LIBRARYFIND: SYSTEM DESIGN AND USABILITY TESTING OF ACADEMIC METASEARCH SYSTEM

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4. LIBRARYFIND: SYSTEM DESIGN AND USABILITY TESTING OF ACADEMIC METASEARCH SYSTEM

4.1. ABSTRACT

Using off-the-shelf search technology provides a single point of access into library resources, but we found that such commercial systems are not entirely satisfactory for the academic library setting. In response to this, Oregon State University (OSU) Libraries designed and deployed LibraryFind, a metasearch system. We conducted a usability experiment comparing LibraryFind, the OSU Libraries website and Google Scholar. Each participant used all three search systems in a controlled setting and we recorded their behavior to determine the effectiveness and efficiency of each search system. In this paper, we focus on understanding what factors are important to undergraduates in choosing their primary academic search system for class assignments. Based on a qualitative and quantitative analysis of the results, we found that mimicking commercial web search engines is an important factor to attract undergraduates. However, when undergraduates use these kinds of search engines, they expect similar performance to web search engines, including factors such as relevance, speed, and the availability of a spell checker. They also expected to be able to find out what kinds of content and materials are available in a system. Participants' prior experience using academic search systems also affected their expectations of a new system.

4.2. INTRODUCTION

Today's academic library websites serve as gateways to digitally-accessible library resources, ranging from full-text newspaper and journal articles to on-line catalogs of physical collections. Yet, undergraduate students often use web-based search engines as a primary tool to find class related information, not only because they are familiar with web-based search engines (Notovny, 2004; Augustine & Greene, 2002), but also because they struggle to use library websites as a gateway for finding information (Stephan, et al., 2006; Notovny, 2004; Yakel, 2004; Chisman et al, 1999; Eliason et al., 1997).

Many researchers in library and information science focus on improving library websites so that navigating library services is easy. These include local resources (e.g., the library catalog), as well as databases offered by third-party vendors (e.g., Academic Search Premier). Yet, navigation

remains difficult for novice users unfamiliar with exploiting the multiplicity of library services. They do not know where to start in part because they do not know which databases are proper for their current information need (Stephan et al., 2006; Eliason et al., 1997). They also find it difficult to identify useful documents from the returned results (Stephan et al., 2006; Eliason et al., 1997). Undergraduates expect that disparate library resources be aggregated so that a single query will return satisfactory results (Augustine & Greene, 2002; Notovny, 2004).

One promising approach to these persistent issues is simplifying the search rather than constantly revising the library website to improve navigation. For that reason, researchers are experimenting with metasearch and federated search systems. In this paper, we distinguish metasearch systems based on whether the system is able to index locally. When a metasearch system (such as LibraryFind) receives a query from a user, it invokes multiple library service providers at the time of the search request to retrieve useful information. Another type of metasearch system (such as Google Scholar) requires those multiple content sources to provide their indices so that they can be searched locally and the results can be retrieved remotely. Researchers vary in how they define metasearch and federated search systems. Christenson & Tennant (2005) refer to the first kind of search engine as a metasearch and the second kind as a federated search. Interestingly enough, this usage of the term "federated search" is inconsistent with previous definitions of the term from database research, where federated search referred to the first kind of search (Lim et al., 1995; Hwang et al., 1993).

We are designing LibraryFind to successfully serve the needs of the library community and specifically college undergraduates. LibraryFind has the look and feel of a web-based search engine but provides access to the high quality content that is traditionally made available only through libraries. One of our goals is to make a system that OSU undergraduates will choose as their primary web-based service to find appropriate information for class assignments. In addition, we expect that OSU undergraduates will find the relevant databases for their information needs so that they can associate their information needs with databases in the future.

To investigate our progress towards these goals, we conducted formal usability testing in the fall of 2006. We assumed that current undergraduates seek academic materials from either the library website or from commercial web-based search engines. Thus, we decided to use three different search systems. The first system is the OSU Libraries website, which is a traditional online library website that serves as a gateway to library resources. The second system is

LibraryFind. For the third system, we chose Google Scholar as a scholarly web search engine because it returns academic materials yet has the familiar Google interface.

Using three different search systems in our usability testing, we investigated three research questions to determine how undergraduates search for academic materials depending on the search system they use.

- Which system do undergraduates choose to use?
- What factors are important in choosing the academic search system?
- How effectively and efficiently did each system work when used by undergraduates?

The following describes the LibraryFind system (4.3), related work (4.4), explains our usability testing (4.5) and then explores the results of that testing (4.6).

4.3. OSU LIBRARYFIND SYSTEM – DESIGN AND IMPLEMENTATION

The design and implementation of LibraryFind was motivated by our desire to have a more effective and efficient library metasearch engine. In 2004, OSU Libraries implemented Innovative Interfaces' MetaFind search system, knowing that the search technology was not fully developed or standardized (Boock, Nichols & Kristick, 2006). Over the next two years, deficiencies in the commercial product led to low use statistics, even though MetaFind was introduced in the library segment of Writing 121, the introductory writing course taken by most first year students. Previous studies have shown that searches from metasearch engines were too slow, that results were difficult to interpret, and that users did not always understand what they were searching (Tallent, 2004; Lee, 2006; Cervone, 2005). OSU Libraries developed LibraryFind to address searching and display issues identified in previous usability studies.

4.3.1. The Initial Search Page

We designed the initial search page to look like any commercial web-based search engine so that potential users could initiate interaction with our system without difficulty. We assume that potential users are accustomed to commercial web-based search systems and have trouble using traditional library search systems because they do not understand what it means to search various library services, or because they do not know which services are appropriate for their current information needs. We also tried to avoid library jargon that users might not understand and instead tried to use terms which are commonly used in any web-based search system.

We minimized text in the initial search page (Figure 4-1) to make the search text box prominent so that users will quickly notice the box. We included three tabs; “General”, “Images and more”, and “Books and more”, and filtered based on document types.

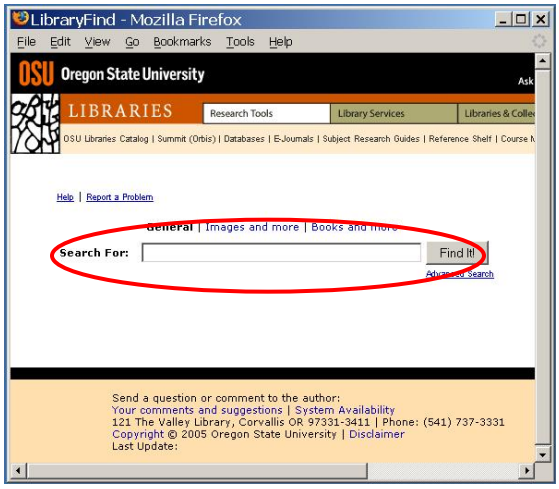

Figure 4-1. LibraryFind Initial Page

4.3.2. Document Retrieval

Once a user submits a query, the metasearch engine sends it to multiple library services. When the number of library services is small, this is a reasonable strategy. However, as the number and diversity of available library services increases, it becomes increasingly probable that results will be included from services that are not relevant to the user’s information need. This large number of irrelevant resources will not only degrade the performance of the system, but also they will increase the number of potentially irrelevant results displayed to the user. This problem of identifying potentially useful information providers to search for a given query is known as the information provider selection problem (Meng et al., 2002). The goal is to select as many potentially useful library resources to search as possible while minimizing the search of less useful library resources. At this time, we have not yet implemented any automated method of determining the best services. Instead, we included a subset of local resources and databases chosen by librarians as the best starting point for a majority of undergraduate research.

4.3.2.1. Query dispatcher

The query dispatcher (Figure 4-2) establishes a connection with the server of each selected library service and passes the query to it. Access to each library service is most commonly

accomplished through the Z39.50[7] or SOAP[8] protocols. Ideally, we would like to harvest metadata directly from OSU's vendors utilizing OAI-PMH[9], as this would allow quicker retrieval through local indexing. However, few vendors currently provide this type of information access to their databases. Each library service has its own query format, meaning that the original user query may need to be translated to a new query before being sent to each service.

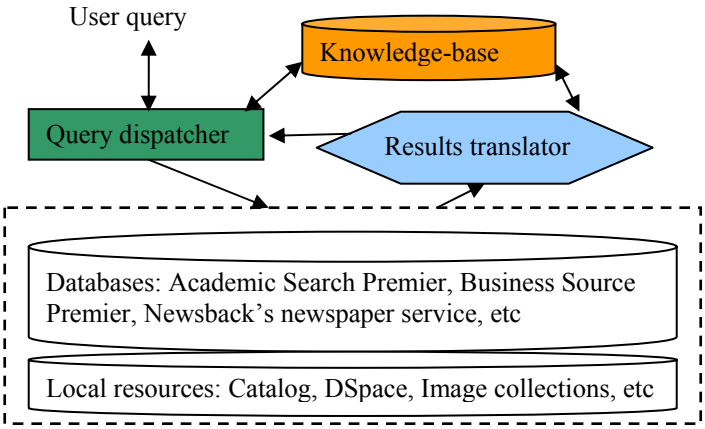

Figure 4-2. LibraryFind software Component architecture.

LibraryFind addresses these issues by utilizing a central knowledge-base, which stores relevant configuration details of each service, such as the connection information, query format, and the format of search results (Figure 4-2). For example, Academic Search Premier uses the Z39.50 protocol and returns results in MARCXML[10]. The knowledge-base uses this information to connect to the service and extract citation information from the returned record sets.

The query dispatcher utilizes information from the knowledge-base to send the transformed query to the target services directly. The search results from each database and local resource are then passed into the results translator where individual results are extracted and normalized for display and ranking.

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[7] Z39.50 is a client server protocol for searching and retrieving information from remote computer databases.
[8] Simple Object Access Protocol (SOAP) is a protocol for exchanging XML based messages over computer network.
[9] Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) is a protocol to harvest the metadata descriptions of the records in an archive so that services can be built using metadata from many archives.
[10] In library and information science, MARCXML is an XML schema based on the bibliographic MARC standards.

4.3.2.2. Results translator

After retrieving results from each database, the results translator merges the results into a single ranked list and presents the merged results. Implementing the results translator presents two challenges. The first challenge is to filter out duplicate records. For example, the same article may be represented with slightly different metadata across different databases. To overcome this issue, we compare metadata to create a confidence value that two records refer to the same publication. The second challenge is to globally rank the results in the merged list. To do this, filtered records are passed through a simple ranking algorithm to sort records within the results set according to the query terms. Results where primary titles, authors or subject metadata exactly match query terms are weighted the highest. More emphasis is given to keyword matches that occur at the beginning of each field, or keyword matches that occur often in each field.

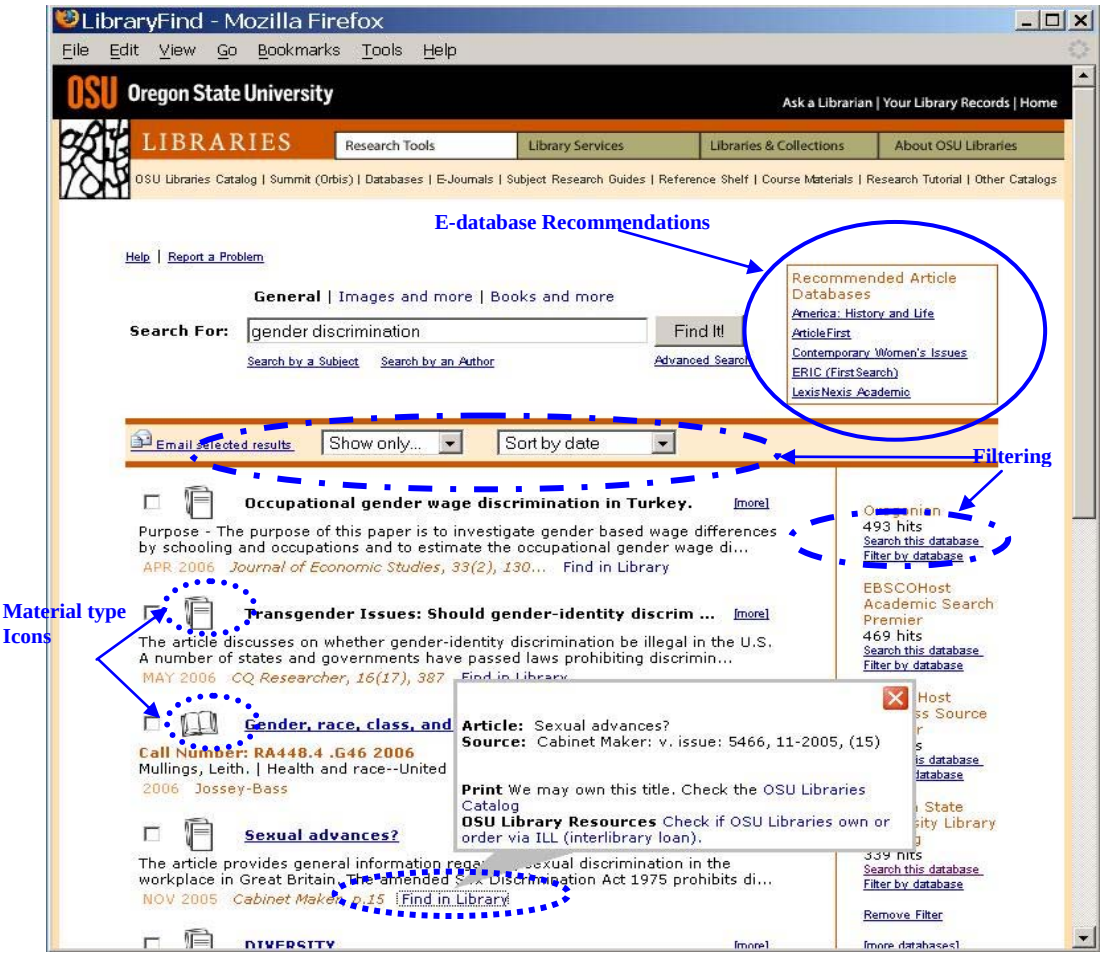

Figure 4-3. LibraryFind results page.

4.3.3. Viewing search results

We present the title of each result along with metadata appropriate for the type of material (Figure 4-3). Users can access materials directly by clicking the title and can see detailed metadata information by clicking a "find in library" link (bottom-center of Figure 4-3).

4.3.3.1. Accessing documents

For some records, we can provide a direct link to the full-text of the resource, often using OpenURL[11] to create links to the full-text when available. These links can be passed to a library's OpenURL Resolver[12], which determines if the organization has access to that particular title. If full text access can be located, then the title of the resource is linked to the full text. If the title is unavailable, an additional "find in library" link provides links to additional content location options returned by the library's OpenURL Resolver. If no access points exist, the tool provides a link to the parent organization's Inter Library Loan.

4.3.3.2. Additional features

One of our goals is to recommend appropriate databases (upper-right of Figure 4-3) so users will be able to find the right gateway to the information they need, even if they did not find that information directly in the LibraryFind search results. "Database recommendations" are determined by matching the user's query against collections of keywords descriptive of each database. The keywords collections for each database are constructed from 120,000 Library of Congress Subject Headings and abstract information about each database.

Users can filter returned results by their material type and database. They can also sort results by date and relevance (upper-center of Figure 4-3). These options were created in response to perceived deficiencies within current metasearch vendor products and librarians' feedback.

4.4. BACKGROUND AND RELATED WORK

Our goal in developing LibraryFind was to create an academic information search tool that students would use. The working prototype of LibraryFind was installed on the OSU Libraries website in the summer of 2006. Previous work on usability studies of library websites and work on evaluation of metasearch systems suggested issues to explore.

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[11] OpenURL is a type of URL that contains resource metadata for use in libraries. National Information Standard Organization (NISO) has developed OpenURL and its data container (the ContextObject) as international ANSI standard Z39.88.

[12] OpenURL Resolver offers context sensitive services based on that metadata.

4.4.1. Usability studies in academic library websites

Recent studies show that users of library websites have difficulty understanding library and archival jargon and lack familiarity with the structure or contents of these interfaces (Augustine & Greene, 2002; Yakel, 2004; Hamburger, 2004; Cobus et al., 2004). Users also have trouble deciding where to start searches, perceiving where they are in their search, other areas of the website (Battleson et al., 2001; Stephan et al., 2006; Thomsett-Scott, 2005; Eliason et al., 1997, Chisman et al., 1999; Travis & Norlin, 2002). Additionally, college students find it difficult to choose an appropriate database from library websites (Battleson, et al., 2001). Novice and experienced users have different goals when using library websites, which complicates library website design (Cockrell & Jayne, 2002; Cunningham, 2005). Some researchers noted that current students' familiarity with web search engines leads them to expect similar functionality and performance in library search systems (Augustine & Greene, 2002; Notovny, 2004).

To remain competitive, library websites must integrate external resources from vendors and provide a user experience similar to web search engines. Despite extensive efforts in overcoming these challenges, library websites still struggle to attain the usability of their competition.

4.4.2. Usability of academic library metasearch systems

While metasearch systems have been around for many years, their importance and use within the library community is a relatively new phenomenon. Metasearch tools allow users to enter their search once and avoid making the user choose a suitable database from a list of hundreds (Crawford, 2004). These users are accustomed to the ease, convenience and speed of web searching (Christensen & Tennant, 2005). Bringing these resources together in an easily searched interface addresses the need users have for clear starting place. For these reasons, librarians have looked to metasearch systems as one solution for bringing together their heterogeneous resource collections (Luther, 2003). At present, libraries spend a large portion of their budgets on library resources that users do not discover, or learn how to access (Luther, 2005). Very few libraries have built their own metasearch systems (Reese, 2006). Most libraries have purchased and modified commercial products, such as ExLibris's MetaLib, WebFeat and Fretwell Downing (Boss, 2002; Breeding, 2005).

Few formal usability studies have been conducted on metasearch systems given their relatively recent implementation in libraries. Also, as most systems are proprietary, testing may occur but results are rarely publicly available. An exception to this is a study done by Endeavor

(commercial metasearch engine) that demonstrated a need for accurate sorting by relevance and then date, and the interest in personalization features (Randall, 2006). Other studies described positive findings including that college students liked having descriptive metadata to aid in evaluating the relevance of items (Reeb, 2006; Randell, 2006), and that they valued the ability to access full text (Lee, 2006). Some negative findings about the use of metasearch engines were also revealed in previous studies. Mandatory user log-ins and the necessity of selecting databases and other resources from a list were barriers that kept college students from using a metasearch system (Tallent, 2004). Users were also dissatisfied with the way search results were returned database-by-database (Lee, 2006; Tallent, 2004), with the slowness of the search (Lee, 2006), and with an interface that they found unintuitive (Tallent, 2004; Cervone, 2005).

In summary, previous user studies examined how students interacted with metasearch systems and identified which features students liked and did not like. None of the studies conducted tested whether a state-of-art metasearch system can serve college students as a primary academic search system or compared it with other search systems.

4.4.3. Usability of scholarly web search engines

A recent study shows that users in an academic setting want more relevant results with the ease of a web search engine (Marshall, et al., 2006). In response to these demands, web search engines with a scholarly focus such as Google Scholar, Citeseer, PubMed, and others emerged.

Much of the literature on these scholarly web search engines (as opposed to Section 4.4.2 library metasearch systems) describe strengths and weakness of Google Scholar (Neuhaus, et al., 2006; Jacso, 2005; Tennant, 2005; Notess, 2005; Burright, 2006; Bosman, et al, 2006). Positive findings include that Google Scholar leverages successful attributes of the Google interface: the interface is highly familiar, and the search experience is intuitive to anyone who has used Google previously. Full-text is often available; users can sometimes find free web versions of otherwise inaccessible full-text articles (Notess, 2005). OpenURL implementation allows users to link to their library's subscribed full-text content from within Google Scholar (Tennant, 2005). Highly cited articles are ranked to appear near the top of the results list, which is good for novice users but perhaps not as useful to the expert (Notess, 2005). Negative aspects of Google Scholar are its lack of transparency about which journals and publishers are included in the search and from what years, its English language bias, its absence of authority control, and a time lag in uploading new content (Meltzer, 2005; Burright, 2006; Neuhaus, et al., 2006; Jacso, 2005).

In summary, while people have examined the positive and negative aspects of these search engines, we are aware of no studies exploring how undergraduates use scholarly web search engines compared with library metasearch systems and traditional online library search systems.

4.5. USABILITY EXPERIMENT

Our first goals with the study were to get a true picture of users' willingness to use LibraryFind as their primary academic search tool and to identify the factors affecting this willingness. Given this, we tested the usability of LibraryFind against two other systems that students would be likely to use in the academic setting, the OSU Libraries' website and Google Scholar. We wanted to get quantitative results in addition to the qualitative, so, we enlisted twenty-four users[13].

4.5.1. Participants

LibraryFind is targeted at OSU undergraduates who take lower level classes and need to use library services for writing papers. We recruited OSU undergraduates to participate for 90-minute time slots. Fourteen participants were upper level students (senior and junior) and ten were lower level students (sophomore and freshman). Nine students had database experience (prior database and catalog experience[14]), seven students had catalog experience (prior catalog experience, but not database experience), and eight students were novices (no prior experience with catalogs and databases). Surprisingly, only three students had prior Google Scholar (GS) experience, three students had prior Library Find (LF) experience, and eight students had not used the library website at all. Majors and genders were distributed relatively equally.

4.5.2. Procedures

We began each session by explaining the experiment's procedures, and then participants completed a background questionnaire. In this paper we define task as a work assigned to participants with one topic and one system. Participants completed each of the first three tasks using one of the pre-selected topics and systems. For the fourth task, participants were allowed to choose any combination of the three systems to search a final pre-selected topic. This choice allowed us to examine their preferences after experiencing all three systems.

To avoid any kind of learning effect from using systems in a certain order, and any advantages or disadvantages from the ordering of topics, each participant searched the three

[13] Nielson (http://www.useit.com/alertbox/quantitative_testing.html)
[14] All subjects who had prior database experience also had catalog experience

systems and four topics in a different order. The system and topic orders were matched according to six unique Latin squares (Kuehl, 1994). We randomly assigned participants to particular sequences. The study employed a within-participants (repeated measures) design.

The participants documented their findings on a session questionnaire after each task. Each participant wrote down three relevant information resources, identified the material type of each, and indicated their satisfaction level using a five point Likert scale. After this step, we asked questions about their experiences with the system, focusing on whether the system was easy to navigate and to retrieve relevant documents. After the fourth task (users' choice of systems), we asked why they chose their system or combination of systems among the three systems.

Two researchers observed each session and took notes. All four tasks were recorded using Morae[15] event recording software. Morae creates clips of experiments that include audio and video, a screen capture video, and a record of mouse and keyboard interactions with the computer. We also requested that participants say whatever they are looking at, doing and feeling as they are performing tasks. The goal of the think-aloud protocol was to allow the participants to report their thoughts while using each system giving us a more direct view of the mental processes searchers are engaged in while searching. After the last task, participants completed post-session questionnaires that solicited their comments on their experience about each of the three systems.

4.5.3. Description of the search systems

We opened the OSU libraries' website interface (Figure 4-4), and from there, participants could choose various types of library services except LibraryFind. For LibraryFind tasks, we opened the initial page of LibraryFind (Figure 4-1) and directed participants to use the search box. For Google Scholar tasks, we opened initial page of Google Scholar (http://scholar.google.com). We did not conduct any tutorial prior to the session because we wanted to investigate how well participants found information using each system without any instructions.

4.5.4. Search Topics

The four search topics were derived from class assignments from lower level OSU writing courses. Before selecting, we confirmed that each had adequate information resources in each

[15] Software by TechSmith corp. http://www.techsmith.com/morae.asp

system. We communicated each topic[16] verbally rather than in written form. We described each topic in depth as if it was an assignment for a writing course. One of the most challenging activities in information seeking is query formulation and most users struggle to formulate search queries (Belkin, 1982). In a controlled experiment, when search topics and guidelines are explicitly given, these tasks are often typed directly as queries. The initial formulation of a query strongly affects search results, and thus affects experimental results. Crestani & Du (2006) found that using speech to formulate one's information need provides a way to express it more naturally than written topics. We believe that using spoken topics prevents users from copying keywords directly from given topics to formulate their queries.

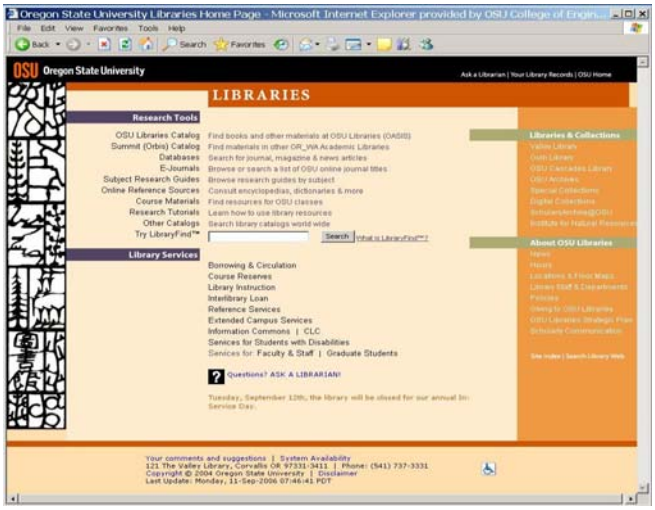

Figure 4-4. OSU Library Website

4.5.5. Data analysis

The Morae recordings and the observations from researchers were reviewed. Answers from open questions were transcribed and grouped into different themes by researchers, such as ease of use, familiarity, relevance, and descriptions of results. The number of answers was counted for each theme, thus yielding a measure of how many of the participants commented on each theme.

We analyzed several metrics per task from user actions and navigation events recorded via Morae. These metrics include time spent to complete each task, the number of queries issued, the number of documents clicked, the number of times results list were returned, the number of times "no results found" returned, and the number of times "next page" was clicked in a search results page.

[16] The topics consisted of 1) history of immigration in Oregon, 2) ethical concerns and political issues surrounding stem cell research, 3) fast food consumption and obesity, and 4) discrimination issues.

We also asked eight librarians to review the information resources that participants selected for their relevance to each topic. The librarians validated participants' material type (e.g. journal article, book) and rated documents in terms of appropriateness for OSU Writing 121 students, especially considering the authority/reliability of the information and its relevance to the topic. For each topic, two librarians reviewed participants' chosen information. We averaged the document ratings between librarians and we considered as "agreed" when at least one librarian agreed with a participant's written material type. Through this validation, we analyzed whether participants were able to recognize material types from each system and whether there is any satisfaction difference between participants and librarians, or between systems.

4.6. RESULTS

We first report on which systems of the three the participants used when given a choice (4.6.1). Then, we explore the factors involved in their decisions (4.6.2) and compared participants' preferences for each system with their success in finding relevant materials (4.6.3).

4.6.1. Which system do undergraduates choose to use?

LibraryFind overcomes some factors that previous studies identified as causing user dissatisfaction (Section 4.4.2). Consequently, we hypothesized that undergraduates would prefer LibraryFind to using the library website and would find LibraryFind as helpful as Google Scholar. To test our hypotheses, we examined which of the three systems participants chose to use in the fourth task. We then analyzed the experience level of the participants in relationship to their system choices, as shown in Figure 4-5.

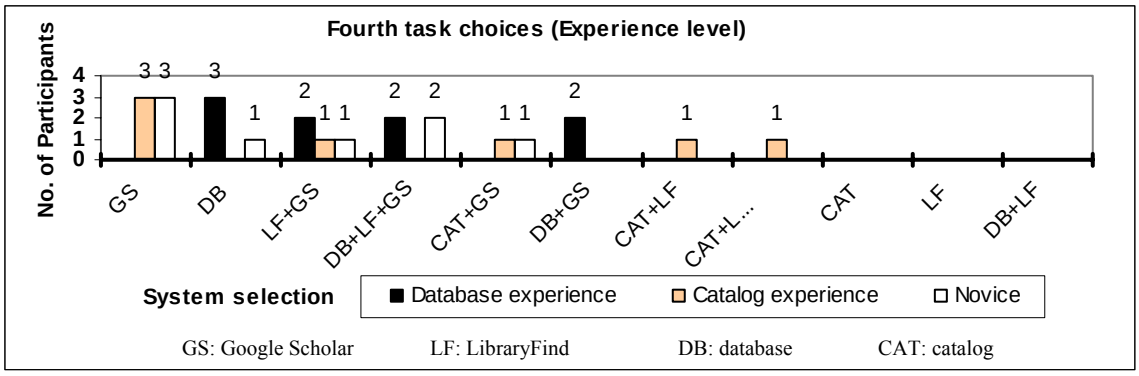

Figure 4-5. Fourth task choices based on participants' experience level as defined in Section 4.5.1.

We found that none of the participants chose LibraryFind or the library catalog from the Library website as the sole system to use in the fourth task. In contrast, four participants chose databases from the library website and six chose Google Scholar as the sole system. Many participants (58%, 14 out of 24) used more than one system when working on the fourth task. This use of multiple systems could suggest that participants were not completely satisfied with the results from one system in terms of relevance; as the task specified that they had to find relevant materials and not a range of material types.

The participants' class level was not related to their choice of system. However, their experience did appear to influence their choice of systems. Participants with database experience tended to select databases over Google Scholar or LibraryFind for the fourth task (78%, 7 of 9). Novice participants (no prior experience with catalogs or databases) favored using Google Scholar (88%, 7 of 8). Among seven catalog experienced participants, only three chose the catalog and all in conjunction with another system. These same participants preferred Google Scholar (6 of 7), while only three participants chose to use LibraryFind.

These results suggest that experience with a library catalog may not be as useful as experience with databases when undergraduates are exposed to new search systems. Only 10 of 24 participants chose LibraryFind for their fourth system, which was not as high as we hypothesized. It might be because they prefer to use familiar systems. However, our results also suggest that undergraduates will switch their primary system if a system can attract their attention through the interface and relevance of returned results. This is demonstrated by catalog experienced participants switching to Google Scholar when given the choice. This means that participants did not choose LibraryFind because they either did not find it compelling enough, they found issues with it, or they found the databases or Google Scholar more compelling.

4.6.2. What factors are important in choosing an academic search system?

A majority of our participants did not choose LibraryFind as their primary academic search system, yet 10 of the 24 did use it in conjunction with another system. We explored why participants chose certain systems for the fourth task by reviewing their stated reasons for choosing a system and their impressions of all three systems. Based on previous studies (Section 4.4.2), we hypothesized that participants would value speed, simple user interface, descriptive metadata, and the availability of full text. We also hypothesized that participants' prior experience would influence their choice of the system.

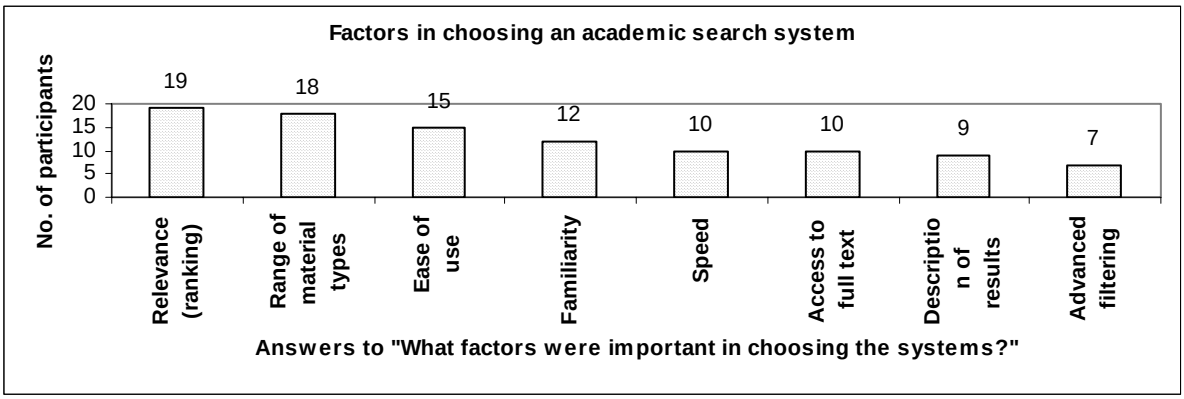

Figure 4-6. Grouped answers from open question

We grouped the comments into eight major factors (Figure 4-6). Getting relevant results with high precision[17] is the most important factor (79%, 19 out of 24). Finding the type of material needed was also important with 75% (18 out of 24) of participants voicing that they considered what each system searched or covered. For example, they chose a search system based on whether they needed a newspaper article, a book, or journal articles. We considered the factors in Figure 4-6 when reviewing the comments on each search system.

4.6.2.1. What factors affect usability of the library website?

Multiple factors emerged that appear to affect usability of the library website as shown in Figure 4-7. Participants value the library website as a means to actually get materials, whether a physical book or a digital article. However, they also perceive a limited range of library resources often due to confusion about various resources, e.g. the differences between the catalog and a database, or experience with one or the others. A majority of the participants still think of the library as a physical place to get actual articles rather than accessing online articles, corroborating Travis and Norlin's findings (2002).

[17] The proportion of retrieved and relevant documents to all the documents retrieved.

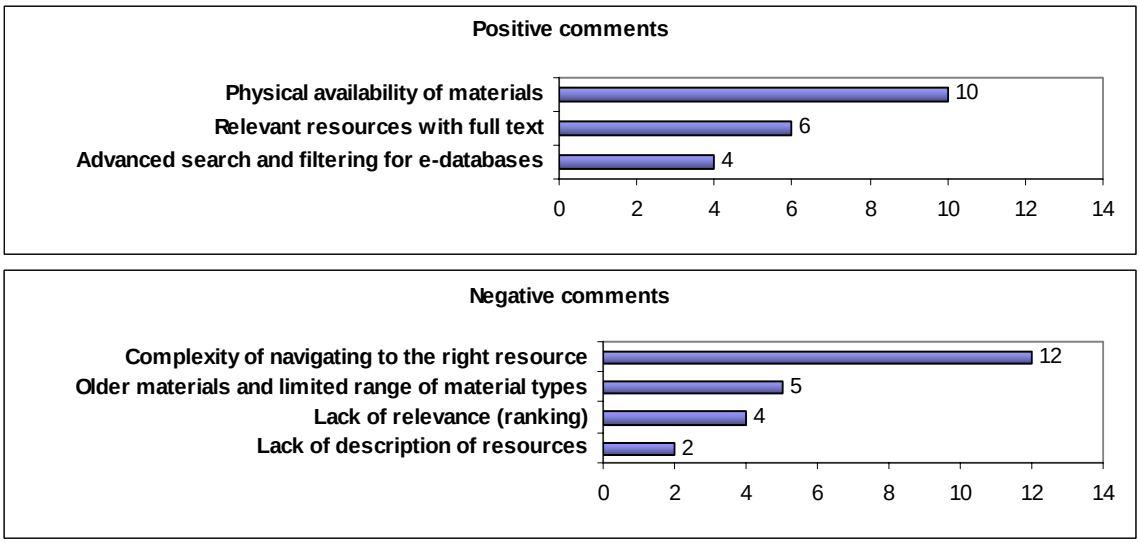

Figure 4-7. Grouped participants' comments about library website

Participants were not satisfied with the catalog as they had difficulty understanding what the library catalog system retrieved and were confused when the returned results were mostly books. For example, P14 searched the catalog to retrieve newspaper article and got confused when he could not find newspapers in the catalog results. This corroborates the findings of previous studies (Eliason, et al., 1997; Chisman, et al., 1999).

They also were frustrated when they got frequent "no results found" errors, since they expected the catalog system to work like web-based search engines which return many results most of the time. When participants encountered the "no results found" error often, they said that catalogs are useful only when they know the call number, exact title, or authors of a book.

> (P06) "It was more specific for like finding a book or for like finding out what the book's about. The majority of all the links on it tended to lead to the call number and where to find it or like just bibliography on the book"

Participants who used the databases from the library website appreciated the relevance of results, full text access, and advanced features. Some gravitated to the databases because they were familiar resources. Once found, these databases could be readily and effectively used.

> (P2) "In middle school and high school, we'd used EBSCO a lot, we had specific library class. I used that because I felt most comfortable with it and because it came out with a lot of good results before"

Navigating to the databases proved frustrating to participants, but seemed to be worth the effort for the participants without database experience. Participants who used a database during the experiment were more satisfied with its performance than Google Scholar. Thus, these participants chose databases in fourth task.

> (P22) "If you find something you like, like here, this subject terms are actually listed there (*by transcriber: EBSCO – narrow results by subject*) and you can click on them too. I like that. I think if I learned how to use this more I'd be a lot better. I like how this set up after you pass all these crazy things (*referring to links necessary to get to EBSCO from library website)*"

Major factors in dissatisfaction and hence usability of the library website were its disorganization and complexity. Participants focused their searching on either the databases or the catalog, and reported differing experiences with each. Problems with the navigation and the interface precluded users from getting to resources so they could judge relevance and satisfaction.

> (P18) "OSU Library website was very disorganized and cluttered. It had bunch of different links to places that I didn't know what they were. Not having global search function really hinders the ability of myself to search. Because I like to be able to at least give general idea what I want"

Catalog-experienced participants struggled to find a starting link from the library website. Four out of seven catalog experienced participants tried other links, but failed to use them and came back to use the catalog. For example, even if they found the databases link, they did not know which database to choose. They also went to the *e-journal list*, which is a listing of holdings, but entered search keywords where the search box prompted for a journal title. Two catalog experienced participants succeeded in using databases and one used only the catalog during the task.

Most of the novice participants also faced obstacles in using the library website effectively. They usually did not find the databases (2 out of 8 novices used databases), and defaulted to using the catalog (4 out of 8 novices), which was not always the best tool depending on the task. Two novices gave up the task. Similar to catalog experienced participants, six (out of 8) novices struggled to use databases or e-journal list.

In summary, the complexity of the library website hindered usability; by attempting to make all resources visible, the library has perhaps made none very accessible. Familiarity through

experience seems to be the key to changing users' perceptions of the usability of the library website.

4.6.2.2. What factors affect the usability of LibraryFind?

Participants did not gravitate to LibraryFind as a first choice, but did appear to be intrigued by it. 42% of all participants (10 out of 24) used LibraryFind in conjunction with other systems when given the choice. The participants who favored LibraryFind noted the range of material types and its ease of use as shown in Figure 4-8. Most of these participants who made favorable comments had no experience with databases.

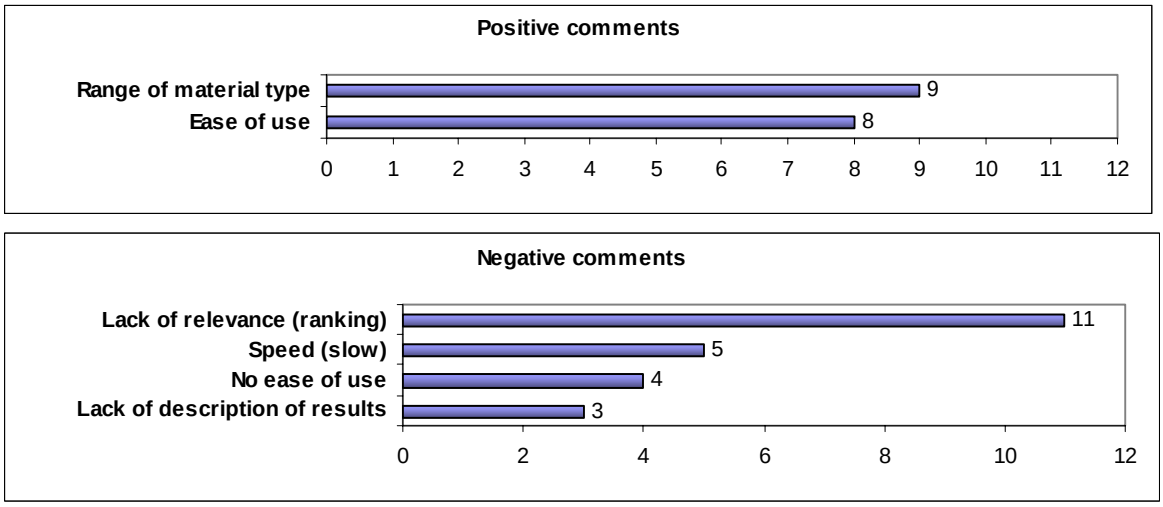

Figure 4-8. Comments about LibraryFind.

Many found it simple to use due to the interface. This reinforces the trend towards most users expecting a search box, rather than navigating links. Participants also liked the range of resources and the sense of discovery.

> (P16)"It's always easy. You type in what you're after, click the button, and it shows you what you can find, where you can find it, and so it's really a while lot less work. LibraryFind ends up finding not only newspapers but also a publication. That's why I like LibraryFind, it finds all sorts of stuff. And then I wanted to find a book. And LibraryFind just had a book, too"

There was disagreement over the relevance of results. From the participants' comments, the dissatisfaction derived from several issues. Several mentioned not understanding what was being searched. There also were comments about knowing enough about the returned results to judge relevance; this argues for longer descriptive summaries or abstracts. Finally, some thought

that LibraryFind results were biased too much towards certain sources such as the local newspaper.

> (P14) “It didn’t really seem to explain or let me have any options for deciding what I was searching in” (P03) “I just didn’t feel like the search results that I was able to identify what was pertinent or relevant to what I had wanted just from the titles or the short summaries” (P05) “It never, never really helps much. When I used it, I was just pulling up articles form the Oregonian”

Slow response time annoyed some participants. Often, speed is a key factor in system choice and satisfaction. Although the majority of participants did not mention slow response time as a dissatisfaction of LibraryFind, most metasearch systems have a speed issue that is not easy to solve given their current configuration.

> (P18) “Search time was a little bit long. I guess it searches through a lot of stuff, but that’s generally kind of annoying, if you have paper due tomorrow”

Even though participants did not choose LibraryFind as their primary system, most did not reject it categorically. They perceived some value and expressed interest in using it more.

> (P04) “If I was looking for things that I could pick up here in a short period of time or local articles, I would definitely be on LibraryFind”

4.6.2.3. What factors affect the usability of Google Scholar?

Participants who favored Google Scholar were satisfied with the relevance, the ease of use, description of results, and familiarity (Figure 4-9). Negative factors were the lack of links to full text and results that participants felt were not appropriate (generally relevant but too advanced) material. Interestingly, participants did not cite relevance as the most important reason they chose Google Scholar. Instead, participants explained that they liked Google Scholar because it returns only academic journal articles and books, unlike Google itself (14 participants). We believe that participants were heavy Google users and so we were surprised that they did not know about Google Scholar.

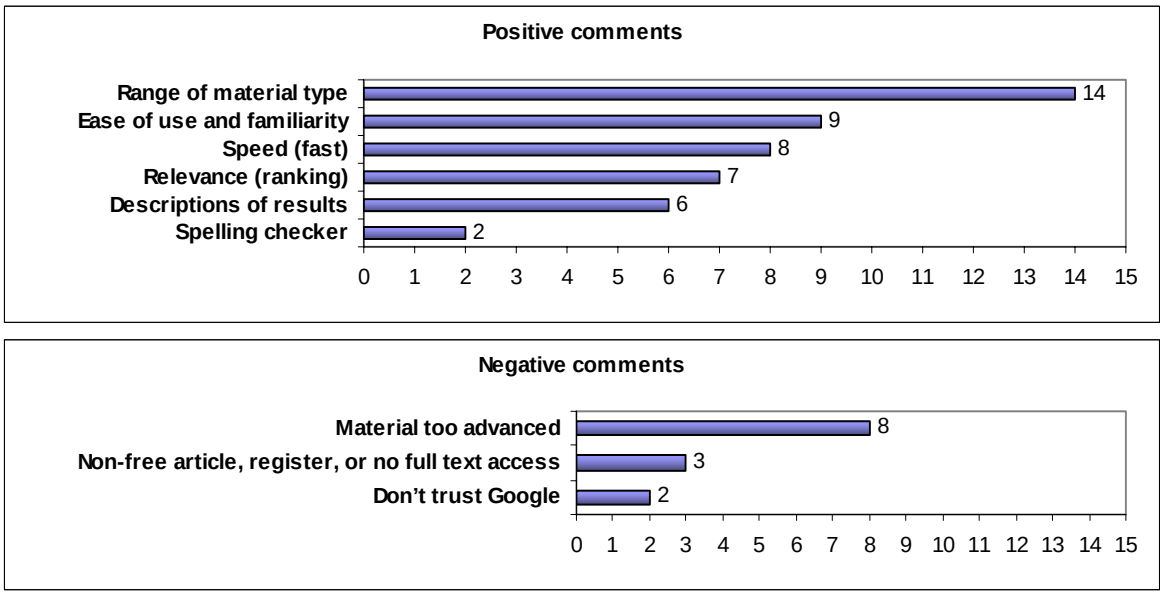

Figure 4-9. Comments in Google Scholar

Our findings suggest that most database experienced participants prefer using databases to Google Scholar, whereas participants without database experience chose Google Scholar because they were not satisfied with LibraryFind or the library website. The following transcript is indicative of participants' reasons for favoring Google Scholar over the other systems:

> (P09) "I was more comfortable with Google Scholar. LibraryFind tended to be a lot slower than Google Scholar. I'm impatient. Also, LibraryFind and Library website (*by transcriber: this participant used catalogs*) are a little bit more complicated and difficult to understand. I think Google Scholar just included the summary. You didn't have to spend your entire time looking through the entire document"

Although participants praised how Google Scholar limited the results to academic journal articles, they also complained that the returned results were targeted too much towards experts (8 participants). Since most journal articles are written for researchers or graduate students, we found that the content was too advanced for undergraduates.

> (P06) "Google Scholar is kind of specific for whatever your topic is. So if you don't have a fundamental grasp of your topic it's a little harder to navigate through it all"

There was also some confusion about access to materials. The links to full text often brought up a request for payment rather than direct access to the information.

> (P14) "The one thing I don't like about Google Scholar is that I don't have easy access to the articles like I do when I'm logged in through the library's website"

Once again, familiarity and past experience influenced choice and impression. Although only three of the participants were familiar with Google Scholar, it is difficult to assess how much their Google experience influenced their Google Scholar comments. Participants were obviously comfortable with Google Scholar's interface even though some had problems with results. Although relevance is important, many participants do not understand how that relevance is decided.

> (P24) "I do like how they show you how the other sources cited it, because that might help me find the relevance of that source. Is it actually sorted by that? So, I'm like wow if there are a lot of other papers mentioning this one, it must be important. So that was good"

4.6.3. How efficiently and effectively did each system work when used by undergraduates?

Our qualitative data identified factors that participants told us they used when choosing search systems. However, the participants' self-reported preferences among systems may or may not reflect their actual usage and success with searching. In this section, we investigate whether there are quantitative differences in participants' search performance among systems. We examined participants' search performance using several metrics described in Section 4.5.5 (4.6.3.1). We also analyzed how participants rated their satisfaction with the documents they selected for each task. We compared their ratings with those of eight librarians as described in Section 4.5.5 (4.6.3.2).

4.6.3.1. Efficiency of searching

We were unable to show any statistically significant difference in the average amount of time that participants spent on each system and on each task (ANOVA, $p > 0.05$). The topic did not affect the amount of time participants spent within each system (ANOVA, $p > 0.05$). This result is not surprising because participants were asked to work on each task for approximately 20 minutes, a time limit we did not strictly enforce. If they were unable to find three satisfactory documents as requested, they wrote down whatever documents they could find into the session questionnaire along with their satisfaction scale. So, while participants spent a similar amount of time with each search system and each topic, their success varied which may lead to perceived differences in the quality and functionality of these search systems.

For the first three tasks, there was no significant difference in the number of queries participants issued (ANOVA, $p > 0.05$). However, participants issued approximately five queries

(4.87) for the fourth task (participants' choice of system), versus seven queries issued on average for each of the first three tasks. Although there is no statistical difference in terms of time spent and number of queries issued, participants spent less time and issued less queries when allowed to choose their system or combination of systems during the last task. This may be related to a learning effect or a comfort level with the testing by the fourth task.

Table 4-1. Three metrics from search results page among systems.

	Search results page		
	Number of times users got first search results page	Number of times users got "no results found" error when queries are issued	Number of times users visited beyond first search results page
Users' choice (fourth task)	114	12 (9.5% of times)	28 (24.6% of times)
Google Scholar	162	14 (8.6%)	52 (32.1%)
LibraryFind	195	37 (19.0%)	84 (43.1%)
Libraries Website	175	51 (29.1%)	34 (19.4%)

Given that the time spent, the number of issued queries, and the number of viewed documents did not significantly differ among systems, we looked for other metrics that might explain participants' different perceptions of each system. We examined the number of search results pages that participants viewed (Table 1). We distinguished between the number of times that participants received at least one page of search results in response to a query (second column of the Table 1) and the number of times participants reached at least one subsequent results pages by clicking "next page" link or clicking on a results page number (fourth column of the Table 1). All of the systems displayed ten documents per search results page as did many of the databases. These numbers suggest how much effort a participant had to expend to find satisfactory results.

Participants viewed more than one results page (e.g. clicking "next page" link) significantly more often when they used LibraryFind than the other two systems (Pearson's Chi-Square test, $\chi 2(3) = 20.13$, $p < 0.01$). Participants clicked "next page" 43.1% of the time (84 out of 195) when they used LibraryFind. This means that users had to look at more pages of results to find satisfactory documents from LibraryFind

Google Scholar returned "no results found" errors significantly less often than the other systems (Pearson's Chi-Square test, $\chi 2(3) = 14.08$, $p < 0.01$), while participants got "no results found" mostly when they used the library website (29.1% (51/175) of the time). Because users

spent effort formulating search queries (Belkin, 1982), they were more likely to get frustrated when they received "no results found" errors.

Overall, the findings suggest that the three systems have similar efficiencies in terms of time spent, number of queries issued, and number of documents viewed. Google Scholar seems to have an edge as participants using LibraryFind viewed more pages, and participants using the library website were more likely to encounter "no results found" errors.

4.6.3.2. Effectiveness of searching

Overall, participants were quite satisfied with the documents they selected (Figure 4-10). Participants were significantly more satisfied with the documents selected during the fourth task when they had more control over their searching choices (ANOVA, fourth task vs. library website, $F[1,131]=16.14$, $p<0.01$; fourth task vs. LibraryFind, $F[1, 134]=15.95$, $p<0.01$; fourth task vs. Google Scholar, $F[1,131]=4.51$, $p=0.04$). Comparing the three systems, participants were the most satisfied with Google Scholar. They tended to be more satisfied with what they found than the librarians reviewing their selections. The difference in ratings between participants and librarians was the least for Google Scholar (0.35) and greatest for the library website (0.95).

Previous studies indicated that librarians were reluctant to use Google Scholar, preferring to use familiar licensed article databases where they were sure of the coverage (Meltzer, 2005; Burright, 2006). Given that our librarians did not know which search systems were used, it is interesting that the librarians were significantly more satisfied with the documents selected from Google Scholar than from any other system (ANOVA, Google Scholar vs. LibraryFind, $F[1,131]=10.66$, $p<0.01$; Google Scholar vs. library website, $F[1,123]=10.87$, $p<0.01$). Recently, the integration of Google Scholar in university library websites indicates that librarians are beginning to accept and promote Google Scholar as a search tool (Mullen & Hartman, 2006; Tenopir, 2005).

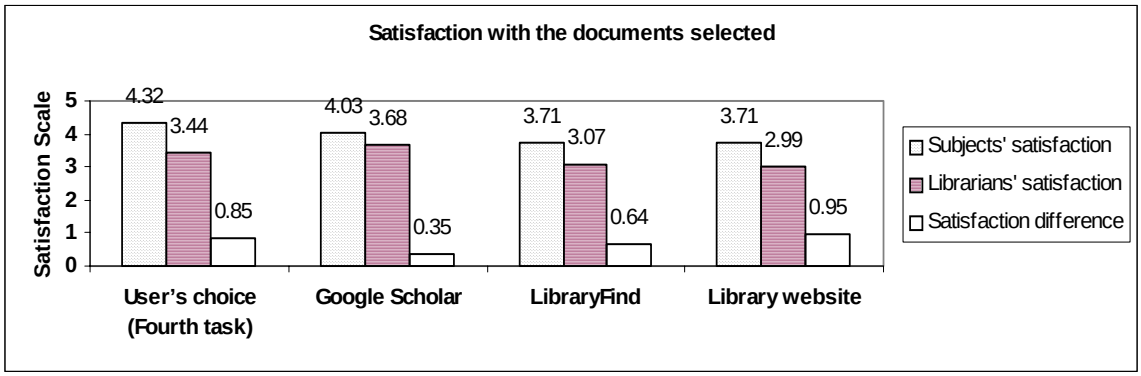

Figure 4-10. Ratings (1 to 5) of participants' satisfaction with the documents they selected for each task, and librarians' review of participants' selections

In terms of material type validation, the librarians classified the selected documents by material type, just as the participants had done during the search sessions. We found that there was a significant variance in librarian-participant rating consistency concerning material types among the systems (ANOVA, $F[3,263]=4.14$, $p<0.01$). The greatest variance was with materials found using the library website (54% agreement) where participants were not confident about assigning material types. For example, the library catalog does not report material types, which confused students. LibraryFind and Google Scholar had similar agreement (79%, and 72%, respectively), and users' choice (fourth task) had 75% agreement. Except for the library catalog, these systems indicate the material type with a word or an icon, which may help explain why LibraryFind and Google Scholar had similar agreement. This feature assisted participants and is valuable when assignments require a range of material types.

The findings in this subsection could suggest that participants are more satisfied with their choice of system while librarians did not agree with users in terms of both satisfaction ratings and material type.

4.7. DISCUSSION AND FUTURE WORK

Throughout this experiment we focused on exploring what makes undergraduates choose their primary academic search system. We also investigated if LibraryFind helps undergraduates find appropriate information efficiently and effectively. Examining the three systems revealed how familiarity, expectations and prior experience inform undergraduates' preferences when choosing a search system. We identified persistent issues that need to be addressed to increase users' satisfaction with LibraryFind and the library website as described in the following sub sections.

4.7.1. Familiarity and Ease of Use

Our findings confirm that familiarity is important, as it shapes the expectations of users. The current generation of undergraduates is familiar with commercial web search engines. Consequently, an interface similar to these web search engines helps users get started and feel confident. For example, users expect results with enough information to make a decision, obvious links to more information or full text, and spell checking. Metasearch engines, including LibraryFind, should develop interfaces that reflect the user's past experience.

4.7.2. Performance Expectations

When metasearch engines incorporate the familiar into their interface, then users expect those systems to perform in a similar fashion. The undergraduates in this study expected relevant results returned quickly. They were disappointed that the simple search box in LibraryFind did not consistently lead to fast, relevant results. These two performance issues are difficult for metasearch engines to overcome because they pass user queries through to multiple sources and return results only as soon as those sources respond.

Improving relevance suggests using more sophisticated ranking algorithms. With preprocessed document indices, we could implement the variants of TF/IDF algorithm (Baeza-Yates & Ribeiro-Neto, 1999). This entails developing the means to index databases sources locally as scholarly web search engines do. Co-citation information is also used by several scholarly web search engines to rank results including Google Scholar. Again, this approach requires local indexing.

Thus, the two obstacles of speed and relevance make metasearch systems less desirable to students as their primary search systems for academic materials. We find that users would accept slower performance only if the results are highly relevant to them.

4.7.3. Recognizing Resources

Users' understanding of what databases or resources they are searching affects their satisfaction with search systems. Participants voiced dissatisfaction when they got results that they were not expecting, when baffled by what they were searching, or when simply not getting results.

When searching the library catalog, some participants received no results when they did not distinguish between keyword searching and title searching, and when they issued misspelled queries. They lost confidence in the system when they got repeated "no results found" errors after

trying to correct spellings several times. These observations suggest that it may be effective to add automatic spell-checking to library search systems.

The library catalog also does not explicitly describe material types in terms that students always understand. The underlying assumption is that the catalog primarily searches for books in the OSU Libraries, whereas undergraduates do not share that assumption.

The lack of clarity regarding what is being searched was observed when users searched the library's e-journals and databases. Almost all the participants without database experience failed to retrieve acceptable results when using the OSU Libraries' e-journals search page. They input their keywords in the search box expecting articles as results, when the e-journals search page is designed to return titles of e-journals. They also avoided using the databases because they were overwhelmed with the number of choices and the lack of guidance on which to select. For these examples, clustering databases by subject may help. Appropriate e-journals or databases could be inferred from the user's search query. One possibility is using metadata and representative keywords to index the e-journals or databases. In that way, we can apply state-of-the-art ranking algorithms to recommend relevant e-journals and databases.

4.7.4. Users' Experience

Users' success with the search systems relates to their experience with those systems. Participants experienced with databases favored using them, even preferring them over Google Scholar. Preference for databases was driven by the availability of advanced search features and the ability to filter results sets. These preferences may help determine whether there is a set of minimum features to implement in academic metasearch engines.

Novices had a great deal of difficulty finding databases on the library's website and identifying which one to use. Given this lack of experience and knowledge of these resources, it may be useful to investigate whether novices would find LibraryFind more helpful if it only searched databases returning just journal and newspaper articles rather than including the catalog. Limiting the range of resources may lead to more satisfaction with the system.

In this study, we focused on participants' prior experiences and class level as predictors of their success. However, we could also examine whether the participant's searching discipline influence their satisfaction with the system.

4.7.5. Future work

This paper reports our preliminary results. One possibility for future work is to analyze query behavior: do users formulate their queries differently when searching academic metasearch tools than when searching the Web? Previous studies showed that users exhibit different query behavior in the home and work environment using the same web search engines (Rieh, 2004). We want to see if our results support the idea of users' query behavior remaining consistent across all types of systems, or whether they adapt their queries significantly based on the systems that they are interacting with. If the search context changes users' searching behavior, then we may need to incorporate a different search algorithm for an academic metasearch system.

It is also possible to design the library website to handle those who are experienced with the different specialized search engines offered (databases and catalogs), and those who are not. For experienced users, the library website could have direct links to databases and the catalog. Such a design is supported by evidence that users who had experience with databases continued to use them. For novices, the most prominent link could take them to a more interactive system, which would educate them as to what the library offers and why they might want to use them. As novices gain experience, they could use direct links (or short trails) from the library home page.

4.8. CONCLUSION

In this study, we explored what makes undergraduates choose their primary academic search system for class assignments and if LibraryFind can benefit them. We conducted a usability experiment comparing three systems. This approach gave us a more objective picture of user response and satisfaction with the academic search systems that college undergraduates actually use. This approach also revealed important general issues with search interfaces and LibraryFind.

Our study reinforced that college undergraduates use what is familiar. Consequently, a new academic metasearch system needs to meld familiarity while capitalizing on the varying experience levels of users. However, when undergraduates face the familiar interface, they expect similar performance to a web search engine, such as its relevance ranking, its speed and certain features. Our participants also expected to know what contents and materials they were searching in a system. Participants' prior experience using an academic search system affects their expectations for and satisfaction with using a new system.

We continue to believe that LibraryFind has the potential to entice undergraduates to use library resources. Until libraries can remove the technical barriers for retrieving highly relevant

materials from multiple resource providers, we will have to settle for offering a good academic search tool, but one that does not yet meet the majority of our users' expectations.

4.9. ACKNOWLEDGMENTS

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4.10. REFERENCES

Augustine, S., & Greene, C. (2002). Discovering how students search a library web site: A usability case study. College & Research Libraries, 63(4), 354-364.

Baeza-Yates, R., & Ribeiro-Neto, B. (1999). Modern Information Retrieval. ACM Press.

Belkin, N.J., Oddy, R.N., & Brooks, H.M. (1982). ASK for information retrieval: Part I. Journal of Documentation, 38, 61-71.

Boss, R. (2002). How to plan and implement a library portal. Library Technology Reports, 38(6).

Battleson, B., Booth, A., & Weintrop, J. (2001). Usability testing of an academic library web site: A case study. Journal of Academic Librarianship, 27(3), 188-198.

Boock, M., Nichols, J. & Kristick. L. (2006). Continuing the quest for the quick search holy grail. Internet Reference Services Quarterly, 11(4), 139-153.

Bosman, J., Mourik, I., Rasch, M., Sieverts, E., & Verhoeff, H. (2006). The coverage and functionality of the citation database Scopus including comparisons with Web of Science and Google Scholar. Utrecht University Library. Retrieved January 20, 2007, from http://www.info.scopus.com/news/coverage/utrecht.pdf

Breeding, M. (2005). Reshuffling the desk. Library Journal, 131(6), 40-54.

Burright, M. (2006). Google Scholar. Issues in Science & Technology Librarianship, 45.
Cervone, F. (2005). What we've learned from doing usability testing on OpenURL resolvers and federated search engines. Computers in Libraries, 25, 10-14.

Chisman, J., Diller, K., & Walbridge, S. (1999). Usability testing: A case study. College & Research Libraries, 60, 552-569.

Christenson, H. & Tennant, R. (2005). Integrating information resources: Principles, technologies and approaches. Oakland, CA: California Digital Library. Retrieved February 26, 2007, from http://www.cdlib.org/inside/projects/metasearch/nsdl/nsdl_report2.pdf

Cobus, L., Dent, V. F., & Ondrusek, A. (2004). How twenty-eight users helped redesign an academic library website? Reference & User Services Quarterly, 44(3), 232-246.

Cockrell, B. J., & Jayne, E. A. (2002). How do I find an article? Insights from a web usability study. Journal of Academic Librarianship, 28(3), 122-132.

Crestani, F., & Du, H. (2006). Written versus spoken Queries: A qualitative and quantitative comparative analysis. Journal of the American Society for Information Science and Technology, 57(7), 881-890.

Crawford, W. (2004). Meta, federated, distributed: Search solutions. American Libraries Online, Retrieved November 14, 2006, from http://www.ala.org/ala/alonline.thecrawfordfiles/crawford2004/crawfordAug04.htm

Cunningham, H. (2005). Designing a web site for one imaginary persona that reflects the needs of many. Computers in Libraries, 25(9), 15-19.

Eliasen, K., McKinstry, J., & Fraser, B. M. (1997). Navigating online menus: A quantitative experiment. College & Research Libraries, 58(6), 509-516.

Hamburger, S. (2004). How researchers search for manuscript and archival collections. Journal of Archival Organization, 2(1/2), 79-97.

Hwang, S-Y., Huang, J., & Srivastava, J. (1993). Concurrency Control in Federated Databases: A Dynamic Approach. Conference on Information and Knowledge Management, 694-703.

Jacso, P. (2005). As we may search - comparison of major features of the Web of Science, Scopus, and Google Scholar citation-based and citation-enhanced databases. Current Science, 89(9), 1537-1547.

Kuehl, R.O. (1994). Statistical principles of research design and analysis. Belmont, Calif.: Duxbury Press.

Lee, J. (2006). Earth Sciences metasearch portal usability testing. Retrieved November 14, 2006, from http://www.cdlib.org/inside/projects/metasearch/nsdl/UCLA_NSDL_062006.pdf

Lim, E-P., Hwang, S-Y., Srivastava, J., Chements, D., Ganesh, H. (1995). Myriad: Design and Implementation of a Federated Database Prototype. Software: Practice and Experience, 25(5), 533-562.

Luther, J. (2003). Trumping Google? Metasearching's promise. Library Journal, 128(16), 36-39.

Narshall, P., Herman, S., & Rajan, S. (2006). In search of more meaningful search. Serials Review, 32(3), 172-180.

Meltzer, E. (2005). UC Libraries use of Google Scholar. Retrieved November 14, 2006, from http://www.cdlib.org/inside/assess/evaluation_activities/docs/2005/googleScholar_summary_0805.pdf

Meng, B., Yu, C. & Lie, K.L. (2002). Building efficient and effective metasearch engines. ACM Computing Surveys, 34(1), 48-89.

Mullen, L. B. & Hartman, K. A. (2006). Google Scholar and the library web site: The early response by ARL Libraries. College & Research Libraries, 67(2), 106-122.

Neuhaus, C., Neuhaus, E., Asher A., & Wrede, C. (2006). The depth and breadth of Google Scholar: An empirical study. Portal: Libraries and the Academy, 6(2), 127-441.

Notovny, E. (2004). I don't think I click: A protocol analysis study of use of a library online catalog in the Internet age. College and Research Libraries, 65(6), 525-537.

Notess, G. R. (2005). Scholarly web searching: Google Scholar and Scirus. Online, 29(4), 39-41.

Randall, S. (2006). Federated searching and usability testing: building the perfect beast. Serials Review, 32(3), 181-182.

Reeb, B., D'lgnazio, J., Law, J., & Visser, M. (2006). Federated search observed in the context of student writing: Taking steps towards improving user experience. College & Research Libraries News, 67(6), 352–355.

Reese, T. (2006). Metasearch: Building a shared metadata-driven knowledge base system. Ariadne, (47)

Rieh, S-Y (2004). On the Web at home: Information seeking and Web searching in the home environment. Journal of the American Society for Information Science and Technology, 55(8), 743-753.

Stephan, E., Cheng, D. T., & Young, L. M. (2006). A usability survey at the University of Mississippi Libraries for the improvement of the library home page. Journal of Academic Librarianship, 32(1), 35-51.

Tallent, E. (2004). Metasearching in Boston College Libraries: A case study of user reactions. New Library World, 105(1/2), 69-75.

Tennant, R. (2005). Is metasearching dead? Library Journal, 28.

Tenopir, C. (2005). Google in the academic library. Library Journal, 32.

Thomsett-Scott, B. (2005). Providing a complete menu: Using competitive usability in a home page usability study. Technical Services Quarterly, 23(2), 33-47.

Travis, T.A. & Norlin, E. (2002). Testing the competition: Usability of commercial information sites compared with academic library web sites. College & Research Libraries, 63(5), 433-447.

Yakel, E. (2004). Encoded Archival Description: Are finding aids boundary spanners or barriers for users? Journal of Archival Organization, 2(1/2), 63-77.