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**Electronic Resource Availability Studies: An Effective Way to Discover Access Errors**

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**Abstract**

**Objective** – The availability study is a systems research method that has recently been used to test whether library users can access electronic resources. This study evaluates the availability study’s effectiveness as a troubleshooting tool by comparing the results of two availability studies conducted at the same library before and after fixing access problems identified by the initial study.

**Methods** – The researcher developed a six-category conceptual model of the causes of electronic resource errors, modified Nisonger’s e-resource availability method to more closely approximate student information-seeking behaviour, and conducted an availability study at the University of Redlands Armacost Library to estimate how many resources suffered from errors. After conducting troubleshooting over a period of several months, he replicated the study and found increased overall availability and fewer incidences of most error categories. He used Z tests for the difference of two proportions to determine whether the changes were statistically significant.

**Results** – The 62.5% availability rate in the first study increased after troubleshooting to 86.5% in the second study. Z tests showed that troubleshooting had produced statistically significant improvements in overall availability, in the number of items that could be downloaded from the library’s online collection or requested through interlibrary loan (ILL), and in three of six error categories (proxy, target database and ILL).

**Conclusion** – Availability studies can contribute to successful troubleshooting initiatives by making librarians aware of technical problems that might otherwise go unreported. Problems uncovered by an availability study can be resolved through collaboration between librarians and systems vendors, though the present study did not demonstrate equally significant improvements across all types of errors. This study offers guidance to librarians seeking to focus troubleshooting efforts where they will have the greatest impact in improving access to full-text. It also advances the availability research method and is the first attempt to quantify its effectiveness as a troubleshooting tool.

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## Introduction

Electronic resource failure is a significant and multifaceted problem for libraries. Encountering an error frustrates library users, and e-resource errors cost the library in terms of lost subscription value and staff time spent troubleshooting problems. Inaccessible resources cause patrons to place unnecessary interlibrary loans or settle for lower-quality information sources that are readily available. Since unavailable subscriptions do not accumulate usage statistics, they bias a common measure used by libraries to gauge the value of their electronic collections. More insidiously, persistent problems with electronic resources undermine staff confidence in the reliability of their own systems, and undercut the library's image in the eyes of the administrators and funding stakeholders to which libraries hope to demonstrate their value. Even when total breakdowns in access do not occur, resources may still suffer from such issues as sub-optimal interface design. The impact is felt in library instruction when instruction librarians emphasize search interfaces and error workarounds, taking valuable classroom time away from discussion of how to develop research topics and evaluate sources.

When resources fail, libraries usually turn to their systems or electronic resource units for a solution. Depending on the size of the library, this may be a team or a single individual. Some errors can be fixed in-house, while others require collaboration with systems vendors – and all the while, the patron is waiting. Given

the time-consuming nature of technical troubleshooting, it is advantageous for libraries to identify the most significant access problems and proactively address what can be fixed immediately.

Problems are often discovered one at a time through interaction with users during a class or at the reference desk, or because other library staff stumbled across the problem during their regular workflows. Conducting evidence-based troubleshooting by auditing resources through an availability study can help libraries take a more proactive approach to identifying and solving problems.

## Literature Review

Libraries have used availability studies for decades to evaluate their ability to provide patrons with desired materials. Mansbridge (1986) and Nisonger (2007) have published review articles describing the development of the availability study. This systems analysis research method uses a sample of items to estimate the proportion of the library's collection that users can immediately access. Researchers can obtain samples by interacting directly with patrons ("real" availability) or by using their judgment to compile a list of items that approximates patron needs ("simulated" availability). Early availability studies often involved surveying library users to find out which books they wanted during a library visit but could not find (Gaskill, Dunbar, & Brown, 1934). Library staff then searched for those books themselves and categorized the reasons

why they could not be found: the library never purchased a copy, the books were checked out or misshelved, the patron looked in the wrong place, etc. Kantor (1976) and Saracevic, Shaw and Kantor (1977) used binomial probability statistics to prioritize these reasons according to how often they occurred, and depicted the results in a “branching” diagram, making it easier for libraries to act on the findings. Overall, Mansbridge and Nisonger reported 60% average availability across the studies they reviewed.

More recently, the availability technique has been applied to study access to electronic resources. Nisonger (2009) conducted the first known electronic resource availability study by creating a list of 50 scholarly journals that he considered to reflect the curriculum of Indiana University. From a handful of recently published articles in each journal, he randomly selected 10 citations to other journal articles, and tried to obtain the full-text of each citation from the library catalogue or a search box on the library website tied into its Ex Libris SFX knowledge base. Nisonger found the full-text of 65.4% of these 500 citations in the Indiana University Libraries’ electronic collections. Acquisitions “errors” in which the library did not hold a subscription, or the holdings entitlement did not include the citation being tested, were the most common reasons for nonavailability. Crum (2011) used the catalogue and link resolver at Oregon Health & Science University Library to test a sample of 414 citations requested by patrons and recorded in the library’s resolver log file. She found just under 80% availability and observed that the link resolver was a special point of failure.

Link resolver performance is also the focus of a related body of research involving the classification of OpenURL errors in order to improve the systems that manage electronic resources. Wakimoto, Walker and Dabbour (2006) conducted a mini-availability study by running 224 likely searches in abstracting databases at California State University Northridge and San Marcos, as part of a mixed-

methods project that also included surveys of SFX users and librarian focus groups. The availability study shed quantitative light on the dissatisfaction with SFX expressed in the user surveys, demonstrating that SFX gave erroneous results 20% of the time at the two campuses. Trainor and Price (2010) found linking errors 29% of the time in a similar study conducted at Eastern Kentucky University and the Claremont Colleges. University of Texas Southwestern Medical Library researchers Jayaraman and Harker (2009) tested 380 randomly selected citations from A&I databases where full-text was known to exist in another subscribed resource, and found that Ebsco LinkSource failed to make the connection 9% of the time (above their target 5% goal). Chen (2012) categorized 432 linking errors reported by Bradley University patrons over a four year period, and found that the most common reasons for link failure involved missing content, incorrect metadata, or knowledge base collections that did not support article level linking. Finally, Stuart, Varnum and Ahronheim (2015) analyzed 430 user-reported errors and randomly tested over 2,000 OpenURLs from University of Michigan link resolver log files over a three year period, concluding that OpenURLs failed with a discouraging 20% frequency.

Research into OpenURL failure provides compelling evidence that e-resource linking sorely needs improvement. The National Information Standards Organization (NISO) has established two relevant working groups to coordinate efforts among librarians, publishers and vendors to address these problems. The Improving OpenURL through Analytics (IOTA) initiative built off Adam Chandler’s earlier research into the relationship between missing metadata elements and OpenURL failure (Chandler, LeBlanc, & Wiley, 2011; Pesch, 2012). IOTA developed a “completeness index” to measure the quality of link metadata and recommended essential fields for content providers to include (Kasprowski, 2012; NISO, 2013). Meanwhile, the Knowledge Bases and Related Tools (KBART) initiative recommended

a data format and best practices for content providers to use when sending metadata to a knowledge base (Culling, 2007; NISO & UKSG, 2010, 2014). The research involved in the creation of these standards has greatly advanced librarians' understanding of OpenURL linking failure; universal compliance with the standards could rectify many linking errors, thereby increasing electronic resource availability for all libraries.

In addition to traditional availability studies and OpenURL accuracy studies, a third type of research – usability studies – also provides insight into why users cannot obtain the electronic resources they seek. Ciliberti, Radford, Radford and Ballard (1998) established an early connection between availability research and user studies when they included “catalog use failures” and “user retrieval failures” in their branching diagram. Their study of patron searches at Adelphi University Libraries attributed one third of unsuccessful searches to difficulty searching the catalogue or finding items on shelf. Later, as librarians became aware of usability research methods, they applied these techniques to test patron access to electronic resources. To note but a few examples from this ample literature: Cockrell and Jayne (2002) asked students to find e-resources using library systems; Cummings and Johnson (2003) observed students using OpenURL linking; Wrubel (2007) offered a concise overview of e-resource usability testing; O'Neill (2009) considered how best to instruct patrons in OpenURL linking based on usability results; next generation catalogues (Majors, 2012) and discovery services (Asher, Duke, & Wilson, 2013; Fagan, Mandernach, Nelson, Paulo, & Saunders, 2012; Williams & Foster, 2011) have been studied thoroughly; Kress, Del Bosque and Ipri (2011) conducted a study to find out why students placed unnecessary ILL requests; and Imler and Eichelberger (2014) investigated how confusing vocabulary acts as a barrier to full-text. Considered as a whole, this usability research demonstrates librarians' awareness that the problems leading to full-text

nonavailability are complex, arising from both library systems and human error.

The question of why users cannot obtain the sources they need is persistent and vexing. Researchers have improved their understanding of this issue by conducting availability studies, link failure studies, and e-resource usability studies. As a result, the traditional availability technique can now be modified to better track linking errors, while accounting for real-life user behaviours.

Since this research method was only recently adapted to measure electronic resource availability, gaps exist in the literature. Most availability studies were conducted at libraries with intensive research collections, leaving smaller libraries without peers to benchmark against. Additionally, no researchers have conducted paired availability studies before and after troubleshooting, as a way to quantify the method's effectiveness at detecting errors. Finally, all electronic resource availability studies published to date have been simulated studies that did not measure availability as experienced by actual library users.

### **Aims**

The present study had a threefold purpose: 1) document electronic resource availability at a smaller academic library; 2) update the availability technique to reflect librarians' current understanding of why electronic resources fail and how students search for information; and 3) determine whether troubleshooting efforts informed by an availability study can produce a statistically significant improvement in full-text access.

The present study took place at Armacost Library, University of Redlands. The user population is approximately 4,800 full time equivalent (FTE) students, faculty and staff. The library's annual acquisitions budget is \$950,000; the physical collection includes just under

500,000 volumes; and the e-resource knowledge base tracks 75,000 unique titles.

Mansbridge (1986) and Nisonger (2007) commented that availability researchers have historically used inconsistent methods, making it difficult to compare results from different studies. Thus, it is important to discuss the rationale behind the researcher’s methodological choices in the present study.

The present study, like Nisonger’s, relies on a judgment sample rather than a randomly selected sample of citations, and so introduces some risk of sampling bias. Statistical validity is a unique attribute of availability studies, but truly random samples would not reflect the way library users interact with electronic resources. The present study derives the sample from student research topics, since students often begin their research with a topic rather than a list of sources.

The researcher also chose to search topics in abstracting and indexing (A&I) databases

commonly taught to students at Armacost Library instruction sessions rather than full-text databases, in order to include OpenURL linking to full-text as part of the study. He chose to run searches as simple keyword searches and tested access to only the first screen of search results in keeping with findings from the Ethnographic Research in Illinois Academic Libraries (ERIAL) study about how students interact with databases (Duke & Asher, 2012, pp. 76, 80). He classified situations where the link resolver did not connect directly to full-text as an error, since students expect direct linking to full-text (Connaway & Dickey, 2010; Trainor & Price, 2010; Stuart et al., 2015). Finally, he chose to test items for availability in the library’s electronic collection first, followed by the library’s physical collection if no electronic access was present, and finally via interlibrary loan if no access through the library’s local collection was present. These resources take increasingly longer amounts of time to return full-text, and students prefer to take the quickest route possible (Connaway & Dickey, 2010).

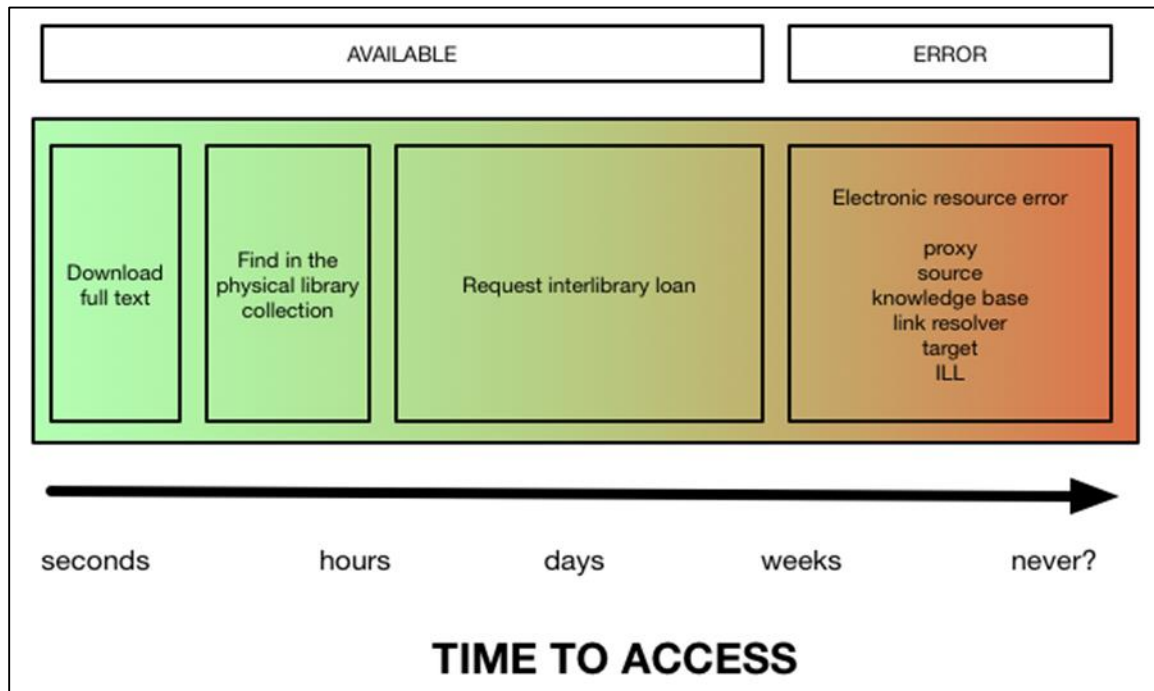


Figure 1  
Full-text availability model

The researcher diverged from traditional practice in the availability literature by classifying nonlocal items as available through interlibrary loan, rather than as “acquisitions errors.” Smaller libraries have historically relied on interlibrary loan to extend their collections, and today even large research libraries are acknowledging that they can no longer expect to acquire the entire scholarly output “just in case.” ILL can be considered a core operational function, rather than an option of last resort, for libraries interested in adopting “just in time” approaches to collection development. Free-lender and courier delivery networks and the ability to leverage knowledge bases to automatically select lenders and receive articles make resource sharing an increasingly practical supplement to subscriptions.

The researcher developed a simple full-text availability model that classified all items as available online, available in the physical collection, available through interlibrary loan, or experiencing an error (Figure 1).

The researcher also created a conceptual model of e-resource failure, depicting the various systems that must work together to allow users to get the full-text of a citation (Figure 2).

The model depicts a typical full-text request process with the following steps:

- 1) Users authenticate to the library proxy server to run off campus database searches (proxy misconfigurations here will also block access to full-text for all users, regardless of location, later in the process)
- 2) Clicking the OpenURL icon causes the A&I database to send a “source” or incoming OpenURL link to the link resolver.
- 3) The link resolver compares the source OpenURL against the library’s self-reported subscription holdings in the knowledge base.

- 4) If the library reported a full-text holding for the desired item in the knowledge base, the link resolver then creates a “target” or outbound OpenURL link to route the user to full-text. If no full-text holding was reported, libraries can configure the resolver to provide users with options to search the library catalogue for a physical copy or request the item through ILL.
- 5) Full-text providers receive the target OpenURL and deliver the full-text of the item, or
- 6) the ILL software receives the target OpenURL, assigns each metadata element to appropriate fields in the request form, and allows the user to submit the request for staff processing.

Each step in the request process carries the potential for error. Proxy errors occur because a resource’s Internet domain name was not registered in the library proxy server’s forwarding table or included in the library’s Secure Sockets Layer (SSL) certificate (Figures 3-4). Librarians can edit the forward table at will, but may need to re-purchase the SSL certificate or wait until the next renewal period to solve certificate errors.

Source errors can be caused by inaccurate information in an abstracting record (such as a missing ISSN) or because the database lacks interface elements required to access full-text (such as the clickable icon needed to trigger OpenURL linking) (Figure 5). Often the solution involves collaboration with the database vendor.

When a library’s subscription entitlement does not match holdings reported in the knowledge base (kb), a kb error may result (Figure 6). Some of these problems are not under the library’s control (for example, if the knowledge base vendor defines a collection in insufficient detail to allow article-level linking).

Link resolver errors occur in rare situations where the logic used by the link resolver fails to

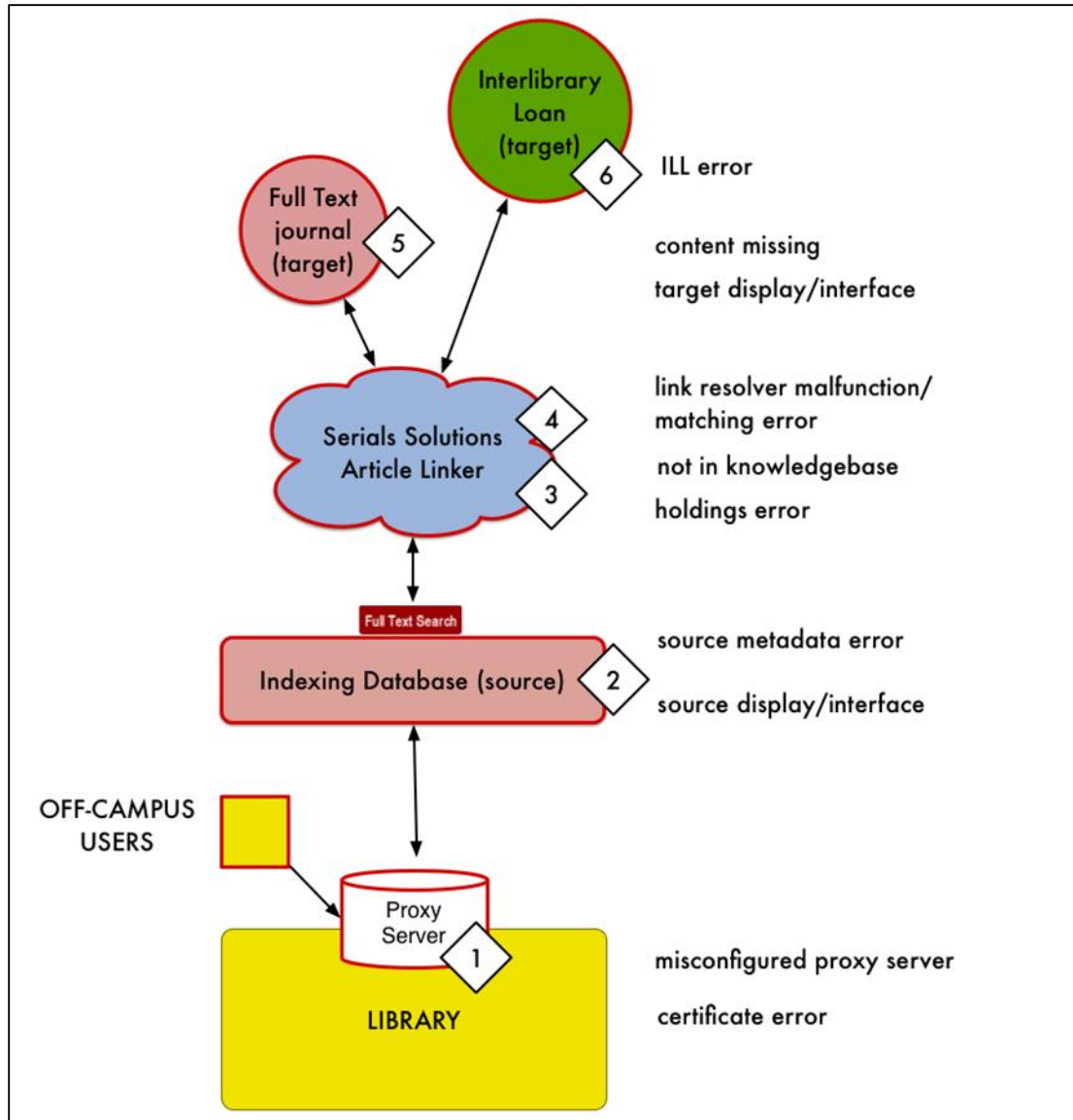


Figure 2  
Conceptual model of electronic resource failure points

retrieve the desired item. Figure 7 depicts one link resolver error, which occurred when an outbound link for a journal article landed on a book in the library catalogue instead. One volume of the journal had been purchased for the library collection and catalogued as part of a monographic series. Since the link resolver was matching on title rather than ISSN, it resolved to this item rather than routing the request to ILL. This problem was fixed by configuring the link resolver to match on ISSN instead.

Target errors typically occur because content is unavailable from the full-text provider; resolution usually requires collaboration between librarians and vendors (Figure 8).

Finally, ILL errors appear when the library’s ILL system fails to correctly populate OpenURL metadata into the online request form (Figure 9). Libraries can correct some problems by adjusting configuration settings in ILL software.

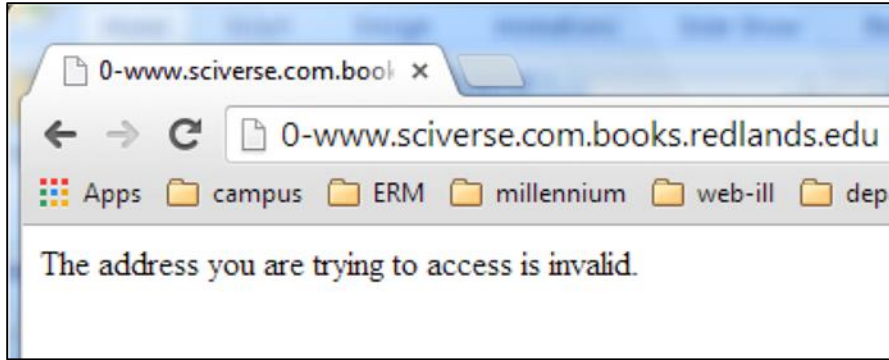


Figure 3  
Proxy error caused by missing domain in forward table

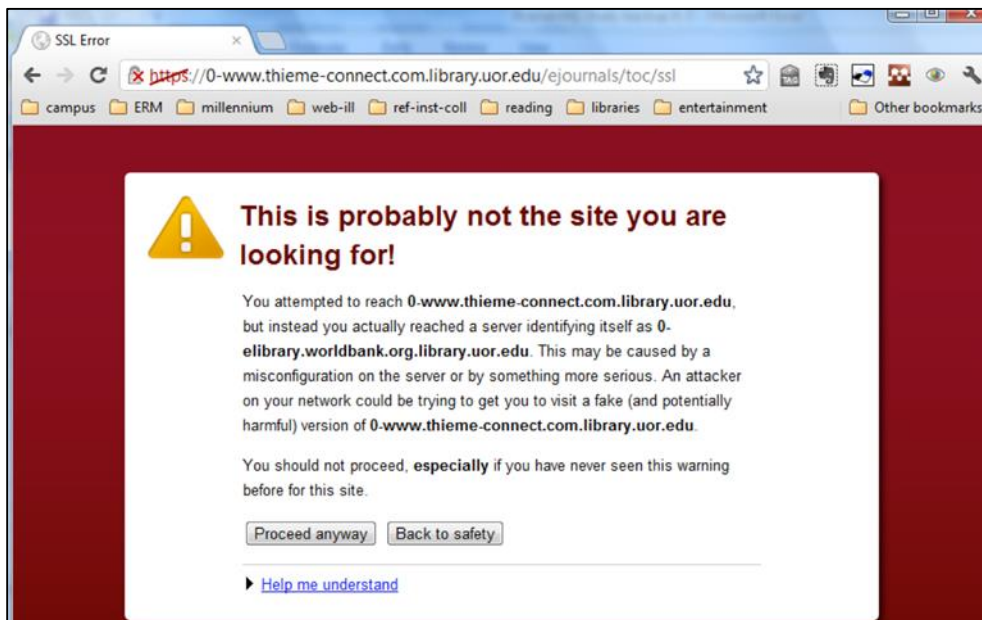


Figure 4  
Proxy error caused by missing domain in SSL certificate

## Methods

The present study involved gathering a realistic sample of citations generated by likely keyword searches, testing them for online, physical or interlibrary loan availability, and attributing any errors to one of these six categories. After performing troubleshooting, the study was repeated and the results were compared using a test for statistical significance.

The researcher obtained a 400 item sample by selecting 10 A&I databases, running four

keyword searches in each database, and testing the first 10 items in each search result for availability or error. This sample size was chosen because statistical calculations based on a pilot study of 100 items showed that a 400-item sample size would approximate the overall collection's availability rate with a 97% confidence interval and +/- 5% margin of error (Brase and Brase, 1987, pp. 284–287). Databases were chosen to represent a variety of disciplines in the humanities, social sciences, and natural sciences. The researcher derived search terms by querying the library's Libstats reference desk



**Citation Finder**

*\* Required: journal title, DOI, PMID, or ISSN*

Format:  Article / Journal  Book  Dissertation  Patent Genre:  ▾

Article Title:

Journal:  ISSN:

Volume:  Issue:  Page:  Date:

DOI:  PMID:

*\* Required: journal title, DOI, PMID, or ISSN*

Figure 5  
Source metadata error caused by missing ISSN

**Full-text is available electronically for these dates:**


Links to content	Electronic Coverage	Electronic Provider
 Get Journal	1997 - present	SCELC Wiley-Blackwell F

Figure 6  
Knowledge base collection that does not support article-level linking

software for four reference questions related to each discipline and isolating key concepts from each question (see Table 1 for the list of search terms). Citations in the sample were classified according to item type (book, article, book chapter, dissertation, other).

The researcher conducted the initial availability study by searching databases from his office at Armacost Library over a one-month time period in April 2012. He tested for electronic

availability by clicking the Serials Solutions “Get Article” link (or “Get Journal” if no article level link existed) for each of the first 10 search results. If the item was not available online, he tested the library catalogue for physical access by clicking the “Search the Library Catalog” link. If items were not locally available in print or online, he clicked the “Submit an Interlibrary Loan request” link and verified that the request form was correctly filled out (without actually submitting a request). Item metadata, inbound and outbound OpenURLs, availability, and error

Table 1  
Databases and Search Terms Used

<b>Discipline</b>	<b>Database</b>	<b>Search Terms</b>
<b>Music</b>	RILM	Lute music of John Dowland Baroque dance suites Feminism and punk rock Music in Taoism
<b>English</b>	MLA	Relativity theory and modernism Joan Didion Magic realism Remedial writing
<b>Philosophy</b>	Philosopher's Index	Homelessness Chinese philosophy Atheism George Berkeley
<b>Psychology</b>	PsycInfo	Happiness as a social construct Psychology of censorship Sexual fetishism Zimbardo experiment
<b>History</b>	America: History and Life	German immigrants Civil War Witchcraft New England United States history and torture Emmett Till and news
<b>Economics</b>	EconLit	Economics of happiness Keynesian economics and deficit spending Ethics and executive compensation Economics of the National Football League
<b>Sociology</b>	Sociological Abstracts	War veterans and PTSD Technology and human interaction Sociocultural adoption Fathers influence sons
<b>Biology</b>	Biological Abstracts	Building muscle and diet Coral reefs Addiction behaviors in animals Glacier melting
<b>Communicative Disorders</b>	ComDisDome	Therapy and autism Fetal alcohol syndrome Oral motor activity Cerebral palsy
<b>Math</b>	MathSciNet	Neurology or brain rhythms Mathematics and games Elementary school Finite mathematics

codes were tracked on a spreadsheet (http://works.bepress.com/sanjeet\_mann). Testing the results of a typical search took about 25 minutes.

Availability was defined as a binomial (yes/no) variable. Items were additionally classified into one of three availability categories (local online, local print, and ILL) or one of six error categories (proxy, source, kb, resolver, target, and ILL). Assigning errors to a category often involved comparing metadata in the source database with inbound and outbound OpenURL links, looking for discrepancies or missing metadata.

The first round of availability testing revealed numerous system errors, so the researcher pursued troubleshooting over a period of several months. He addressed the most frequent category, ILL errors, by working with the Web Librarian to update the ILLIAD Customization Manager tables and online request forms. He addressed knowledge base errors by updating

the Serials Solutions knowledge base; in particular, one problematic consortial e-journal collection was switched to a different collection that was more accurate. Proxy errors were fixed by adding domains for e-journal providers to the Innovative Web Access Management (WAM) forward table. The researcher also opened numerous support tickets with database vendors to address source metadata errors and missing content in target databases, though these categories of errors were not pursued exhaustively.

After the initial study took place, OCLC upgraded the ILLIAD software to use Unicode to correctly render diacritic marks or non-Roman characters embedded in an OpenURL. Several database vendors also made interface changes and updated content.

Were these changes enough to improve full-text access for Armacost Library users? To find out, the researcher conducted a second round of availability testing using the same databases and search terms in March 2013, producing another

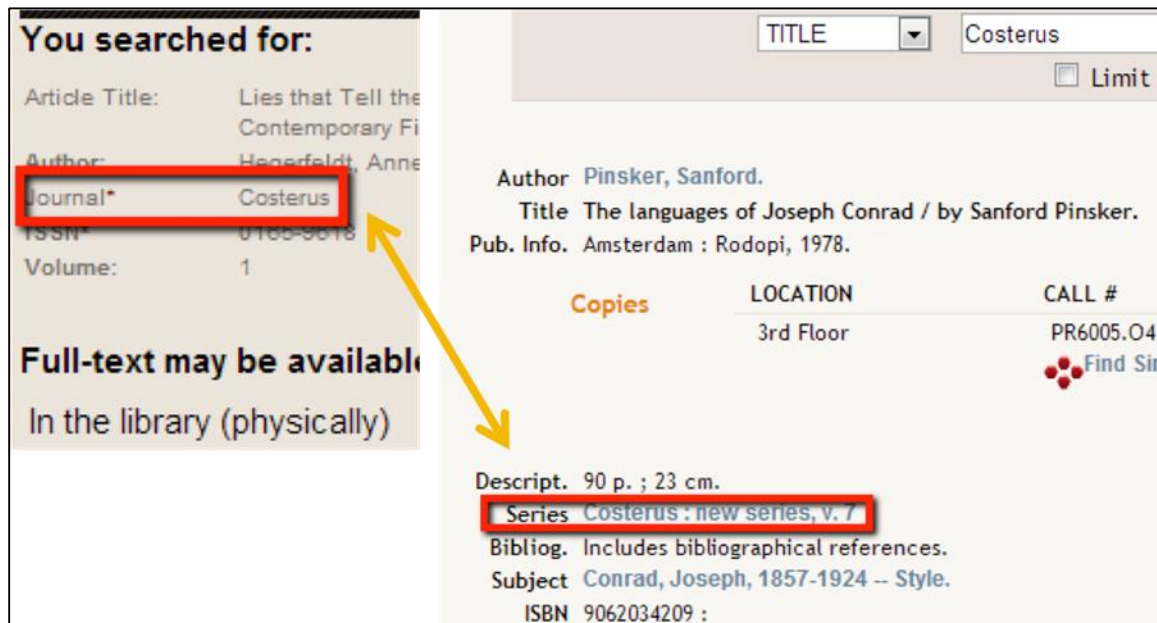


Figure 7  
Link resolver erroneously matching on title

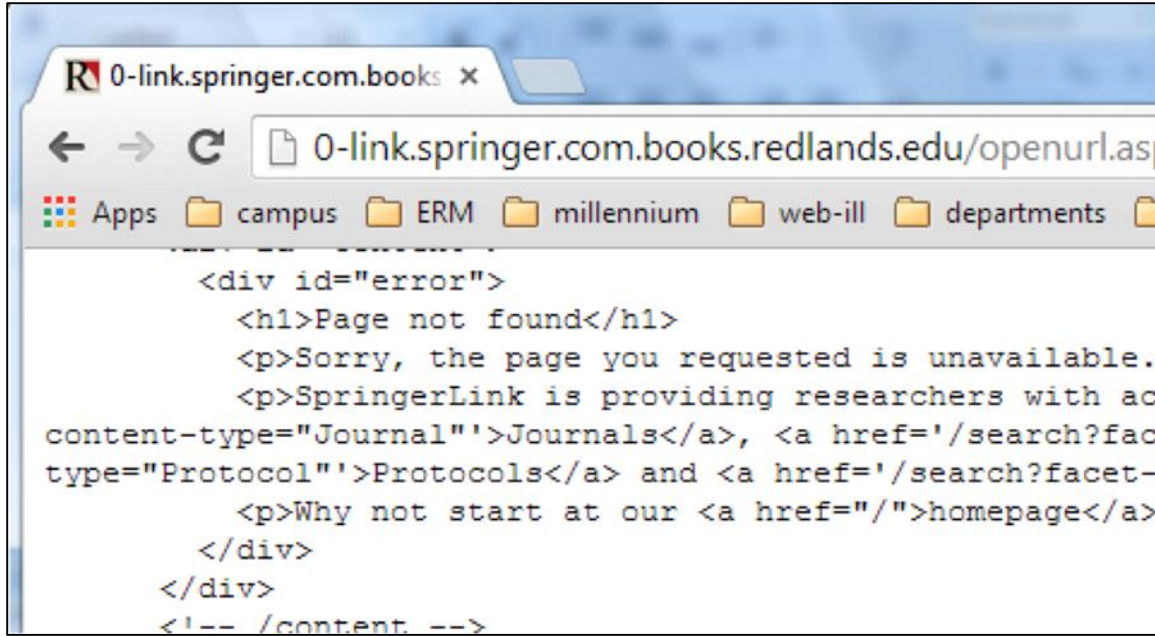


Figure 8  
Target error due to missing content

Figure 9  
ILL error caused by misconfigured request form and lack of Unicode support

400-citation sample recorded in its own spreadsheet ([http://works.bepress.com/sanjeet\\_mann](http://works.bepress.com/sanjeet_mann)). Availability was higher in the second study, so the researcher used Z tests for the difference of two proportions to determine whether the differences were statistically significant (Kanji, 2006). This statistical test compared percentages from the second study against percentages from

the first study to determine whether the changes were large enough to be unlikely to occur by chance.

**Results**

Availability increased from 250 of 400 items (62.5%) in the first study to 346 of 400 items (86.5%) in the second study. A comparison of the

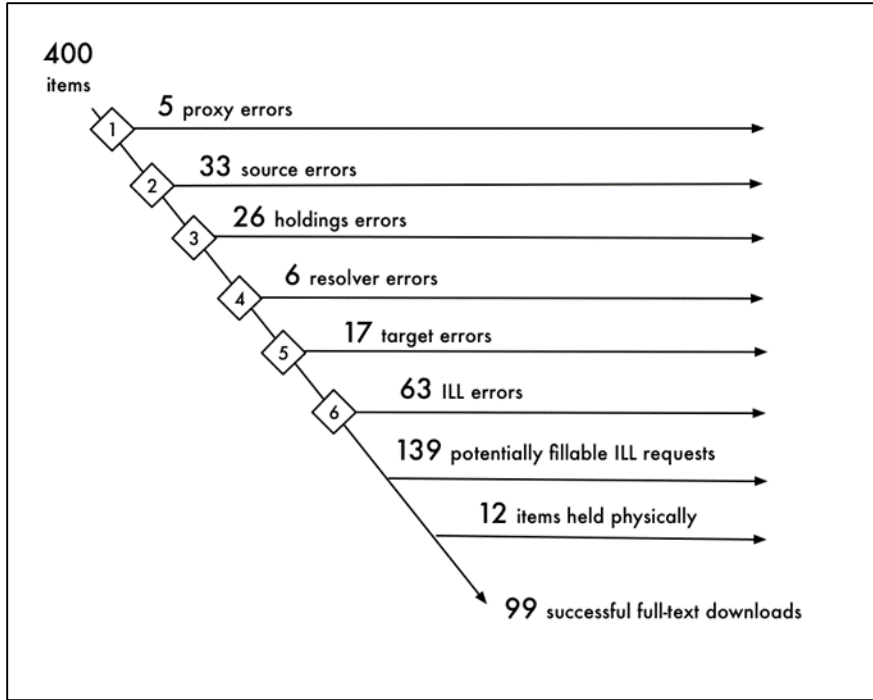


Figure 10  
Branching diagram, 2012 study

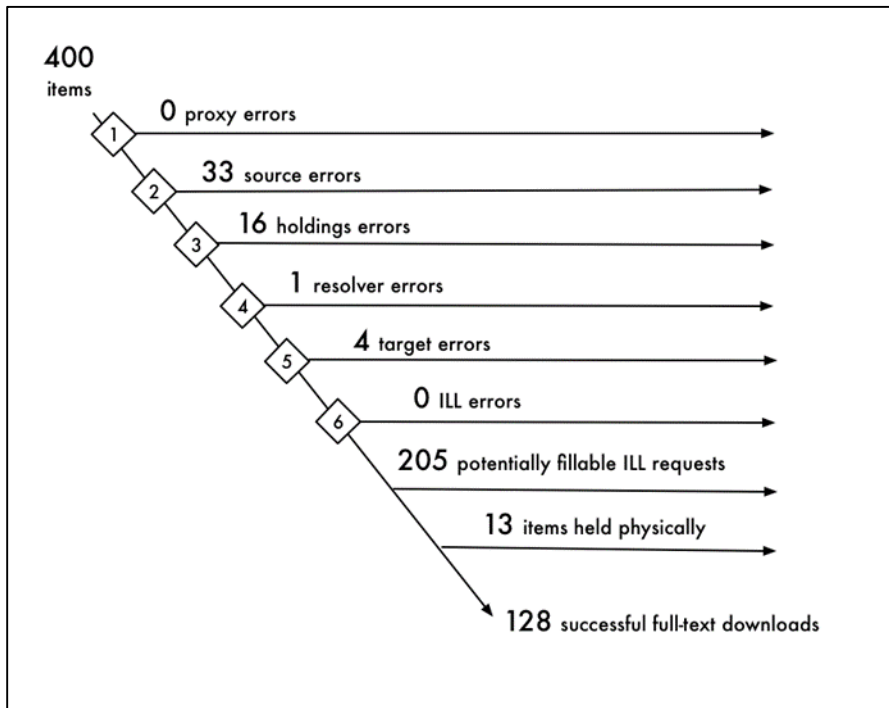


Figure 11  
Branching diagram, 2013 study

Table 2  
Availability Rates

	<b>2012 study</b> <i>(n = 400)</i>	<b>%</b>	<b>2013 study</b> <i>(n = 400)</i>	<b>%</b>
<b>Available</b>	<b>250</b>	<b>62.5</b>	<b>346</b>	<b>86.5</b>
Online	99	24.8	128	32.0
Print	12	3.0	13	3.3
ILL	139	34.8	205	51.3
<b>Error</b>	<b>150</b>	<b>37.5</b>	<b>54</b>	<b>13.5</b>
<b>1 – proxy</b>	5	1.3	0	0.0
<b>2 – source</b>	33	8.3	33	8.3
<b>3 – kb</b>	26	6.5	16	4.0
<b>4 – resolver</b>	6	1.5	1	0.3
<b>5 – target</b>	17	4.3	4	1.0
<b>6 – ILL</b>	63	15.8	0	0.0

branching diagrams from the two studies in Figures 10-11 clearly illustrates the gains in full-text downloads and fillable ILL requests.

Since overall availability increased in the follow up study, overall error frequency decreased. Source errors were the only error category that did not decline (Table 2).

However, Z tests showed that the changes in print availability, kb errors and resolver errors were not statistically significant ( $\alpha=0.05$ ) (Table 3).

Table 3  
Z Test Results

	<b>Z Score<sup>a</sup></b>
<b>Availability</b>	<b>7.787*</b>
Online	2.274*
Print	0.203
ILL	4.713*
1 – proxy	2.243*
2 – source	0.000
3 – KB	1.585
4 – resolver	1.898
5 – target	2.875*
6 – ILL	8.270*

<sup>a</sup>  $p < 0.05$ .  
\* Significant difference ( $Z > 1.96$ )

Most items in the sample were journal articles. Articles displayed higher availability than books or book chapters even after troubleshooting (Table 4).

Availability improved in the second study for all but one discipline. Music and English displayed the greatest gains, while Philosophy was the only discipline not to reach at least 75% availability after troubleshooting (Figure 12).

## Discussion

The significant improvement in overall availability and in three of six error categories found in the 2013 availability study suggests that the initial 2012 study effectively alerted the researcher to errors that were systematically blocking access to electronic resources. Libraries must be proactive in seeking out electronic resource errors; according to one study, “relying solely on user reports of errors to judge the reliability of full-text links dramatically underreports true problems by a factor of 100” (Stuart et al., 2015, p. 74). Conducting an availability study gives e-resource librarians reliable evidence to focus their efforts.

Table 4  
Availability by Item Type

	2012 study		2013 study	
	Count ( <i>n</i> = 400)	% Available	Count ( <i>n</i> = 400)	% Available
<b>Articles</b>	<b>304</b>	77.6	<b>299</b>	91.6
<b>Books</b>	<b>19</b>	5.3	<b>27</b>	70.4
<b>Chapters</b>	<b>34</b>	26.5	<b>33</b>	57.6
<b>Dissertations</b>	<b>37</b>	0.0	<b>34</b>	94.1
<b>Other</b>	<b>6</b>	66.7	<b>7</b>	28.6

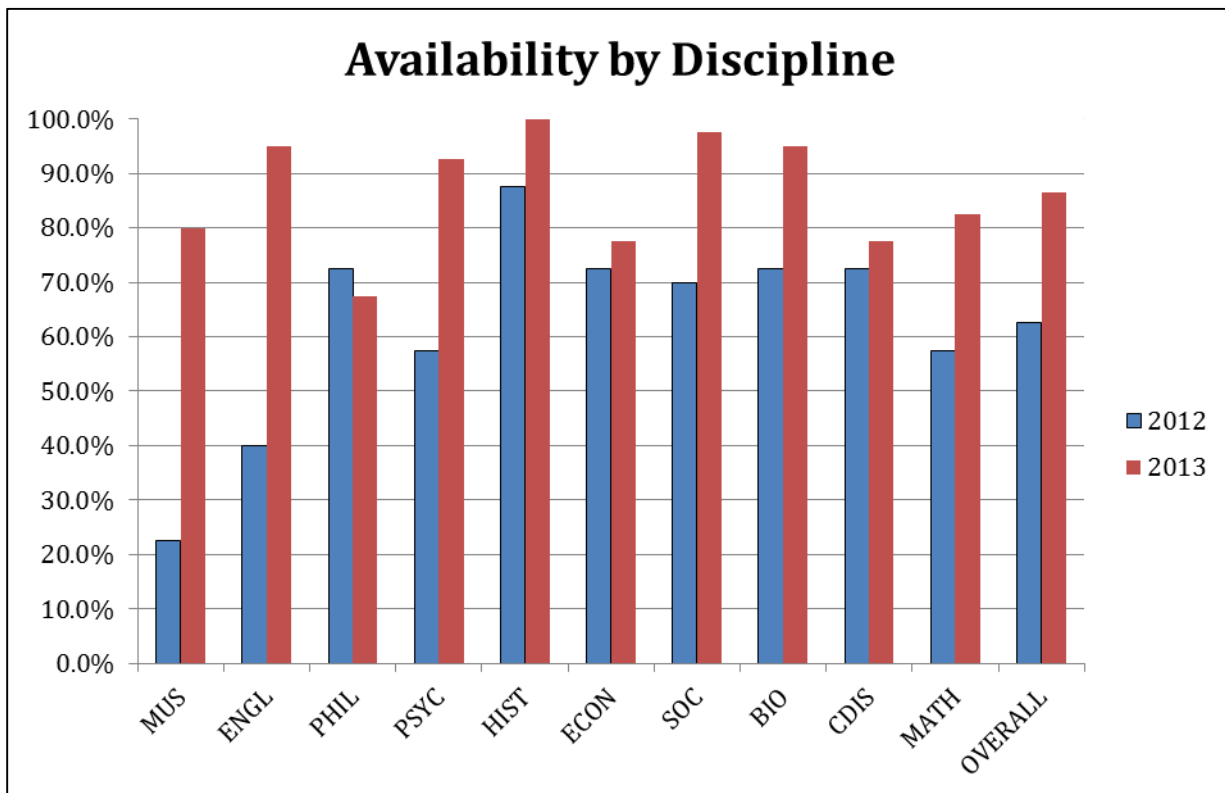


Figure 12  
Availability by discipline

It is important to note some issues inherent to e-resource troubleshooting which will limit libraries' ability to maximize their improvements. Based on the results of this study, the problems that affect the most resources are not the problems that can be fixed most efficiently. The quickest fixes – proxy errors – only accounted for 1% of errors in the

original study. ILLIAD errors improved the most, but it is unclear how much of this success came from the library's own actions, versus the system upgrade coincidentally implemented by OCLC. The researcher had little influence over target errors (the other category to show significant improvement) beyond reporting problems to the vendor and setting reminders to

follow up with the assigned support agent at regular intervals. Many kb errors found in the 2012 study could be corrected in-house, but this task required complex troubleshooting skills and did not produce statistically significant improvement. As Chen (2012, p. 223) observed, many open access journals do not support OpenURL linking at the item level, limiting the knowledge base's ability to connect to these titles. The most common problems – source errors – were the most difficult to fix. It was often unclear whether the publisher, A&I database vendor, or full-text vendor was responsible for correcting these problems, which still comprised 8% of sampled items in the 2013 study.

Since availability studies are time consuming (requiring about 25 minutes per search), and the most productive troubleshooting strategies listed here (such as customizing ILLIAD) will likely yield one time improvements, there may be diminishing returns for libraries that attempt multiple full-scale availability studies. However, smaller-scale availability studies could be effectively incorporated into a library's e-resource workflows on an annual basis. A ten-search study of 100 items still has a 79% confidence interval with +/- 5% error, which may be "good enough." A student worker could conduct the searches, leaving it to the electronic resources librarian or well-trained staff to fix problems.

This research has intriguing implications for other areas of library operations. Those interested in benchmarking availability as an assessment metric should note that local availability is affected by a library's acquisitions budget and the size of its physical and electronic collections. Future studies at other institutions can place the present study's results in proper context. The 62.5% availability rate in the 2012 study is comparable to the typical 63% availability rate at other libraries reported by Nisonger (2007), though those studies could have reported 25% higher availability rates if they did not count ILL-requestable items as

"acquisitions errors." Troubleshooting appears to have raised Armacost Library's availability rate to a similar level (86.5%) in the 2013 study.

Collection development librarians may wish to further increase full-text availability rates at their institutions by adding subscriptions and switching A&I databases to full-text. This study presumed that nonlocal availability was not an obstacle, because libraries can now efficiently provide users with items at the point of need. However, one could argue that local electronic downloads best satisfy library users' demand for immediate access to full-text. Wakimoto et al. found that nearly 50% of students expected to get full-text from an OpenURL click "always" or "most of the time" (2006). Imler and Hall (2009) found that Penn State students rejected sources whose full-text was not immediately available online. ERIAL researchers reported Illinois Wesleyan students abandoning sources which had triggered a system error: "virtually any obstacle they encountered would cause them to move on to another source or change their research topic" (Duke & Asher, 2012, p. 82). The finding that even after troubleshooting, clicking an OpenURL link in Armacost Library databases did not produce a full-text download two out of three times suggests that online availability may be not be meeting user expectations.

Instruction librarians could reduce students' frustration with unavailable full-text by waiting to introduce A&I databases until students are ready to conduct advanced research in their discipline. Instruction should include explanations of how to place interlibrary loan requests, how to exercise reciprocal borrowing rights, or how to refine the search to find a different source that is locally available. These skills can be "scaffolded" atop other concepts such as question formulation and source evaluation, which could be introduced to lower-division students through full-text resources.

Metadata-related errors persisted in the 2013 study despite troubleshooting; if these problems are unavoidable, librarians must consider how



and when to teach error workarounds. Conversations surrounding the Association of College and Research Libraries (ACRL) Framework for Information Literacy and the Critical Information Literacy (CIL) movement demonstrate librarians' desire to de-emphasize instruction in search mechanics and engage students in discussion of how scholarly communities construct notions of authority, or the consequences of inequitable access to information in our society. Yet the dispositions of "persistence, adaptability and flexibility" described in the ACRL Framework (Association of College and Research Libraries, 2015) can be strengthened by classroom examination of why e-resources fail and what students can do about it.

Subject liaisons should note that library users will have varying experiences with A&I searching across the disciplines. These differences could be related to the A&I database vendors and full-text content providers chosen, or the type of items indexed. Some databases like RILM (Répertoire International de Littérature Musicale) indexed many error-prone books and chapters, while others like America: History and Life only returned journal articles, which were less likely to produce errors. This simulated study also did not account for search strategies naturally employed by researchers in various disciplines.

Finally, it is necessary to acknowledge limits to the availability technique as a way of studying real-life user interaction with electronic resources. However refined the methodology, simulated availability studies conducted by a librarian can only detect system errors, not "human errors" which arise as library users navigate databases while trying to make sense of their information need. In theory, recruiting patrons to test items themselves would allow availability researchers to expand the conceptual

model of error causes given above to include problems with search strategy or source evaluation, which librarians could address by improving interfaces or changing what they teach. However, the researcher's first attempt at a "real" e-resource availability study revealed a methodological problem with adapting the availability technique in this manner (Mann, 2014). Simulated availability studies produce a sample of database citations, while studies of library users produce a sample of user interactions with a resource – two different types of data that could not be compared directly. Furthermore, the challenges of recruiting students resulted in a sample too small to support significance testing. At what point must researchers give up the ability to make a statistical inference about the entire library collection in order to learn realistic and actionable information about user behaviour? Perhaps availability studies should remain simulated and limited to observation of system errors, but be conducted alongside e-resource usability studies as part of a mixed-methods research project.

## **Conclusion**

A 400 item sample of electronic resource citations allowed the researcher to accurately estimate the availability of items in Armacost Library A&I databases. Z tests showed that overall availability improved significantly after troubleshooting, though only 1 in 3 items were available as electronic downloads. Electronic resource availability studies produce evidence that can inform discussions and address concerns felt in various library units. However, there are limits to how well a simulated electronic resource availability study can approximate the behaviour of library users. Further directions for this type of research include conducting availability studies at other types of libraries, and combining availability studies with usability studies to account for both technical and human errors.

## References

- Asher, A. D., Duke, L. M., & Wilson, S. (2013). Paths of discovery: Comparing the search effectiveness of EBSCO Discovery Service, Summon, Google Scholar, and conventional library resources. *College & Research Libraries*, 74(5), 464–488.  
<http://dx.doi.org/10.5860/crl-374>
- Association of College and Research Libraries. (2015). *Framework for information literacy for higher education*. Chicago: ACRL. Retrieved from  
<http://www.ala.org/acrl/standards/ilframework>
- Brase, C. H. & Brase, C. P. (1987). *Understandable statistics: Concepts and methods* (3rd ed.). Lexington, Mass: Heath.
- Chandler, A., Wiley, G., & LeBlanc, J. (2011). Towards transparent and scalable OpenURL quality metrics. *D-Lib Magazine*, 17(3/4).  
<http://dx.doi.org/10.1045/march2011-chandler>
- Chen, X. (2012). Broken-Link reports from SFX users: How publishers, vendors and libraries can do better. *Serials Review*, 38(4), 222–227.  
<http://dx.doi.org/10.1016/j.serrev.2012.09.002>
- Ciliberti, A., Radford, M. L., Radford, G. P., & Ballard, T. (1998). Empty handed? A material availability study and transaction log analysis verification. *Journal of Academic Librarianship*, 24(4), 282–289.  
[http://dx.doi.org/10.1016/S0099-1333\(98\)90104-5](http://dx.doi.org/10.1016/S0099-1333(98)90104-5)
- 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.  
[http://dx.doi.org/10.1016/S0099-1333\(02\)00279-3](http://dx.doi.org/10.1016/S0099-1333(02)00279-3)
- Connaway, L. S., & Dickey, T. J. (2010). *The digital information seeker: Report of the findings from selected OCLC, RIN, and JISC user behaviour projects*. Dublin: OCLC. Retrieved from  
<http://www.jisc.ac.uk/media/documents/publications/reports/2010/digitalinformationseekerreport.pdf>
- Crum, J. A. (2011). An availability study of electronic articles in an academic health sciences library. *Journal of the Medical Library Association*, 99(4), 290–296.  
<http://dx.doi.org/10.3163/1536-5050.99.4.006>
- Culling, J. (2007). *Link resolvers and the serials supply chain*. Oxford: UKSG. Retrieved from  
[http://www.uksg.org/sites/uksg.org/files/uksg\\_link\\_resolvers\\_final\\_report.pdf](http://www.uksg.org/sites/uksg.org/files/uksg_link_resolvers_final_report.pdf)
- Cummings, J., & Johnson, R. (2003). The use and usability of SFX: Context-sensitive reference linking. *Library Hi Tech*, 21(1), 70–84.
- Duke, L. M., & Asher, A. D. (2012). *College libraries and student culture: What we now know*. Chicago: American Library Association.
- Fagan, J. C., Mandernach, M. A., Nelson, C. S., Paulo, J. R., & Saunders, G. (2012). Usability test results for a discovery tool in an academic library. *Information Technology and Libraries*, 31(1), 83–112.  
<http://dx.doi.org/10.6017/ital.v31i1.1855>
- Gaskill, H. V., Dunbar, R. M., & Brown, C. H. (1934). An analytical study of the use of

- a college library. *The Library Quarterly*, 4(4), 564–587.
- Imler, B., & Eichelberger, M. (2014). Commercial database design vs. library terminology comprehension: Why do students print abstracts instead of full-text articles? *College & Research Libraries*, 75(3), 284–297. <http://dx.doi.org/10.5860/crl12-426>
- Imler, B., & Hall, R. A. (2009). Full-text articles: Faculty perceptions, student use, and citation abuse. *Reference Services Review*, 37(1), 65–72. <http://dx.doi.org/10.1108/00907320910935002>
- Jayaraman, S., & Harker, K. (2009). Evaluating the quality of a link resolver. *Journal of Electronic Resources in Medical Libraries*, 6(2), 152–162. <http://dx.doi.org/10.1080/15424060902932250>
- Kanji, G. K. (2006). *100 statistical tests* (3rd ed.). London: Sage Publications.
- Kantor, P. B. (1976). Availability analysis. *Journal of the American Society for Information Science*, 27(5), 311–319. <http://dx.doi.org/10.1002/asi.4630270507>
- Kasprowski, R. (2012). NISO's IOTA initiative: Measuring the quality of OpenURL links. *The Serials Librarian*, 62(1-4), 95–102. <http://dx.doi.org/10.1080/0361526X.2012.652480>
- Kress, N., Del Bosque, D., & Ipri, T. (2011). User failure to find known library items. *New Library World*, 112(3/4), 150–170. <http://dx.doi.org/10.1108/03074801111117050>
- Majors, R. (2012). Comparative user experiences of next-generation catalogue interfaces. *Library Trends*, 61(1), 186–207. <http://dx.doi.org/10.1353/lib.2012.0029>
- Mann, S. (2014). *Why can't students get the sources they need? Results from a real availability study*. Presented at the 29th Annual NASIG Conference, Fort Worth, TX. Retrieved from [http://works.bepress.com/sanjeet\\_mann](http://works.bepress.com/sanjeet_mann)
- Mansbridge, J. (1986). Availability studies in libraries. *Library & Information Science Research*, 8(4), 299–314.
- NISO. (2013). *Improving OpenURLs through analytics (IOTA): Recommendations for link resolver providers*. Baltimore, MD: National Information Standards Organization. Retrieved from [http://www.niso.org/apps/group\\_public/download.php/10811/RP-21-2013\\_IOTA.pdf](http://www.niso.org/apps/group_public/download.php/10811/RP-21-2013_IOTA.pdf)
- NISO, & UKSG. (2010). KBART: Knowledge bases and related tools (No. NISO-RP-9-2010). Baltimore, MD: National Information Standards Organization. Retrieved from <http://www.niso.org/publications/rp/RP-2010-09.pdf>
- NISO, & UKSG. (2014). Knowledge bases and related tools (KBART) recommended practice (No. NISO RP-9-2014). Baltimore, MD: National Information Standards Organization. Retrieved from [http://www.niso.org/apps/group\\_public/download.php/12720/rp-9-2014\\_KBART.pdf](http://www.niso.org/apps/group_public/download.php/12720/rp-9-2014_KBART.pdf)
- Nisonger, T. E. (2007). A review and analysis of library availability studies. *Library Resources & Technical Services*, 51(1), 30–49.
- Nisonger, T. E. (2009). A simulated electronic availability study of serial articles through a university library web page.

- College & Research Libraries*, 70(5), 422–445.  
<http://dx.doi.org/10.5860/crl.70.5.422>
- O'Neill, L. (2009). Scaffolding OpenURL results: A call for embedded assistance. *Internet Reference Services Quarterly*, 14(1-2), 13–35.  
<http://dx.doi.org/10.1080/10875300902961940>
- Pesch, O. (2012). Improving OpenURL linking. *Serials Librarian*, 63(2), 135–145.  
<http://dx.doi.org/10.1080/0361526X.2012.689465>
- Saracevic, T., Shaw, W.M., & Kantor, P. (1977). Causes and dynamics of user frustration in an academic library. *College & Research Libraries*, 38(1), 7-18.  
[http://dx.doi.org/10.5860/crl\\_38\\_01\\_7](http://dx.doi.org/10.5860/crl_38_01_7)
- Stuart, K., Varnum, K., & Ahronheim, J. (2015). Measuring journal linking success from a discovery service. *Information Technology and Libraries*, 34(1), 52–76.  
<http://dx.doi.org/10.6017/ital.v34i1.5607>
- Trainor, C., & Price, J. (2010). *Rethinking library linking: Breathing new life into OpenURL*. Chicago: American Library Association.
- Wakimoto, J. C., Walker, D., & Dabbour, K. (2006). Myths and realities of SFX in academic libraries. *Journal of Academic Librarianship*, 32(2), 127-136.  
<http://dx.doi.org/10.1016/j.acalib.2005.12.008>
- Williams, S. C., & Foster, A. K. (2011). Promise fulfilled? An EBSCO Discovery Service usability study. *Journal of Web Librarianship*, 5(3), 179–198.  
<http://dx.doi.org/10.1080/19322909.2011.597590>
- Wrubel, L. S. (2007). Improving access to electronic resources (ER) through usability testing. *Collection Management*, 32(1-2), 225–234.  
[http://dx.doi.org/10.1300/J105v32n01\\_15](http://dx.doi.org/10.1300/J105v32n01_15)