"I Don't Know What I'm Looking at":
Understanding Student LibGuide Use with Eye-Tracking Software

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Introduction

Do LibGuide users know what they are looking at? Does the guide design communicate what the guide is and what it will help them do?

In the spring of 2016, we conducted a usability study of one of our subject guides, developed in Springshare's LibGuides platform. We sought to gain insight into how students at our university use the guide to complete complex research tasks, to identify usability problems they encountered, and to determine whether they engaged with instructional content. We were also interested in the ways that students understand and make sense of the guide. By combining the cognitive think-aloud protocol with eye-tracking measurements, we shed light on participants' thought processes as they completed the tasks. As we analyzed the recordings and compared what participants were doing with what they were saying and where they were looking, we asked deeper and more critical questions related to participants' mental models.

Literature Review

Academic librarians develop research guides to support the complex task of scholarly research. Guides are curated selections of links, search widgets, and instructional content, intended to help users meet their academic information needs, regardless of whether they have attended library instruction sessions.[1] Much of the research literature on LibGuide usability takes student success in completing specific tasks as a measurement of adequacy of design, or the researchers make alterations in design and determine whether those changes positively influenced usage. They generally conclude with specific guide design recommendations, such as eliminating clutter, focusing scope, reducing jargon, minimizing top-level navigation, and standardizing page layout.[2]

Understanding users' cognitive process is a significant factor in optimizing usability. Little advised guide authors that the complexity of research can overtax users' "intrinsic cognitive load," and that disorganized presentation and inclusion of irrelevant content can overtax their "extrinsic cognitive load."[3] Sinkinson et al. used a card sorting study to conceptualize users' and librarians' mental models of content that belongs in a guide, and how it should be organized. The researchers concluded that "while librarians recognize that students approach research differently, research guides often reflect librarian models of research rather than replicating student preferences." The librarians in their study "discarded" content at a high rate—implicitly acknowledging that

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guide content needs to be minimized. However, students still saw the guides as overwhelming and cluttered, indicating "a contradiction between espoused and enacted pedagogies."[4]

Concluding a recent assessment of the "enduring landscape of online subject research guides," Jackson & Bates suggest that more information "about the ways in which students use subject guides is definitely needed."[5] Along these lines, Alverson et al. focused on how students "experienced and understood the research guides," digging into "the bigger picture issues of purpose, audience, and context." The researchers found that guides "could not successfully be all things to all people," and, therefore, pared them down to a succinct list of the most important subject-specific resources, removing general resources, such as the library catalog, and moving more in-depth instructional content to a separate guide.[6]

The present study seeks to continue building a deeper understanding of users' mental models as they interact with research guides. Mental models are internal representations constructed in the human mind that people use to understand or explain phenomena, and to solve problems by making comparisons, predictions, and projections.[7] People develop mental models "through analogy by identifying and relating similarities and differences between known systems and facts and the new information or domain encountered."[8] Users engaged in web-based information-seeking will develop a mental model for the web page (comparing it with previous website interactions) and also for the task itself (comparing it with previous information-seeking experiences). Task complexity influences the way users proceed, and more complex tasks require more complex information about the "problem domain and problem solving."[9]

The cognitive think-aloud (CTA) protocol in usability testing asks participants to verbalize what they are thinking as they conduct the test. This data can provide insight into why a problem exists, what they are thinking as they try to work around it, and whether the way the system works aligns with the way it was designed.[10] Eye-tracking works by emitting an infrared LED, which reflects off the surface of the eye, creating a "glint" around the pupil. Eye-tracking software captures data on the movement of the glint as the eye moves across the screen.[11] *Fixations* are moments when the eyes momentarily pause. The meaning of a fixation is ambiguous—it may indicate that participants do not understand what they are seeing; that they see something interesting, confusing, or problematic; or they could be thinking about something entirely unrelated to the test.[12] They may not even remember looking at an area of fixation, as our study confirmed. In general, more fixations indicates less effective searching.[13] *Saccades* are the rapid motion of the eyes between fixations, and are the fastest movement the body can produce.[14]

It is impossible to tell from eye-tracking data alone what people are thinking.[15] At the same time, people always filter their thoughts before verbalizing them, and you cannot always know what goes through their mind.[16] In addition, people visually process information at faster rates than they can verbalize. Therefore, combining CTA and eye-tracking observations can "provide more insight into the types of thoughts and processes that can be visualized by both methods."[17]

Methodology

We worked with 8 student participants, from a wide variety of classifications and programs of study. Each participant engaged in a testing session that lasted between 20 and 40 minutes. The test sessions were divided into three parts. In the first part, participants were administered a pretest questionnaire about their classification, school, and research experience. Specific research-related tasks and activities included in the questionnaire addressed the frequency with which students searched for a book, searched for an article, searched for the full-text of a source from a citation, and sought help from a librarian.

After students filled out the questionnaire, we conducted a brief, semi-structured interview to learn more about their prior research experience and if they had ever visited the library website or encountered a LibGuide.

Participants were then shown the test guide on the laptop. They were also given instructions about the CTA method and eye-tracking recording software.

In the second part of the session, participants were given four research tasks: find a book on a given topic, find a peer-reviewed article by topic, find an article by citation, and find a journal by title. These tasks were based on common research questions and homework assignments we have encountered during interactions at the research desk and in library instruction sessions. For all four tasks, participants used a LibGuide created specifically for usability testing.

Our study combined the CTA protocol with the use of eye-tracking data to provide us with a more comprehensive picture of what participants experienced as they performed the tasks. To track eye movements, we used the Gazepoint GP3 Eye Tracker, which rested on a tripod underneath the computer monitor. We used the Gazepoint Analysis software to collect and analyze eye-tracking data.

The third part of testing consisted of a post-test interview in which participants were invited to provide feedback about design elements, describe their experience using the test guide, or ask questions about the tasks. We also used this opportunity to get more information about students' thought processes and online search behaviors.

After the testing phase of the study was completed, we analyzed the results in several waves. First, we each watched the participant recordings individually, coding various actions and making note of significant quotes. The recordings were overlaid with a camera recording of the participant's face, as well as graphic renderings of their saccades and fixations, including the duration in milliseconds of each fixation (for an example of this, see Figure 6. Saccades below). We then rewatched the recordings, looking for similarities amongst the different participants in an attempt to identify trends in the way they viewed or interacted with the LibGuide. As we began to develop our discussion on the study, we watched the videos yet again, this time as a group, paying particular attention to themes that were supported by our own observations, what was said by participants, and eye-tracking data. We also created heat map visualizations, with red portions indicating longer fixation duration on a given area, and blue portions indicating shorter fixation duration. Twenty percent of outlier fixations were removed to hone our focus on areas of greater fixation. Eye-tracking data for two participants was deemed invalid due to technical problems with the eye-tracking hardware.

Guide Organization and Description of Content

Guide Organization

The guide was divided into six pages, labeled: Home, Search Strategy, Background Info, Articles & Journals, Books & Ebooks, and Citing & Writing Help. The page labels were displayed as tabs along the top horizontal menu bar that served as the guide's primary navigation tool. The Home page (see Figure 1) was based on an internal template created by the library's Web Committee to promote consistency across subject guides. A tabbed box, labeled "Key Research Databases & General Resources for Writing," featured prominently in the upper left section of the Home page template. It contained the following tabs: Databases, Journals List, Library Catalog & Course Reserves, Library Services, and Help. The primary purpose of this "Key Research Databases" box was to provide a shortcut to popular databases and offer additional access points to content on other pages of the guide. The template also included a "Guide Contents" box which provided a list of links to other pages of the Guide, serving as an alternative navigation option from the Home page.

Description of Content

Our library's subject guides aim to direct users to relevant search tools and resources in their discipline. This type of referential content includes links to relevant databases, websites, or books. Referential content also includes

FIGURE 1
Home Page
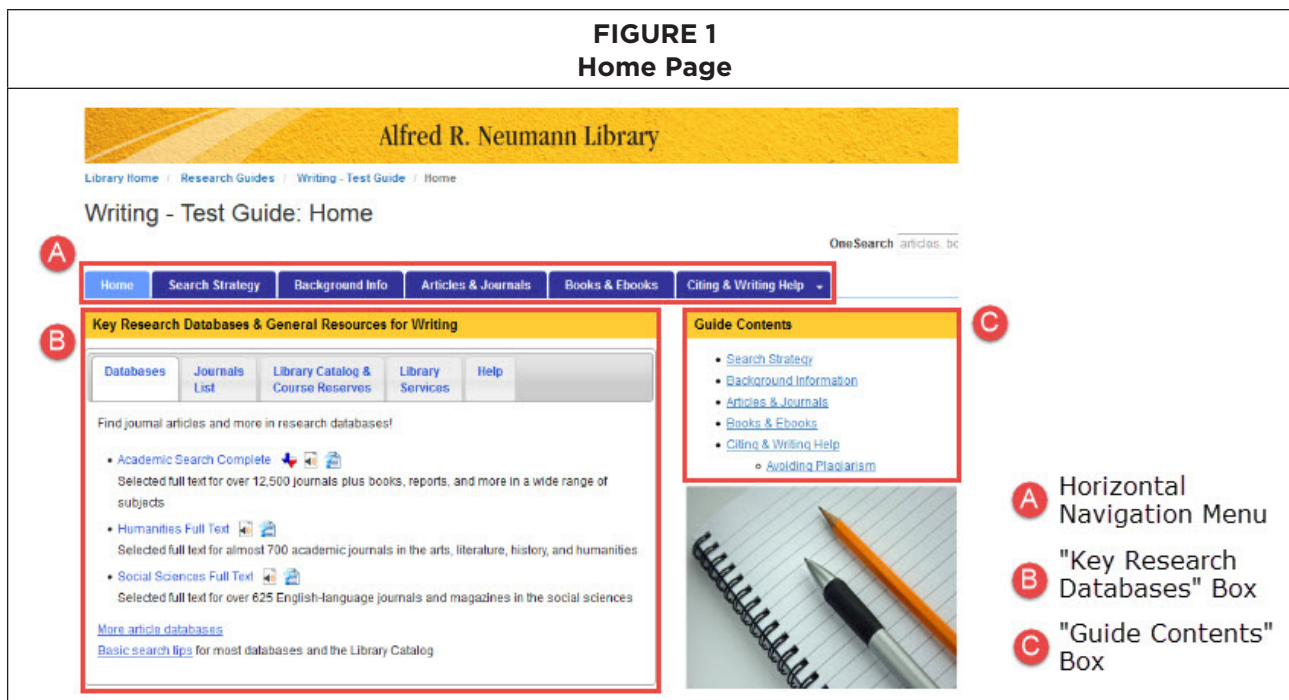
search box widgets that enable users to search other systems without leaving the guide interface. Most subject guides also include instructional content about the research process or a specific search tool in the form of a screenshot, text, or video tutorial. Like most subject guides, the test guide featured both referential and instructional content. (see Figure 2).

FIGURE 2
Articles & Journals Page

FIGURE 3
Heatmap: Example of Term Matching
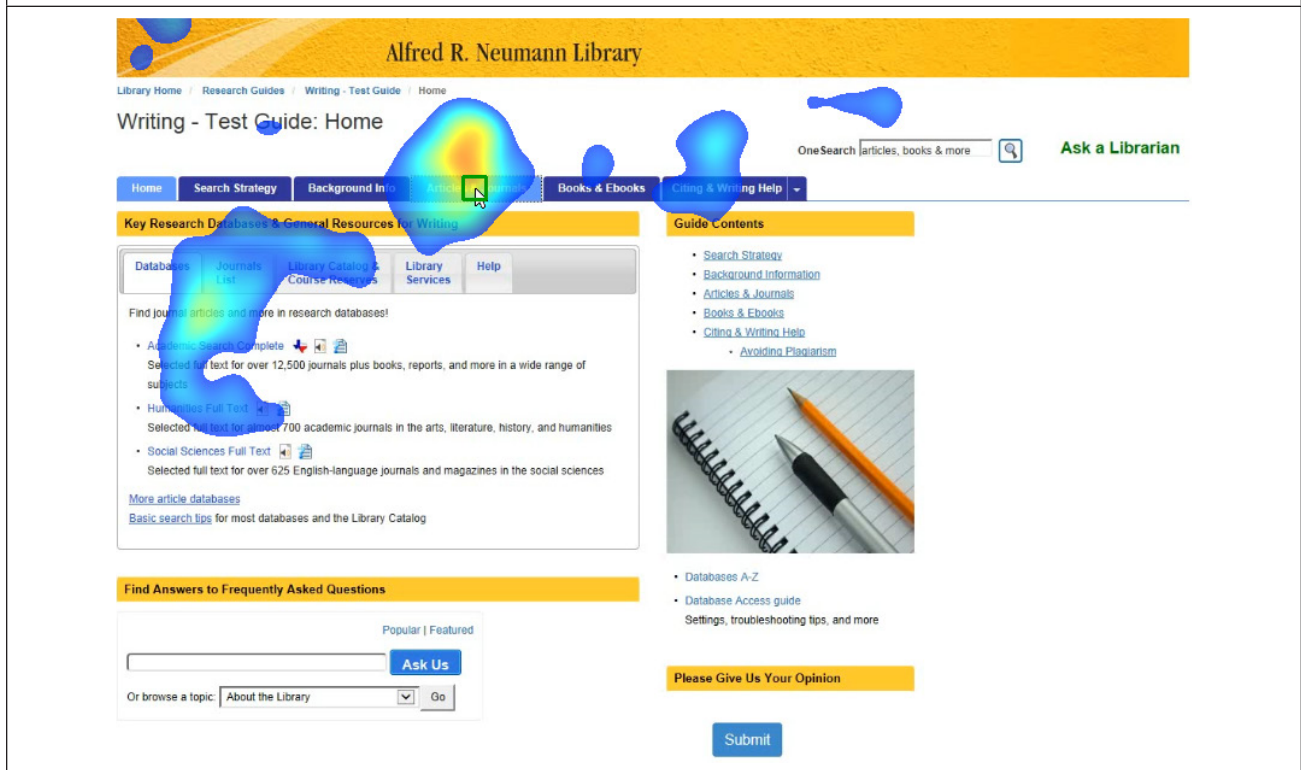
Findings

### *Guide Navigation*

As participants performed the tasks, they looked for words mentioned in the task description to serve as navigational cues. As they thought aloud, several participants explained they clicked on a tab because it contained the word "articles", "books", or "journal." Eye-tracking data confirms that they tended to fixate more frequently on these terms. The heatmap in Figure 3 represents the fixations of one participant as she searched for an article by citation, showing longer fixation duration on the word "article" in both the "Key Research Databases" box and the horizontal menu bar. Most participants used the horizontal menu bar as a primary navigation tool and spoke favorably of it in post-test interviews. "It's pretty easy to navigate because it's pretty specific: if you're looking for an article or specific journal, or looking for a book or ebook," said one participant, who had used the menu bar for all four tasks.

Use of the "Guide Contents" box as a navigation tool was far less frequent, with only one participant using it more than once. Several participants expressed ambivalence about its utility as an additional navigation option, calling it "repetitive" or "redundant." Others did not understand its purpose. "The heading itself is 'Guide' so I thought it would have guidelines on it," commented one participant.

Some participants relied almost exclusively on the "Key Research Databases" box for their tasks, especially if they spotted a target word. Figure 4 is a heatmap of one participant's cumulative fixations on the Home page across all tasks. The green squares indicate each click on the page, illustrating that her focus stayed predominately on this box. In certain instances, the "Key Research Databases" box provided quick access to desired content. On other occasions, participants were misdirected to a resource that was ill-suited for the task at hand, as one participant discovered after failing to locate books about the death penalty in *Academic Search Complete*. Three

FIGURE 4
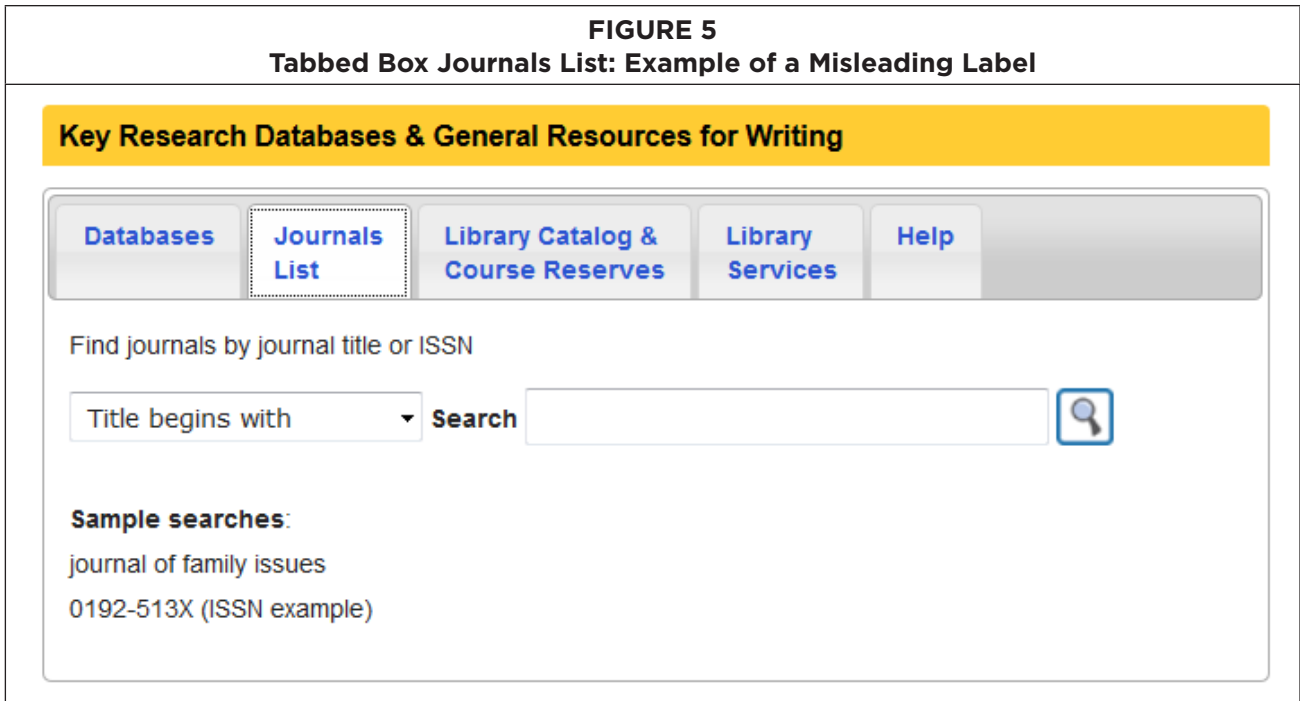**Heatmap: Focus on "Key Research Databases**
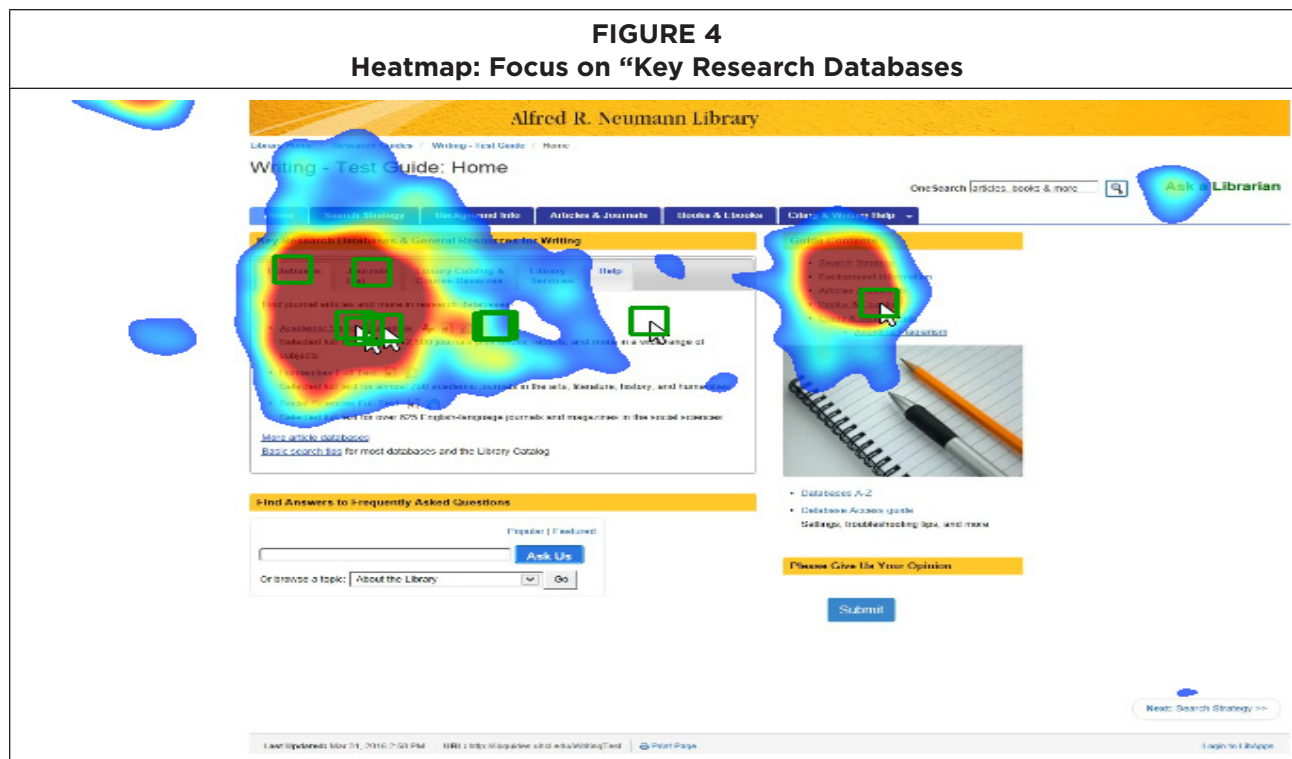
participants had difficulty navigating between different content areas of the tabbed box because of the poor contrast of active tabs (white) against inactive tabs (light gray) and would repeatedly click on a tab that was already active until the moderator intervened.

Many participants also had trouble situating tabbed boxes within the organizational structure of the guide. In post-test interviews, participants asked if the box tabs were a subset of a page – that is, a second level navigation tool. Given the structural similarity between tabbed boxes and the top navigation guide, it was understandable how one might make the parent-child association. Yet the actual parent-child relationship was the page tab and the box, which would effectively make the relationship between page tab and box tab grandparent-grandchild. That participants perceived the latter's relationship as parent-child is problematic for two reasons. First, it suggests they may have excluded potentially relevant content on the page that was visually dissimilar (e.g., non-tabbed boxes). Eye-tracking data indeed shows that participants were far less attentive to content outside tabbed boxes, including information directly related to their tasks. Second, the misidentification of box tabs as subsets of the page reveals that participants were unable to fully account for what unified box tabs. In other words, they did not see the box headings or they did not understand what they meant.

Mental Models

Although participants were usually able to identify a page related to their task, the content they found often did not match their mental model for the guide. For some participants, the mental model appeared to be based on a directory containing an itemized title list of articles and journals. One participant explained that he clicked on the Articles & Journals tab "'cuz it said 'Journal'" and was annoyed to find that the journal he was looking for was not listed. "I just feel like it [the Articles & Journals tab] is kind of useless if that's going to happen," he said. It is possible that the participant's mental model of the test guide as a directory was reinforced by the list of database links on the page, making it more difficult to recognize other relevant content on the page, including a catalog
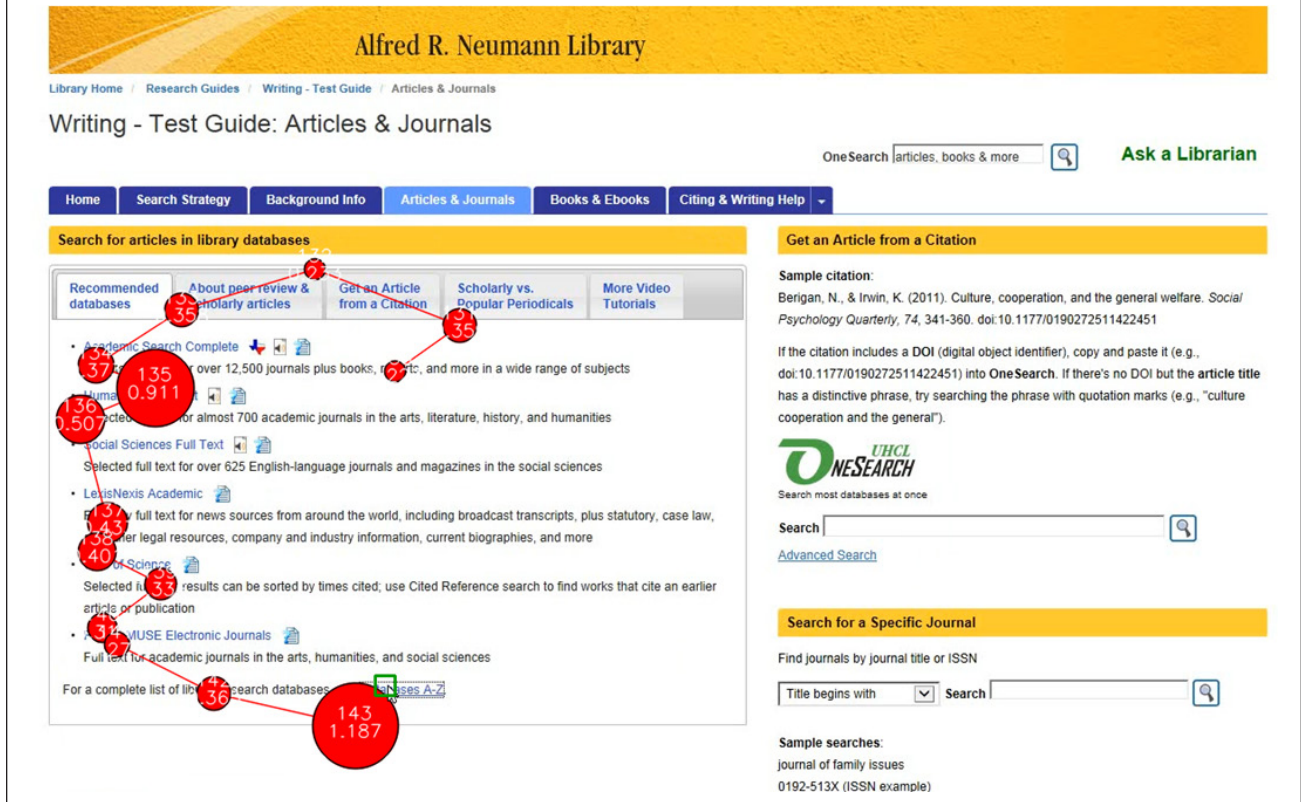

FIGURE 5
Tabbed Box Journals List: Example of a Misleading Label

Key Research Databases & General Resources for Writing

| Databases | **Journals List** | Library Catalog & Course Reserves | Library Services | Help |

Find journals by journal title or ISSN

Title begins with ▾ **Search** [   ] 🔍

Sample searches:
journal of family issues
0192-513X (ISSN example)

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search widget box titled "Search for a Specific Journal." Eye-tracking data shows the participant did not look at that area of the page.

In some cases unclear terminology on the guide contributed to the perception of the guide as a directory. For instance, several participants told investigators that they clicked the Journals List tab of the "Key Research Databases" box expecting to find a list of the library's journals (see Figure 5). Interestingly, these participants were able to adjust their mental models almost instantaneously when they saw the catalog widget search box, as evidenced by the speed with which they entered the journal title. The ability to discard the directory mental model so easily can almost certainly be attributed to the predominance of Google and other search engines.

The influence of Google on participants' mental models was particularly evident in the task in which they were asked to find a peer-reviewed journal article. With the exception of two individuals who had prior experience looking for articles in a library database, participants overwhelmingly passed over database links on the guide in favor of OneSearch widgets. Navigation routes for this task varied widely, making it difficult to compare participants' gaze patterns across a common content area. Some participants who visited the Articles & Journals page scanned the database list but not the box titled "Search for articles in library databases", which may explain why their purpose was unclear. Said one participant in his post-test interview, "It wasn't clear that if I clicked on one of those it would be a place where I could search for articles. I didn't think this would lead me anywhere useful." Figure 6 shows his scanpath as he glances at the databases, opting not to click on any of them.

In some cases, participants' mental models could be traced to prior experience with a specific search tool, such as *Academic Search Complete* or OneSearch. Several participants spoke of using these resources before, and eye-tracking data revealed significant areas of interest around familiar names. Prior experience with resources, such as *Academic Search Complete,* did help these participants successfully complete some tasks, but there were also instances in which participants used them in tasks that did not fit their purpose, such as finding an article by citation.

FIGURE 6
Saccades

Use of Instructional Content

We observed a number of occasions in which participants sought instructional content for help with a task but found information that was irrelevant or unhelpful. For example, one participant could not figure out how to search for a peer-reviewed article, having been unable to make sense of the list of databases on the Articles & Journals page. He clicked the About Peer Review box tab, which contained only a text-based definition of peer-review and an embedded video tutorial, which he did not watch. Another participant who experienced similar difficulty with this task clicked on the Search Strategy page, which contained a screenshot of a sample database search and general tips, but no practical information about databases or how to access them.

In other instances participants came across instructional content that directly related to their present task but did not use it. For example, several participants found the "Get an Article from a Citation" box on the Articles & Journals page, which contained a OneSearch widget with specific instructions about how to construct a search (see Figure 2). Eye-tracking data showed that two participants did not look at the instructions at all, while the third skimmed part of the text but misunderstood the instructions. After several failed attempt to construct a viable search statement, he was unable to complete the task successfully.

Discussion

By combining CTA protocol with eye-tracking technology, we were able to form a more robust understanding of cognitive processes of students as they perform research tasks. The information gleaned from eye-tracking software enabled us to "see through the eyes" of our participants, observing where they looked, and equally

significantly, where they did not. By correlating participants' eye movements with their comments, we were able to identify specific usability problems in the test guide, such as an ambiguous visual hierarchy that misdirected users and obscured important content. We also came away with a better awareness about how users' previous information-seeking experiences shaped their expectations of both the guide and the tasks they were asked to complete. This awareness provided a valuable point of contrast to our own mental models, which were often replicated in the guide.

Findings from this study show that many users lack the information literacy skills necessary to complete common research tasks in a disintermediated environment. One of the biggest obstacles is the lack of awareness about the complexity of academic research. Participants from our study who had previous research experience or received library instruction performed somewhat better, but their knowledge of search tools was limited to a single resource. The test guide was moderately successful in directing participants to search tools that were relevant for finding a specific type of information but did a poor job of communicating what the resources were. Specific mistakes can be tied to design flaws, such as the yellow box headings that so many participants over-looked, or misleading terminology, such as the box tab labeled Journals List. Other problems related to issues beyond our control, such as the names of databases, which are often generic or inexplicable. Compounding these design problems were our faulty assumptions about what users know (for instance, that the test guide is not an interface for searching articles) or will be able to infer (for instance, that because database links are located on the Articles & Journals page, users will understand they are tools for accessing articles).

Although this study used LibGuides as a platform for studying students' research behaviors, we believe that the challenge of presenting academic search tools in a way that communicates their function is a universal usability issue for libraries. Because many academic search tools are complex and sometimes have usability problems of their own, students also need instructional support to use them effectively. We found that the instructional content in the test guide did not meet participants' information needs because it lacked specificity or was not presented effectively. Thus, we submit that if instructional content is to be offered in a subject guide, it must be presented in a way that distinguishes it from referential content while making their relationship clear.

Limitations of the Study and Suggestions for Further Research

One thing we would like to add to future iterations of this study, and urge others to consider, is a retrospective think-aloud component. While we were able to gather significant insights from the two techniques we utilized in this version (CTA protocol and eye-tracking data), being able to review a participant's' recordings with them, and ask them their thoughts on what they saw on a page or what they were thinking when they clicked the option they chose, would remove ambiguity of their actions at the time of analysis.

Eye-tracking can yield an abundance of quantitative data, but it requires a greater number of participants to draw significant inferences. For instance, analyzing the number of fixations per page or per participant can indicate search efficiency, participant experience, or ease of task. Fixation density can indicate semantically informative areas. The number of saccades is related to task difficulty or mental workload.[18] As eye-tracking research is in its early stages, researchers are still developing a standard correlation scheme between eye-tracking metrics and usability problems.[19] Future studies may recruit a higher number of participants, and focus on analyzing these measurements.

Restricting the number of participants does, however, allow for a deeper study of information collected. We were able to very closely examine the scan paths of all participants and view them in conjunction with the voice recordings captured to obtain a clearer picture of their thought processes, something that would not have been as feasible with a large number of participants.

Notes

1. Puckett, Modern Pathfinders, 7–8.
2. For extensive reviews of research guides usability findings, see Thorngate & Hoden, "Exploratory," 2–9; Slemons, "Design Standards," 7–13.
3. Little, "Cognitive Load," 53–54.
4. Sinkinson et al., "Guiding Design," 78–9.
5. Jackson & Bates, "Enduring Landscape," 228.
6. Alverson et al., "Creating Audience," 131–2.
7. Al-Diban, "Mental Models," 2200; Brandt, "Information Technology," 82–3.
8. Brandt, "Information Technology," 82.
9. Bystrom and Jarvelin, "Task Complexity"; Case, "Looking for Information," 129.
10. Rubin, Handbook of Usability Testing, 54.
11. Cooke, "Eye-tracking," 75.
12. Holmqvist et al., "Eye-tracking," 377–9.
13. Kim et al., "Eye-Tracking," 527
14. Holmqvist et al., "Eye-tracking," 23.
15. Ibid., 71.
16. Rubin, Handbook of Usability Testing, 54.
17. Elling, Lentz & de Jong, "Combining," 207.
18. Holmqvist et al. 405, 412–16.
19. Ehmke & Wilson, 119.

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