Improving the Student Search Experience in LibGuides

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ABSTRACT

This study is an in-depth look at the use of the LibGuides search function by college students. We sought to better understand the mental models with which they approach these searches and to improve their user experience by reducing the percentage of searches with no results. We used two research methods: usability testing, which involved 15 students in two rounds, and analysis of search terms and search sessions logged during three different weeks. Interface changes were made after the first round of usability testing and our analysis of the first week of search data. Additional changes were made after the second round of usability testing and analysis of the second week of search data.

The usability tests highlighted a mismatch between the LibGuides search behavior and the expectations of student users. Results from both rounds of testing were very similar. The search analysis showed that the level of no-result searches was slightly lower after the interface changes, with most of the improvement seen in Databases A-Z searches. Within the failed searches, we saw a reduction in the use of topic keywords but no improvement in the other causes we studied. The most significant change we observed was a drop in the level of search activity.

This research provides insights that are specific to the LibGuides platform—about the underlying expectations that students bring to it, how they search it, and the reasons why their searches do and do not produce results. We also identify possible system improvements for both academic libraries and Springshare that could contribute to an improved search experience for student users.

IMPROVING THE STUDENT SEARCH EXPERIENCE IN LIBGUIDES

Southern Methodist University is a private institution in Dallas, Texas, that serves approximately 5,000 graduate students and 7,000 undergraduate students annually. Since 2008, the libraries of SMU have used Springshare's LibGuides platform to publish online research guides, of which there were 387 when our research data were gathered. We also make use of LibGuides' Databases A-Z page, a directory of the more than 700 licensed databases that the libraries provide.

A 2022 review of search term logs revealed a good deal of misunderstanding among users about how the LibGuides search function works and how it should be used. We could see that many of the terms entered would not produce useful results and, in some cases, no results at all. In response, we started researching how our students thought about the LibGuides search boxes and what changes we might make to increase their success in finding relevant databases and guides. We explored two research questions:

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Submitted: 16 October 2023. Accepted for publication: 16 June 2024. Published: 16 December 2024.

- What is the mental model that students have for the search function provided on LibGuides pages?
- Can we, through interface modifications, reduce the percentage of failed searches?

LITERATURE REVIEW

Within the academic library literature, we looked for research that included the LibGuides search function. More broadly, we explored existing evidence about the mental models that users bring to library search tools and the typical search behaviors and preferences of college and university students.

Mental Models
According to Holman, a "mental model is an internal cognitive representation of a tool or system that helps one master it. It is the user's mental image of a system and its capabilities that he employs to understand how to operate it."[1] An interesting finding from Holman's research is that the mental model used by some students does not include strict matching of keywords. Instead, they understand keywords as a "concept rather than as a literal string of letters."[2] Lewis and Contrino described students entering natural language questions into a search box and expecting the system to understand them and respond accordingly.[3]

A mere seven years into the Google era, Griffiths and Brophy determined that commercial search engines were the dominant model for students seeking information. "It seems that students' use of resources is now very colored by their experience with search engines, which in turn may lead to expectations that may not be realistic for different types of services."[4] They concluded that "students' use of search engines now influences their perception and expectations of other electronic resources."[5]

It is clear from more recent literature that, for most students, Google serves as the single, well-known mental model that is applied to all their online searching.[6] This translates to simple, unrestricted keyword searches.[7]

Zhang studied how mental models for searching are developed, finding that users draw upon their experience with similar systems. Building on this experience, they iteratively modify elements, assimilate new ones, and phase out others. Over time, their search strategy becomes better aligned with the new system.[8] That does not seem a likely scenario in academic libraries, however, when we consider the overwhelming influence of Google and the limited exposure to library research tools that many students have.

Beyond the mental model of how a search works, it is also important to have an accurate model of what is being searched. Unfortunately, this is something that students are unlikely to consider. Katie Sherwin of the often-cited Nielsen Norman Group wrote,

> Users expect search to include the entire site. People expect to be able to enter a term in a search field and get relevant results from **anywhere** on your site. To most people, anything on the website is part of a single entity, and search should include all of it. Users' understanding of the "entire" site depends on their mental model of the website or organization.[9]

Asher and Duke and Georgas found that study participants lacked basic understanding of how information is organized.[10] Willson and Given found that many searchers do not distinguish between different sources of online information and have difficulty understanding what types of

resources they are accessing.[11] All of this can contribute to problems in the LibGuides environment, where the resources searched are typically limited to guides and databases. Sherwin cautioned that misunderstanding the limitations of such a search can lead users to devalue the site and leave it in frustration.[12]

Search Behaviors of Students

The Ethnographic Research in Illinois Academic Libraries (ERIAL) Project used ethnographic methods to study student research behaviors, among other things, in five academic libraries. The researchers found that most of the student participants "exhibited significant difficulties that ranged across nearly every aspect of the search process."[13] Another important finding was that students tend to give up quickly and will change search terms, database, or research topic if they do not get the results they expected.[14] Other researchers have found that when reviewing results, students usually do not go beyond the first page.[15]

Among the issues observed by Holman were incorrect use of punctuation, frequent misspellings, repeating failed searches, reuse of the same search terms and syntax across different systems, and the inability to recognize why searches did not get the desired results. She also saw students hastily searching and evaluating results, which can exacerbate the other problems.[16] Along with Willson and Given, Holman observed that today's students depend on technology to provide correct spelling and often do not recognize their own spelling errors.[17] This can lead to the erroneous assumption that the library cannot fulfill their information needs.

When studying student searching of Google and a library search tool, Georgas reported frequent use of natural language, failure to try synonyms and related terms, and little evaluation or revision of search terms. Date limits were infrequently used.[18] Despite all these indications of weak skills, students tend to overestimate their abilities as searchers.[19]

LibGuides Research

Since its debut in 2007, scores of articles have been written about LibGuides, Springshare's content management system for library guides. We found only a small number, however, that discuss the search functionality included in the system. Several others speak to the lack of a student mental model for LibGuides as a whole.

Though academic libraries serve up research guides by the hundreds, studies by Lierman et al., Conrad and Stevens, and Castro Gessner et al. found that students did not have a clear understanding of their form or function.[20] In the latter one, participants were not able to distinguish them from other online, library-provided resources such as databases and articles.[21] Similarly, Conerton and Goldenstein reported that some students were completely unfamiliar with the term "guides," while others equated it with library databases.[22] Quintel also found unfamiliarity with library guides, with nearly two-thirds of participants having never used one.[23]

Regarding the Springshare-provided search boxes in LibGuides, researchers have long described misunderstanding and inappropriate use. Tawatao et al. saw that they were consistently used incorrectly in usability tests and removed them from their LibGuides pages.[24] While testing a prototype primary website built using LibGuides CMS, Vargas Ochoa reported that students used the LibGuides search as a "search-all search box."[25] The same behavior was observed by Azadbakht et al., with some participants trying repeatedly to search for book, journal, and article titles.[26] Sonsteby and DeJonghe reported that after the LibGuides search box was moved from the header to the bottom of the pages, students in their study requested a search box and expected it

to perform like the library's discovery tool. The researchers observed that the participants' desire to search was strong, but they did not understand what was being searched.[27]

Some students in the Conerton and Goldenstein study expected the LibGuides search box on guide pages would search within the guide, while others expected to get articles in response. The researchers also observed that the most relevant results were not at the top of the list. Because of its weak performance and the confusion it generated, they initially removed the search from all pages except the LibGuides homepage, but restored it when the option became available to search within an individual guide.[28] In contrast, Lierman et al. found that participants were successful in using the search box on their LibGuides homepage to find content within the guides.[29]

Conrad and Stevens conducted usability testing of two versions of LibGuides. Version 1 guides used the built-in Springshare search function in the header area; Version 2 guides replaced it with a search of the library's discovery system. Almost all the participants used a search box in their attempts to find requested information, either alone or in combination with browsing. Like other researchers, they found that students often used the LibGuides search boxes that were designed to find databases and guides to look for articles and books. Another participant tried searching for guides using the search on the Databases A-Z page, which returns results for databases only. Their tests also revealed the inflexibility of the LibGuides search, as in the example of a course code search that failed because of a missing space between course prefix and number. Because the discovery system search aligned better with user expectations and provided an experience consistent with other library webpages, their library chose to use it in the header of all guides moving forward. They also noted, however, that "many of their searches navigated students away from the very guides that were designed to help them."[30]

METHODS

We conducted a mixed-methods study with two components: usability testing of the LibGuides search function and analysis of search term logs. Because it included human subjects, the project was submitted to the SMU Institutional Review Board and approved as Exempt research under US Department of Health and Human Services regulations (45 CFR 46). The University's Office of Research reviewed and approved the recruitment materials, consent form, and testing protocol.

Usability Testing
The usability testing participants were recruited from all SMU undergraduate and graduate students. Digital signs, social media posts, flyers, and tabletop tent cards were all used in our recruitment efforts. In addition, email messages were sent to students who had participated in a previous research project and had given permission to be contacted about future ones. An Amazon gift card was offered as an incentive to complete a research session. The students who participated included both undergraduate and graduate students, together representing all of SMU's schools and colleges. Many were returning students, but some were in their first semester.

The testing was conducted in two rounds: in April and July 2022 (Round 1), before interface changes were made, and from September to November 2022 (Round 2), after the first set of interface changes were made. There were seven participants in the first round and eight in the second. We conducted and recorded the sessions remotely on Zoom with a single facilitator. Both of us reviewed the recordings later before discussing them.

Participants were asked questions about their prior use of the search function and what they expected it to find. They were asked to conduct a search using terms of their choosing, then

describe their reaction to the results and assign them a numerical rating based on a five-point scale. We observed the participants using the LibGuides search box on both the homepage for our Research Guides and on the Databases A-Z page. The test script is found in the appendix.

Search Term Analysis
For the search term analysis portion of the study, we analyzed and compared more than 1,200 LibGuides search terms used during three, one-week periods: April 3–9, 2022; October 16–22, 2022; and February 12–18, 2023. We intentionally selected weeks during the fall and spring semesters when students would be on campus and actively engaged in their courses. This helped to ensure that a broad cross-section of our student population was represented.

Initially, we worked with the Search Tracking report provided through the LibGuides CMS administrative interface. This led us to see that our analysis would benefit from knowing which searches in the logs were entered by the same searcher. Subsequently, we requested and received reports from Springshare that included the timestamp and session ID number for each search term. This contributed greatly to our understanding of the search behaviors, and we are grateful to the Springshare staff for providing the custom reports. They contained no personal identifiers or IP addresses.

Before any coding of data was performed, the search logs went through a two-step process to remove duplicate terms:

- The Location column in the reports indicated what was searched: the Databases A-Z list (indicated as "AZ" in the report) or the other pages in LibGuides (indicated as "System"). Searches launched from the Databases A-Z list search only that source, so the search terms appeared once in the report. Searches launched from other pages search all enabled sources—in our case, Research Guides pages and the Databases A-Z list. Those search terms appeared twice in the Searches report—once as "System" and again as "AZ." Technically, both sources are being searched at the same time. However, we wanted to analyze these terms only once, so the "AZ" terms generated by Research Guides searches were removed from the reports.
- Searchers often use the same term more than once in a given session, so we also removed duplicate search terms with the same session ID.

The search function is not case-sensitive, so we disregarded differences in case. Within each report, we saw many examples of the same search term used in separate sessions. Some of these were probably entered by the same searcher but, with no way to verify that, we left them in the datasets for analysis. The session ID, then, served as a proxy for an individual user. Table 1 contains the number and types of searches in each dataset after duplicates were removed.

Table 1. Numbers and types of searches analyzed by week

Week sampled	Databases A-Z	Research Guides	Total
Week 1—April 2022	335 (72%)	130 (28%)	465
Week 2—October 2022	258 (66%)	132 (34%)	390
Week 3—February 2023	300 (71%)	122 (29%)	422

After deduplicating the search terms, we replicated the searches and studied the results. We recorded whether they produced results or not, as well as reasons for their success or failure.

Search terms that produced any results were counted as successful. This part of the study did not try to assess the quality of results or their usefulness to the searcher.

We divided the search terms between us for initial coding. We then reviewed each other's work before meeting to discuss questions raised and to resolve differences.

For Databases A-Z searches with results, we recorded matches between one or more words in the search string and words in the database name, description, and subject fields. We recorded the same matches for Research Guides searches, as well as matches with course-related guides and general guides.

For failed searches—defined for the purposes of this study as those that produced no results—we tracked three types of problems that emerged from the data: misspellings, citations, and topic keywords. Only one of these was recorded for a given search term. We did not track other causes of failure, such as searches for resources our libraries do not provide. In addition to the obvious typos, misspellings included variations on database names, such as "world cat" for the WorldCat database. Counted as citations were the search strings that included the title of an article or a major work such as a book or a film. We counted search strings as using topic keywords when, in our best judgment, the words could plausibly be used in that way.

After completing Round 1 of usability testing and analyzing the first week's data, we made several interface changes in coordination with the SMU Libraries LibApps Team. These were designed to help users better understand at a glance the purpose of the pages and how to use the search and filter functions. They were completed in August 2022.

Databases A-Z Changes, August 2022
- On the Databases A-Z page, the existing description beneath the page title was "find the best library databases for your research." This description was revised to better communicate available functionality: "Find the best database for your research by name, subject, content type, or description."
- At the top of the page, the background box was expanded to include the alphabetical anchor links. A heading, "Filters," and an icon were added to indicate that all the components— alphabetical links, drop-down menus, and search box—serve that purpose. The "Clear Filters" button was moved up to just below the filters rather than below the count of databases found.
- In the Filters area, the text at the top of the Database Types menu was updated from the default, "Any Database Type," to "All Content Types."
- The search box placeholder text was changed from "Search for Databases" to "Search This Page."

Research Guides Changes, August 2022
- On the Research Guides homepage, we added a new description beneath the title to explain the function of guides: "Find selected resources to help with research."
- Since some students in our tests were expecting to find specific information resources like articles or books, we replaced the small "Search Library Resources" link with a large button in the sidebar.
- The placeholder text in the search box was changed from "Search all guides" to "Search within guides only" to better indicate the limitations of the search. The color was changed to a darker shade of gray for better legibility.

- The search button text on guide pages was changed to "GO" to match the button on the Databases A-Z page. High-contrast colors were used to make both buttons more prominent.
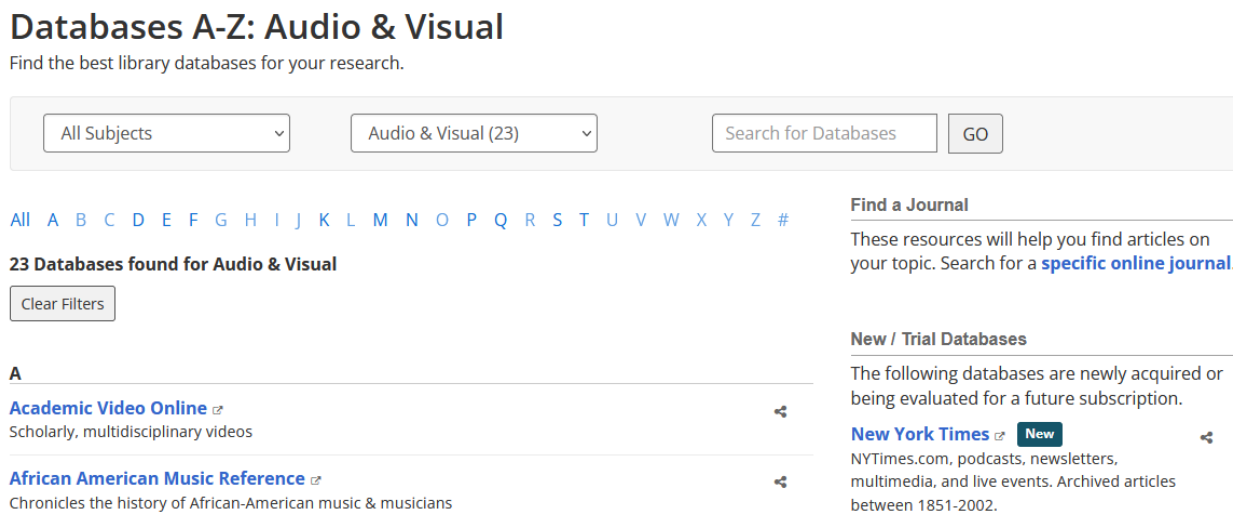
After Round 2 of usability testing and analyzing the second week of search data, we felt there was still more we could do to improve the interfaces. Additional changes were made in January 2023.

Databases A-Z Changes, January 2023
- Point-of-need instruction was added in the form of search tips labeled "Search by" and "Don't search by." They briefly communicate what types of searches will and will not be successful. These were placed in the sidebar just beneath the search box.
- A button linked to the Database FAQ list was added in the same area.

Figures 1 and 2 show the Databases A-Z page before and after the interface changes.

Figure 1. Databases A-Z page before interface changes

Figure 2. Databases A-Z page after two sets of interface changes

Research Guides Changes, January 2023

- The placeholder text in the Research Guides search box was updated again to "Search for guides & databases." Since usability testing participants were often surprised by the search results, we wanted to signal clearly what they should expect to see.
- The search tips were also added to the results page for Research Guides searches below the lists of results. In many cases, the tips would not be visible without scrolling, so a message was inserted between the search box at the top and the boxes containing search results: "Search tips are available below. To find specific items like books or articles, explore the guides and databases or use Library Search."
- Headings for the two search result boxes were changed from "Research Help" and "A-Z Database List" to simply "Research Guides" and "Databases."

Figure 3 highlights the changes to the Research Guides search results page.

Figure 3. Research Guides search results page after additions and changes

Finally, we analyzed search terms from the third week, February 12–18, 2023, and compared them with the previous weeks.

RESULTS OF USABILITY TESTING

Many of the participants in our usability tests had used the tested LibGuides pages before. Out of a total of 15, only four told us that they had not visited them. Yet many encountered challenges when using the search boxes. We tested a diverse group of undergraduate and graduate students, and it quickly became obvious that there was a wide range of understanding of the pages and how the search functioned. While most participants struggled to get useful results, two demonstrated comprehension of the system and skill in their searches.

Research Guides Pages
On the Research Guides homepage, we first asked participants how they could use the search box and what they would expect to find. In Round 1, several participants did anticipate that the results would be guides and databases and that they would have to search or browse within them to find specific information resources. However, the majority expected results that were more akin to those in Google Scholar or the SMU Libraries discovery system. They mentioned specific content types such as books, newspaper articles, papers, documents, and photos.

Half of the participants in Round 2 expected research guides or databases in the search results, but this may have had more to do with their prior experience than the changes made to the interface after Round 1. Some mentioned their previous use of research guides for specific courses. The other half of this group had expectations that the search included journals, research articles, case studies, topic overviews, and course descriptions. One student told us very clearly: "It's like Google, that's what I'm expecting."

Participants were then asked to think about one of their current courses and to run a search that would be appropriate for a research assignment in that course. We observed whether their

searches produced results or not. In Round 1, four did, and three did not. Among those who got results, three confirmed that the results matched their expectations. The other explained that a list of books, papers, or journals was expected. In Round 2, five searches produced results, and three did not. Within the successful group, one set matched expectations, and another was deemed "better than I expected." The other three described some degree of mismatch.

After reviewing their search results, participants were asked to give the search results a numerical rating from 1–5, with 1 being "not useful at all" and 5 being "very useful." In Round 1, a single student gave the results a 5 rating; the rest gave them a rating between 1 and 3. Ratings in Round 2 were similar: one 5, one 4, and six in the 1–3 range. In both rounds, the average rating was 2.5.

Databases A-Z Page
Our questions and procedures for testing the Databases A-Z page were very similar to those used on the Research Guides homepage. We started by asking participants which of the filtering options they typically used. When the participant was unfamiliar with the page, we asked which filter looked most useful. Their clear preference was the Subject filter—six out of seven in Round 1 and six out of eight in Round 2. One participant preferred the alphabetical links, one the search box, and another did not use the filters at all, instead scrolling down the page to locate a favorite database. When responding to this question, some participants may not have considered the alphabetical links to be filters. From Hotjar analytics data we know that, collectively, they are used more than the filters with drop-down menus or the search box.

Next, we again explored the participants' mental models for search results. In both rounds, most of the participants were expecting to see databases. A third of them, however, expected item-level results as in the Research Guides search. We also learned that the word "databases," though ubiquitous in our library communications, is not understood by all students. Asked about the search box and what they would expect it to find, one participant explained, "It's not very specific at all. It just says, 'Databases,' so I have no idea what that could be talking about." Another made a similar comment in response to search results.

We also heard expectations from the students that went well beyond a simple search of metadata. Like Holman, we mostly saw searching for concepts, not necessarily specific words, even on the Databases A-Z page.[31] One participant in our study expected metasearch functionality: launching simultaneous searches within all the relevant databases to determine which ones contained a specific topic. Another expected to see databases "as well as something specific within the database, like an article."

In both rounds of the Databases A-Z searches, we had one participant who did an extra search. In Round 1, we saw four searches that returned results and four that did not. In Round 2, only one of the nine searches attempted returned any results. Four out of the five participants who got results said they were in line with their expectations. Three of those searches were for names of databases. Two searches that produced zero results also matched expectations. In those cases, the participants observed that their search terms were too specific. What follows are a few examples of how this search fell short of student expectations.

- "I expected to see ATLA, since religious ethics is part of the journals that are in there."
- "Carbon-13 isn't very non-popular. It's an important thing in research, so I would expect to see it."
- "I hoped that what I searched would be in the tags for the journals."

- "What does surprise me is that it didn't give me a recommended search option instead."
- "I was pretty sure the Baroque era was broad enough to find some sort of database information on it."

For searches on the Databases A-Z page, six participants gave their results a 1 rating. Three gave them a 2, one a 3, two a 4, and three a 5. For Round 1, the average rating was 3.1, and for Round 2, it was 2.1. While most participants found this search problematic, a couple of experienced and savvy researchers successfully used the search box in combination with another filter to get precise results.

To conclude the usability tests, we asked for suggestions on improving the search function on the two pages tested. The students gave us a number of thoughtful suggestions, some of which we used in our subsequent interface changes. Their ideas included the following:

- introductory text for Research Guides to explain their purpose and function
- explanation of how the search box works and what it searches
- more sophisticated searching that would incorporate phrase searching and include close matches in the results
- sub-categories of subjects assigned to databases and guides
- search suggestions, similar to "Related searches" in Google
- more detailed database descriptions

RESULTS OF SEARCH TERM ANALYSIS

We analyzed the two types of searches tracked by the LibGuides system: those conducted on the Databases A-Z page and those launched from other pages. The three time periods studied consisted of a week prior to the interface changes, a week after the first set of changes and before the second set, and a week following the second set.

It should be noted that, in the LibGuides System Settings, we have configured the "System Search" option as opposed to "Guide Search." Searches launched from our Research Guide pages search across all published guides, as well as the Databases A-Z page. Searches launched from the Databases A-Z page are limited to the metadata describing our database collection. These are the only search sources we have enabled, though it is possible to include search results from other LibApps products and external systems.

For both types of searches combined, we found that searches with no results were 45% of the total in Week 1, 31% in Week 2, and 36% in Week 3. Figure 4 shows the breakdown by week for Databases A-Z searches and Research Guide searches.

Figure 4. Percentages of searches with no results
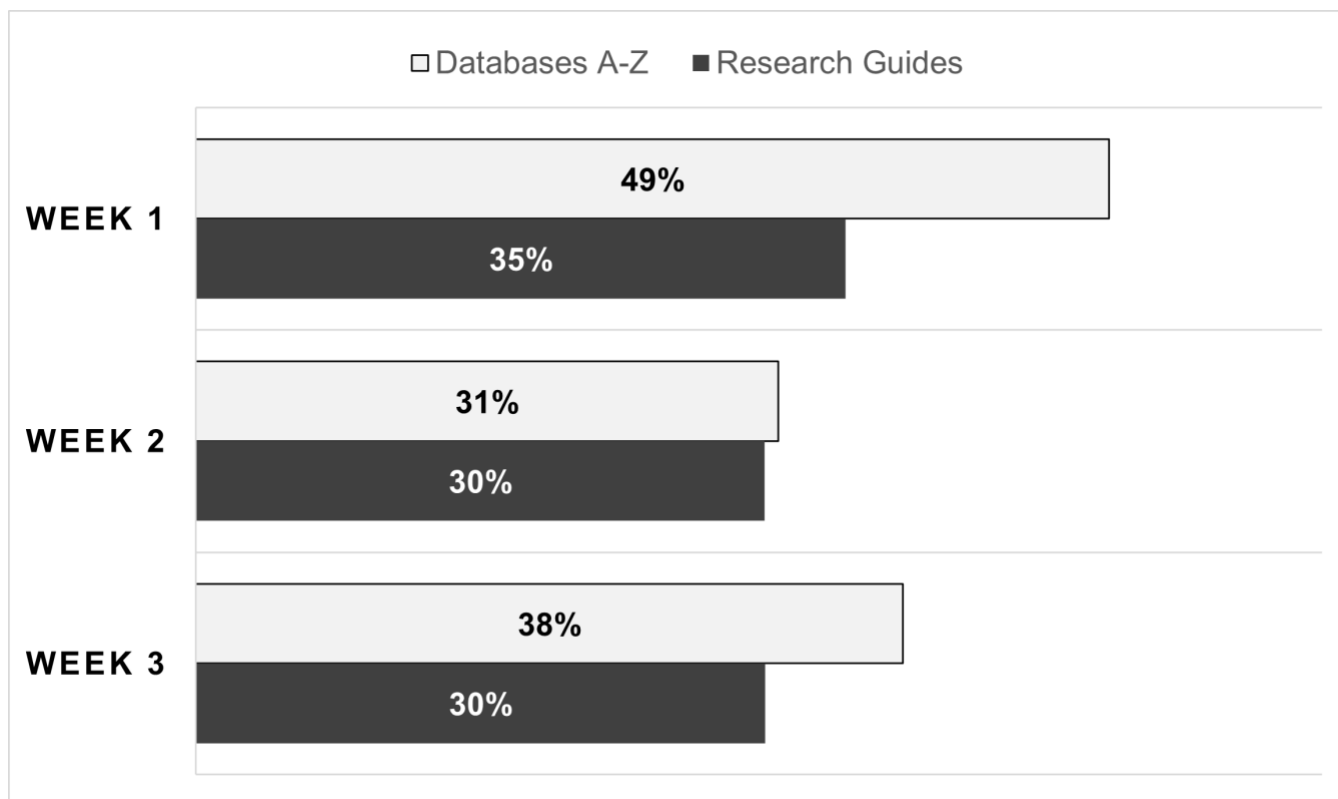
As we replicated the searches from the search term reports, we recorded matches with the metadata and reasons for failure. Table 2 shows the results of searches on the Databases A-Z page in percentages. In almost all cases, the productive search terms matched one or more words in a database name. They matched the broad subject categories assigned to the databases only 7%–11% of the time. Matches between the search terms and the database descriptions were more variable. We observed rates of 52%, 37%, and 61%. In addition to matches within the Description field, we found and included matches within the optional More Info field and even within database URLs.

Table 2. Search term matches and causes of failure in Databases A-Z searches

Sample period	Matches (%)			Reasons for failure (%)		
	Database name	Database description	Database subject	Misspelling	Citation	Topic keywords
Week 1	92%	52%	9%	14%	7%	71%
Week 2	99%	37%	7%	9%	5%	61%
Week 3	93%	61%	11%	16%	8%	49%

In the search terms that produced no results, we found that misspelling was a factor in 9%–16% of cases. However, the reports also showed that some searchers realized their errors and immediately corrected them.

Citations used as search terms were the most obvious type of problem we observed in the Databases A-Z searches, but not a common one. These represented 5%–8% of the no-result group. Some were the titles of books or films, while others were full bibliographic citations, most likely copied from another page and pasted into the search box.

By far, the biggest reason that Databases A-Z searches produced no results was the use of topic keywords. For Week 1, they accounted for 71% of the no-result terms. That figure declined to 61% for Week 2 and 49% for Week 3.

The search term matches in Research Guides searches are detailed in Table 3. Predictably, the productive search terms used on these pages most often matched words in a guide. Course Guides—those with a course code in the title—were matched in 58% of searches with results in Week 1. For Week 2, it was 80%, and for Week 3, 76%. General Research Guides were matched at an even higher rate: 86% in Week 1, 87% in Week 2, and 79% in Week 3.

Table 3. Search term matches in Research Guides searches

Sample period	Percentage of search terms				
	Course guide	Other guide	Database name	Database description	Database subject
Week 1	58%	86%	28%	9%	6%
Week 2	80%	87%	38%	25%	18%
Week 3	76%	79%	28%	24%	11%

Results from this search also included databases, so we also recorded matches with the Databases A-Z list. Words in database names were matched by 28%–38% of the search terms, words in database descriptions by 9%–25%, and database subject words by 6%–18%.

The recorded reasons for Research Guide searches failing to produce results are detailed in Table 4. Here, misspelling was a more significant problem than we observed with searches on the Databases A-Z page, ranging from 18% to 24% of the terms. Citations also accounted for a larger share, 13%–15%. Topic keywords were again the most frequent problem, 60% in Week 1. However, this dropped to 40% in Week 2, followed by 46% in Week 3.

Table 4. Causes of research guides search failure

Sample period	Percentage of search terms with no results		
	Misspelling	Citation	Topic keywords
Week 1	20%	13%	60%
Week 2	18%	15%	40%
Week 3	24%	14%	46%

In addition to search term matches and causes for failure, we made a few more observations about patterns within a search session and the number of words used.

- In both types of searches, we saw many examples of iterative searching—adding and subtracting words or characters, such as a plural "s," before running a new search. When citation searches failed, some users responded by removing all but one or two words and

searching again. As noted above, repeating a search term within the same session was fairly common.

- Search term word counts were calculated separately for the two types of searches. Combining data from the Databases A-Z page for all three weeks, search terms ranged from one to 22 words. The median number of words used was one due to the many uses of database names. (We did not consider the mean to be useful here, as it was skewed by the entry of complete citations.) Word counts for all the Research Guides searches ranged from one to 25 words. The median was again one, though close to two. Together, these calculations tell us that, while some use far too many words, most LibGuides searches consist of just one or two.

After analyzing the search terms used in LibGuides, we also looked at changes in search activity. In the 12 months following the interface changes, the number of searches launched on the Databases A-Z page decreased by 27%. The monthly total was higher in March than the previous year, and for May, it was about the same. Totals were lower for all other months. These are shown in Figure 5.

Figure 5. Search activity comparison for Databases A-Z page
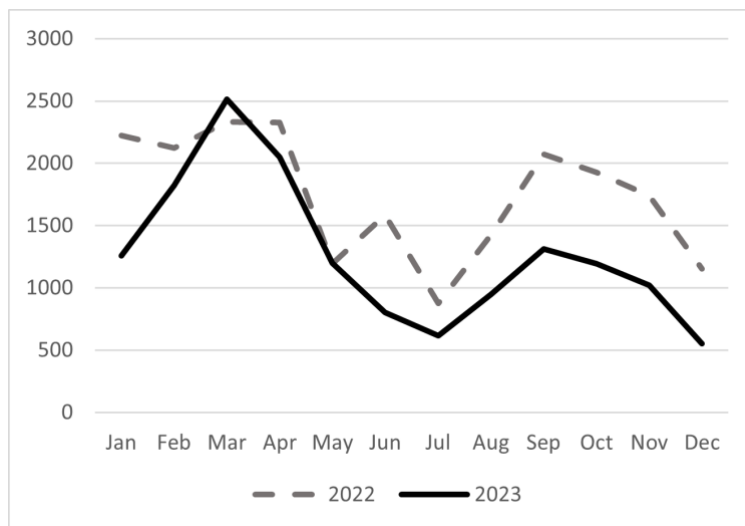
Similarly, searches launched on other LibGuides pages were down 35% year over year. Monthly totals were higher in March and May, but lower for the other months. These are compared in Figure 6.

Figure 6. Search activity comparison for Research Guide pages
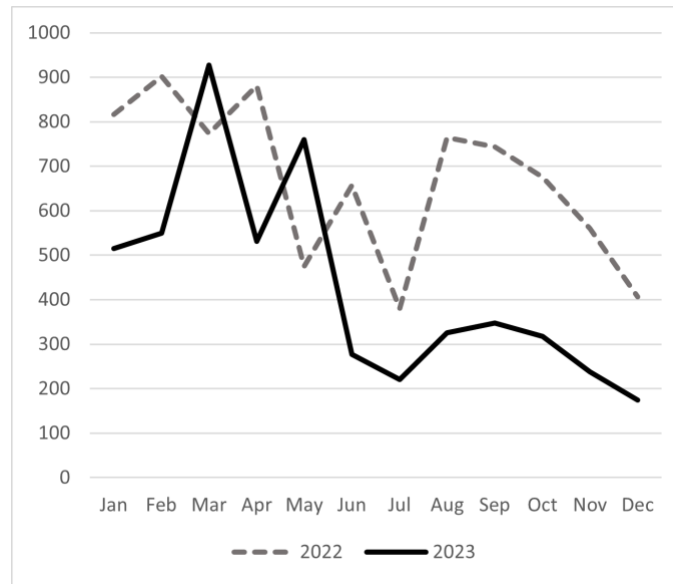
These decreases stand in contrast to the relatively stable use of the LibGuides system during the same period. While monthly session statistics varied as much as 23% year over year, total sessions for the year rose 3%.

DISCUSSION

The usability testing revealed considerable variation in the understanding of and familiarity with LibGuides searches. Asher and Duke and other researchers have found that Google and other search engines provide the mental model most students apply when searching library resources.[32] Our research confirms that this is true for the LibGuides system. Many of our participants expected results to include item-level information resources, not another finding tool to be browsed or searched.

Most visitors to our LibGuides pages start their user journey with Google or another search engine. Google Analytics reports show that search engines accounted for 69% of the traffic to our LibGuides pages over the past year. When visitors use a search engine just seconds before starting their LibGuides search, in most cases, it is to be expected that they would continue to search in the same way. Referrals from other websites represented only 11% of the LibGuides traffic, though we provide access from other LibApps products, the SMU Libraries homepage, our discovery system, and the Canvas learning management system. The remaining 20% of visits are considered "direct" and include such actions as typing the "friendly" URL into the address bar, selecting a bookmark, or linking from a document.

The results of the first round of usability testing were used to inform the initial interface changes we made in August 2022. In the second round of testing, we did see that the changes had some impact—for example, some participants saw and read the new placeholder text in the search box out loud. However, the results of Round 2 were not substantially different from those in Round 1.

In participants' interactions with the search boxes, we often saw a disconnect between their search terms and the placeholder text. On the Databases A-Z page, only two participants entered database names. One used an article title, another a newspaper title, and the rest entered topic

keywords despite the placeholder text of "Search for Databases" (Round 1) or "Search This Page" (Round 2). The search terms used were similar on the Research Guides homepage, where the placeholder text was "Search All Guides" (Round 1) or "Search within guides only" (Round 2). One participant used "citing" to find links to a citation help guide. One entered an author name, one an article title, and the rest entered topic keywords. While the placeholder text was intended to communicate the limitations of the searches, many participants still expected them to search across all library collections and provide item-level results. These test results clearly showed us that disrupting the ingrained search behaviors of college students is very challenging.

Students who are new to the academic library environment may not have a good understanding of terms like "databases" and "research guides." That makes it even more difficult for them to comprehend how a LibGuides search box differs from those they have used elsewhere. The more experienced researchers, even if they had a good understanding of what the search results would contain, expected more from the searches than they delivered. Some imagined they were searching the controlled vocabulary of databases or were disappointed that the results page did not provide links to preformulated searches for them to try.

The participants found the limited nature of the LibGuides searches surprising, disorienting, and somewhat frustrating. To improve the user experience and reduce the number of failed searches, we must consider changes that academic libraries can make to LibGuides, as well as others that Springshare might make to its product.

Since these search boxes do not function as most users expect, it is important to communicate contextual differences to the extent possible. We did this by adding descriptive text, changing labels, and changing the placeholder text in search boxes. After not seeing much change in the search logs following the first set of interface changes, we added search tips at the point of need to directly communicate what constitutes productive and unproductive search terms.

The search term analysis revealed that the use of topic keywords is the most prominent reason for failure. Together with entering citations, this behavior corresponds with the expectations we observed in usability testing. After making changes to the search interface designed to discourage these types of searches, we saw a reduction in the use of topic keywords. The level of citation searching was unchanged.

Returning to our second research question, could we reduce the percentage of searches that produce no results? Maybe, but not in a dramatic or conclusive way. Most of the improvement was seen in the Databases A-Z searches. We expected to see further reductions in Week 3 following the second set of interface changes but instead saw a slight increase in the Databases A-Z figure and no change in the one for Research Guides. The results were likely influenced by factors that could not be measured, so our one-week snapshots did not provide definitive results. Analysis over a more extended period would be needed to determine whether the decreases in no-result searches are consistent and lasting.

The most important outcome of our interface changes, it seems, is not the changes in search terms or results but rather the searches that were not done at all. No additional usability testing was done after the final interface changes, so we have no data that explains why search activity decreased substantially. However, it is what we would expect to see if students were heeding the added search tips and responding in one of two ways: searching more efficiently or avoiding the search function entirely.

While some academic libraries have chosen to remove the native search function from their LibGuides instance, we did not see that as a viable option for SMU Libraries. It is an important means of navigating to the many course and topical guides that are not linked from the main landing page. Our Databases A-Z page is the primary way our users access those critical resources, and it provides information, like brief descriptions and "Best Bets" tags, that supports the selection process and is not available in our discovery system.

At Cal Poly Pomona, where Conrad and Stevens conducted their study, librarians replaced the LibGuides search with a search box for their discovery system because that better aligned with students' expectations.[33] We see that as problematic because it takes searchers to another environment where guides and databases can be difficult to find among many other resource types. Once they navigate away from LibGuides, they are unlikely to return. If they did, it would be the result of an inefficient, circular workflow. We think it best for the search function to keep users within LibGuides, even though it challenges their mental model of what a search box is and does.

Besides the interface changes implemented, we saw several improvements that could be made behind the scenes. Many search failures arise from the imprecise entry of database names. It is common for databases to be branded with concatenated words like PitchBook or ScienceDirect. Since we offer hundreds of databases, it is understandable that users may not know or remember which names include spaces between words and which do not. Centuries take different forms, too, with some spelled out and others using numerals in the database name. An acronym or a shortened form of a database name may be commonly used by instructors and their students but fails to produce results in the LibGuides search.

The Databases A-Z list provides an Alternate Name field where variants can be saved and recognized by the LibGuides search. Figure 7 shows a database record to which alternate names have been added.

Figure 7. Database record with alternate names

Capital IQ

Database Types	
Alternate Name(s)	S&P Capital IQ, Cap IQ, Capitaliq
Database URL	https://www.capitaliq.com/
Use Proxy?	No
Window Target	Inherit system setting
Friendly URL	
Best Bets & Subjects	Business
Description	Public & private international companies transactions, M&A & fixed income data

Up to this point, SMU Libraries added alternate names on a case-by-case basis as we became aware of a need anecdotally. In the research data, we could see these names in use and producing results. However, we also saw a greater need for alternate names and, as a result of our research, added them systematically throughout the database records. Wherever words or syllables (as in PubMed) are concatenated, we created an alternate name with a space between them. Where database names contain a space but could reasonably be concatenated (Capital IQ), we accommodated that too. We also added alternate names for any titles that include centuries. Through continued monitoring of the search term reports, we can identify short forms of database names (IBIS for IBISWorld) and acronyms (EEBO for Early English Books Online) that are being searched and add alternate names for them as well.

These additional access points will result in fewer dead ends and less frustration for our users, so we consider them worth the investment of time and effort. Ideally, the LibGuides search would include a concatenated version automatically when two words are entered and a version with a space when a capital letter occurs in the middle of a name. Partial names, such as Lexis or Nexis (both of which appeared in our search logs), should produce results instead of just LexisNexis. If these enhancements were made to the search software at a system level, then the need for libraries to create and maintain alternate names would be greatly reduced.

As we listened to the suggestions of usability testing participants and reflected on our search experiences elsewhere, we thought of several other ways to make the LibGuides search more flexible and to accommodate differences in search behavior and understanding.

- Search suggestions (autocomplete) could be used to reveal database names and other words found in LibGuides as the user types in the search box. This would help guide them to appropriate terms and correct spellings. Based on their research, Ward et al. recommended including this functionality in all library search interfaces.[34] Kate Moran of the Neilsen Norman Group wrote, "In recent years, search suggestions have become an expected sign of a well-designed search feature. . . . Suggested terms that return zero results, or irrelevant results, are worse than unhelpful—they sidetrack users and are downright irritating."[35] To make a positive impact in LibGuides, suggestions should be drawn from the institution's instance of LibGuides rather than from all instances.
- Similarly, "Did you mean . . . ?" suggestions would help users get back on track after a search with no results. This could address spelling errors and show users related terms used in the system. Holman advised: "Database developers who design algorithms that make allowances for spelling errors will facilitate student search success."[36]
- Automatic stemming or lemmatization would expand results to include different endings for a search term. For example, the term "market" could yield "market," "markets," "marketer," and "marketing" in the list of results. However, the results of these techniques vary widely for English-language texts and stemming reduces precision.[37] Therefore, it might be best to employ them only when a search string would otherwise produce few or no results.

LIMITATIONS

The positive changes in search behavior that we observed in our analysis may have been due in part to factors other than the interface changes, such as the experience level of the users represented and the number who were repeating their searches in separate sessions. While we are confident that most of the analyzed searches were conducted by students, the data were

anonymous and may have included searches conducted by faculty members, university staff, or unaffiliated visitors. Ongoing maintenance of our LibGuides pages may have caused some differences in results when the searches were replicated weeks or months later.

CONCLUSIONS

For academic librarians, usability testing is a valuable way of seeing library websites through the eyes of our student users. After being immersed in our online environment for years, we tend to forget what it is like to approach a website like LibGuides for the first time. This research has reminded us that we cannot assume familiarity with library terminology and systems. Rather, we must meet each student where they are and provide the individual support needed to understand and utilize the library's resources.

The current generation of college students has never known a world without Google. Searching it and other websites has been a daily part of their lives, and they bring those years of experience to LibGuides. It is no fault of the students that they expect the search boxes to perform like those they used previously. With our unified indexes and Google-like discovery tools, academic libraries have reinforced that mindset. Therefore, when a website search has a different goal and a more limited focus, it is incumbent upon our system designers and administrators to communicate that to users. At the same time, it should conform as much as possible to website norms and user expectations. Through clarity and conformity, we can lower barriers, expand mental models, and decrease the percentage of failed searches.

Our research showed us that interface modifications can have a positive impact on student search behaviors. But that is only a partial solution to the problems we identified. By complementing that strategy with smarter system design and administration, we can make the search function more flexible, robust, and intuitive, thereby improving the user experience and reducing the number of roadblocks students encounter. We are hopeful that Springshare will take advantage of available technologies to improve the performance of the LibGuides search. At SMU Libraries, we have implemented alternate names for databases systematically and will continue to explore other ways to improve the search function of our LibGuides pages. Options could include providing search access on selected pages only, reducing the scope of the Research Guides search to individual guides, adding our discovery system to the search sources in LibGuides, substituting a Google Programmable Search Engine, or providing a browse navigation option for guides that are currently dependent on search. All are possible pathways for further research.

APPENDIX: USABILITY TESTING SCRIPT

Instructions for the moderator	Instructions given to the participant
Greet the participant and thank them for participating.	[Participant's name], as you saw in the e-mail, this should take 10 minutes or less, and I will be recording the computer screen and your voice. Do you have any questions about our research project? I want to emphasize that we are testing web pages, not you, and there are no right or wrong answers to the questions I will ask. If you don't want to share your video, just click on "Stop Video" at the bottom of the Zoom window. That should also hide your name and profile picture. Give me just a moment to start the recording, then we will begin the research activities.
Start the recording and announce the following: "We are now recording, and this is participant [unique number]."	Today I will ask you questions about two library web pages and ask you to do a couple of searches.
Put this link into the chat: https://guides.smu.edu/home	Please open the chat window, follow the link that I'm putting there, and then share your screen with me.
	Thank you. Have you visited this page before?
	Please look at the search box at the top of the page. How do you think you could use that, and what would you expect to find?
	Let's imagine that you have been given a research assignment in one of your current classes. Try using the search box now to find something useful for that assignment.
	Please describe what you see in the search results. Are they what you expected to see or not, and why?
	On a scale of 1 to 5, with 1 being not useful at all and 5 being very useful, how would you rate these search results?
	Thank you. You can stop sharing your screen for moment, and I will put another link into the chat for you.
Put this link into the chat: https://guides.smu.edu/az.php	Now please follow that link and share your screen again.
	Have you visited this page before?
	Please take a look at the options in the box labeled "Filters." IF PREVIOUSLY VISITED: Which of those do you typically use? OTHERWISE: Which one looks most useful to you?
	If you were using the search box here, what would you expect to find?
	Thinking about the same course and research assignment as before, try a search here and see what you get.
	Please describe what you see in the search results. Are they what you expected to see or not, and why?

Instructions for the moderator	Instructions given to the participant
	On a scale of 1 to 5, with 1 being not useful at all and 5 being very useful, how would you rate these search results?
	Do you have any suggestions for improving how the search function works on these pages?
	Those are all my questions, and I want to thank you very much for your time today. You're helping us to improve our web pages for all SMU students and faculty members. To show our appreciation, we will send a $15 Amazon gift card to you online. You will need to complete a form for that, so watch for an email message from [staff member]. She will provide instructions and send you the gift card. Any final questions?
Wish the participant a good day and sign off. Save a copy of the recording to your computer, then upload it to the designated folder in Box and verify that it will play there.	

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