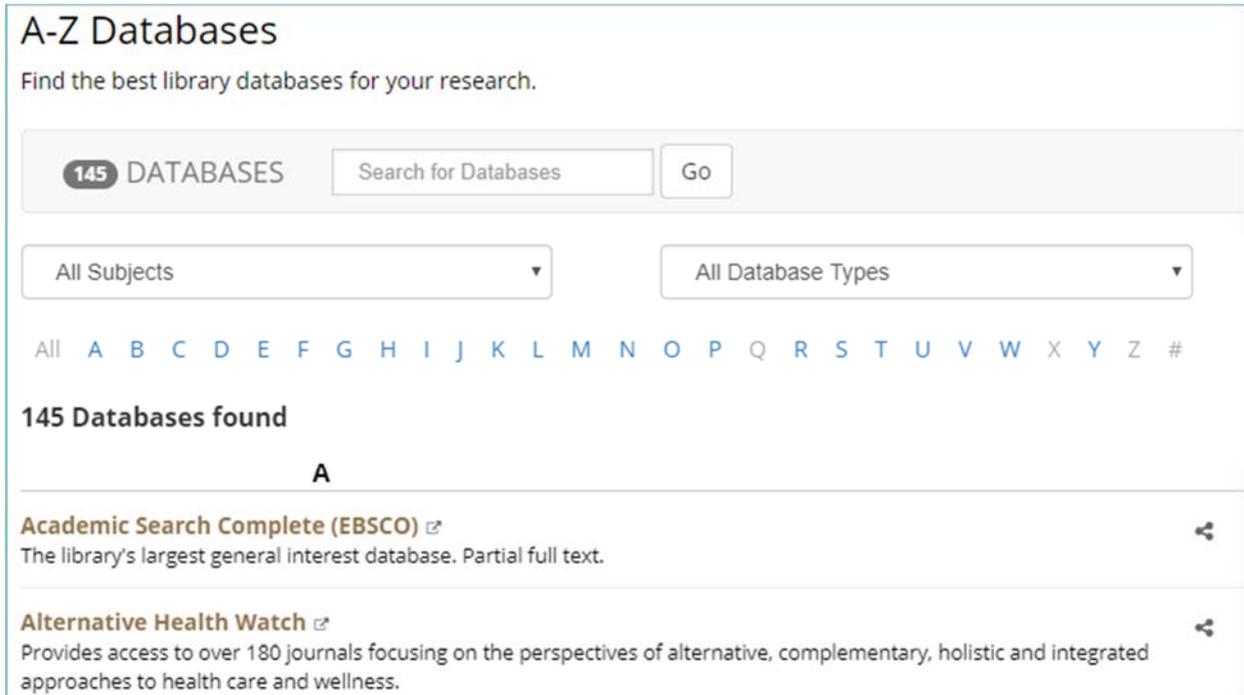both and all preferred the prototype (see Table 2).

Figure 3. Prototype databases page: Springshare's A–Z List.

Table 2. Student responses to the original and prototype databases pages.

2016 Student responses	
Original databases page	Prototype A-Z databases page
- Takes effort to find something. - The page is confusing. - There's a lot going on. - There are a lot of tabs. - The page is hard to navigate without a librarian showing you how. - This page doesn't allow you to apply two limiters at the same time the way the prototype does.	- I like the format and being able to search for a database by title. - I like the limiters, specifically for database type because I like being able to see primary sources. - This database page was more direct/obvious - I like the aesthetic. It looks more current.

These tests were valuable for identifying and later addressing the difficulties users had.

After reviewing the results of a usability test, library staff can return to the prototyping stage and

propose changes to the website with the intention of making certain tasks easier. Moving from

the testing/implementing stage to the prototyping stage is an example of the iterative and non-

linear nature of the design cycle. Results from one stage may be used to inform actions in
another.

Our results from the testing/implementing stage of spring 2016 informed our actions in
the prototyping stage. After reviewing the usability test results of 2016, we noticed that many
students were unaware of the tabs on the database page, which organized databases by subject,
by type (e.g. newspapers, encyclopedia), and by A-Z.

After deliberation, the library decided to replace the current databases page with the
Springshare LibGuides A-Z databases page. The cleaner interface of the LibGuides A-Z list and
its ability to dynamically generate subject- or type-specific lists of databases via two simple
dropdown menus made it seem more user-friendly. Moreover, the participants' positive
responses to the prototype databases page supported the change.

To make databases more accessible from the homepage, we also renamed our "Articles"
tab as "Articles & Databases." We also added a database dropdown menu to this tab so a user
could more easily access databases from the homepage. In addition to website changes related to
databases, we wanted to address the findability of subject-specific librarians. We created a
dropdown menu under the header "Find Your Subject Librarian" with a list of subjects, each
linked to the subject-specific librarian's page with contact information. We placed these
dropdown menus on the "Staff and Departments" page and the "Ask a Librarian" page. We also
created a new page that had an A-Z list of subjects showing the corresponding librarian for each
subject and their contact information.

These enhancements completed our second prototyping stage. A year later, we were
interested in knowing whether they had made an impact on users' experiences, so we ran the
same usability test in spring 2017 with IRB approval, again with 10 undergraduates. The

usability scores in these categories showed marked improvements for two specific tasks (see

Table 3). Improvements in finding databases and subject-specific librarians indicated the

prototypes were a success. There was little variation between the results from the 2016 and 2017

tests in other task categories (e.g. finding books, logging into an account, finding library hours).

Table 3. Comparison of 2016 and 2017 task results.

Task	2016 result	Enhancement	2017 result
Finding a subject specific librarian	60% success	Adding librarian by subject page and librarian by subject dropdown menu	90% success
Finding subject specific databases	90% success	Replace databases page with simpler, cleaner, dynamic page from Springshare	100% success

Limitations and further research

This article examines the design cycle in the context of a website redesign, so the examples of

methods and descriptions of how they were deployed in our project are oriented towards website

design. However, the design cycle can be applied to a variety of library projects and is not

limited to projects involving websites. Focusing on one project area (our website redesign) was

intended to make the principles of the design cycle easier to understand by way of specific

examples.

This article does not attempt an exhaustive treatment of all usability methods. Instead, it

explores popular methods based on a survey of the library literature. The aim of this article is to

illustrate the principles of the design cycle, the popular methods associated with each stage of the

cycle, and in doing so make it easier to choose methods based on the needs of a project.

Moreover, explaining the limitations of certain methods is intended to encourage a mixed

methods approach in each stage of the design cycle.

Further research could attempt to validate the effectiveness of the design cycle with

empirical evidence. Throughout this case study, there is an emphasis on following the order of

the design cycle and using different methods in a specific sequence. To test the significance of

the sequence, researchers could run two usability projects using methods in different sequences

and compare the results by doing usability testing at the end of the projects. For instance, does

conducting a content audit before performing a card sort increase findability of pages of a site?

In other words, do specific methods need to be used in a certain order to obtain the best results?

This case study also stressed the importance of using multiple methods. Further research might

explore the efficacy of using a mixed methods approach by conducting two usability projects;

one using multiple methods in each stage of the design cycle and the other using a single method

in each stage of the design cycle.

Recommendations for applying a design cycle approach

An understanding of the design cycle gives a librarian many advantages when undergoing

usability projects. First, the design cycle provides a structure to follow during the project with

clear steps:

- To make anything more usable, it is necessary to understand and empathize with users.

  What do they want? What are they struggling to do when using a service?

- Using data to understand and empathize, begin brainstorming ideas for the project.

- While brainstorming, recruit users to generate ideas to make a service more usable. These

  ideas lead to users and librarians working as co-designers in creating prototypes to test.

- The next stage is testing a prototype and collecting data from the test.

- The test results help to understand and empathize with users, which can then lead back to

  the brainstorming stage.

- These stages can be repeated, with the intention of making the system better and better in

  each iteration.

  This structure can be applied to any library design project.

Understanding the various types of methods, the limitations of each method, what kind of

data they collect, and how they relate to each other allows a practitioner to pair methods to

compensate for the weaknesses of a single method. As described above, surveys and interviews

(attitudinal category) are a useful method for hearing users' preferences or thoughts. However,

the methods in this category do not show how users actually interact with a website or service, so

a contextual method (e.g. usability tests, analytics) is needed to counterbalance the findings from

the attitudinal category. Both types provide valuable data, but a practitioner should not rely

exclusively on a single type.

Table 4 provides a checklist to simplify the process of selecting methods from different

categories.

Table 4. Design cycle and mixed methods checklist.

DESIGN CYCLE & MIXED METHODS CHECKLIST				
For each stage select a category of method from **Type A** AND **Type B**. Strive to use all four method categories for a project. Stages cannot be skipped. The user must be involved in some way in each stage.				
	TYPE A		**TYPE B**	
STAGES	Attitudinal	Qualitative	Behavioral/Contextual	Quantitative
Observe	☐	☐	☐	☐
Prototyping	☐	☐	☐	☐
Test/Implement	☐	☐	☐	☐

Questions about the selection of methods that a library should ask before and during a

usability project include:

- What methods are appropriate for gathering data about specific usability problems or

    issues?

- Does each method allow users to comment on new or previously-unknown usability

    issues?

- Is there another method that could supplement the data gathered from the first method?

- Are there other methods that were overlooked? Why would these not be useful?

- How can the findings from this stage of the design cycle inform the actions in the next

    stage?

There are obviously time constraints on librarians, particularly those working alone on

usability projects. These limitations make it more difficult to apply multiple methods during a

project, but also make choosing an appropriate method more important.

Conclusion

"A single twig breaks, but the bundle of twigs is strong" (Tecumseh, 1795, as cited in Philip,

2006, p. 27).

In this case study, our library tried to avoid relying too heavily on one method during each stage

of the design cycle. A single method did not dictate the direction and completion of the project.

The methods were all connected and the project was guided in each stage by the findings

obtained with multiple methods. The shortcomings of each method were addressed by using

different categories of methods with different strengths and weaknesses. The data gathered from

this mix of methods revealed usability problems and helped to set goals and create an action plan

to improve usability. Perhaps most importantly, library users were included during each stage of

the design cycle. Their preferences determined the changes we made. Using the design cycle for

projects creates an order, a structure, and a logic that can guide libraries through the complex

process of choosing what to test, how to test, and how to apply the results of testing.

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