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Google vs. the Library (Part III): Assessing the Quality of Sources Found by Undergraduates

Helen Georgas
CUNY Brooklyn College

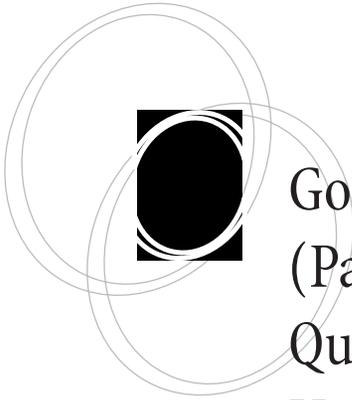# Google vs. the Library (Part III): Assessing the Quality of Sources Found by Undergraduates

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abstract: This study assesses and compares the quality of sources found by undergraduate students when doing research using both Google and a library (federated) search tool. Thirty undergraduates were asked to find four sources (one book, two articles, and one additional source of their choosing) related to a selected research topic. Students used both Google and a federated search (resource discovery) tool to find material they believed to be relevant. Each source was evaluated for topic relevance, authority, appropriateness, and date, and assigned a total quality score. Results showed that the books found via Google were slightly higher quality than those uncovered via the federated search tool. The articles and additional sources students found via the federated search tool were slightly to moderately higher quality, respectively, than those discovered via Google.

Introduction

Undergraduates use Google to do research and, for many of them, it may be the *only* search tool they use.[1] Librarians acknowledge that Google can be a good starting point or can serve as a complement to searching library resources, but they are concerned that students consider Google entirely sufficient for doing research at the college level. Google is convenient, fast, and easy to use, librarians admit, but the results can vary vastly in quality. In addition, by using only Google to do research, students miss out on high-quality, relevant resources that are freely available to them (often in full-text versions) via the library's collections.

> **Undergraduates use Google to do research and, for many of them, it may be the *only* search tool they use.**

With the advent of Google Scholar, however, Google has greatly increased the possibility of students finding (or being led to) more scholarly sources. Indeed, recent studies have shown either no significant difference between Google Scholar and library databases, or have found that Google Scholar actually outperforms library databases in the scholarliness of its content.[2] Furthermore, ordinary Google is "smart" enough to suggest Google Scholar results when words such as "article" or "journal" are included in searches, thereby seamlessly leading students from Google to Google Scholar and then directly into the library's databases (if an academic library participates in Google's Library Links program), blurring the line between sources students find via Google and those they find via the library's subscriptions.[3] In addition, Google Books can lead students to books published by scholarly presses and held by academic libraries. Given these improvements, how good has Google become? If an undergraduate *only* uses Google for his or her research, what will the quality of sources be? Will they be vastly different in quality when compared to those available within library collections?

This article is the third in a series that examines the use of Google and a library (federated) search tool by undergraduates within a research context. The first part of the study focused on student preferences and perceptions when using each search tool, with students expressing a slight preference for the federated search tool over Google for doing research.[4] The second part of the study analyzed search patterns and behaviors, showing that undergraduates believed themselves to be knowledgeable researchers but that their queries and behaviors did not support this belief. Students lacked an understanding of how "search" works in different tools and how information is structured. Undergraduates also did not examine their research topics to identify key concepts along with relevant keywords and related terms, relied heavily on the language presented to them, and performed natural language or simple keyword or phrase queries. In addition, they failed to significantly modify their search queries or their overall approach to research, to move beyond the first page of results, to examine metadata to refine their searches, or to significantly alter their search behaviors depending on the tool being used.[5]

> **Students lacked an understanding of how "search" works in different tools and how information is structured.**

This study—the third in the series—evaluated the sources students found using both Google and the federated search tool to determine how effective each was at leading users to high-quality results. The study also attempted to determine whether undergraduates were able to accurately identify sources and cite them correctly. In other words, despite undergraduates' lack of sophisticated searching skills, were they still able to find high-quality sources?

Literature Review

Assessing "Quality"

Citation analysis is a commonly used method for assessing the quality of sources found in undergraduate student bibliographies. Quality is subjective, however. To evaluate it as objectively as possible, as Bonnie Gratch says, "Criteria and a process for rating must

be formulated."[6] Common criteria for assessing quality have included the number of sources, the variety of sources, format, currency, relevance, authority, appropriateness, and scholarliness. However, the definitions of these terms, as Chris Leeder, Karen Markey, and Elizabeth Yakel point out, "are not standard and vary from study to study, as do the methods of measurement."[7]

Thomas Kirk scored bibliographies according to criteria for variety, relevance, and scholarliness.[8] Amy Dykeman and Barbara King considered the number and variety of sources, the use of scholarly journals, and the authority of the sources.[9] Building on Dykeman and King's study, Gratch used four criteria: the number of sources used, the variety of sources used, their currency vis-à-vis the topic, and their quality vis-à-vis the topic. Gratch based her idea of quality on "the reputation of the publisher, author, and any other clues that might help establish the quality of the information."[10] David F. Kohl and Lizabeth A. Wilson (and later, Virginia E. Young and Linda G. Ackerson) used a four-point scale (ranging from completely inappropriate to superior) for three criteria, looking at whether the type of source was appropriate for the topic, whether it was timely, and its quality.[11] In both studies, the authors based their assessment of quality on the scholarliness of the source (where each source was rated using a four-point scale ranging from popular to scholarly). Philip M. Davis and Suzanne A. Cohen focused only on scholarliness to determine the effect of the Web on student citations.[12] Andrew M. Robinson and Karen Schlegl created eight categories to specifically deal with online sources. Three were considered scholarly (electronic-scholarly, electronic-journal, and electronic-government document), and four were considered nonscholarly (electronic-news, electronic-magazine, electronic-other, and electronic-low quality).[13] Anne Middleton developed and assigned a scholarly index (SI) ranking for each student bibliography (total number of citations divided by how many were scholarly).[14] Maria Elizabeth Clarke and Charles Oppenheim considered the format of materials referred to, the age of materials, and the overall number of citations.[15] David H. Mill took into account format (journals, books, open Web sites, newspapers, and other) and scholarliness (scholarly or nonscholarly), and recorded the oldest item, newest item, and the average age of items in each bibliography.[16]

Casey M. Long and Milind M. Shrikhande evaluated sources for quality, variety, citation format, and information use, meaning whether the source was properly cited with no evidence of plagiarism. The authors considered material to be high quality if recommended by a librarian in instruction sessions or otherwise provided by the library. Lastly, they considered sources high quality if they were both appropriate and authoritative for the topic being addressed.[17] Sarah Clark and Susan Chinburg divided citations into eight categories based on type (peer-reviewed journals, textbooks, scholarly/technical books, dictionaries, and the like).[18] Thomas L. Reinsfelder developed a detailed rating scale that provided each citation with a quality score based on relevancy, authority, the appropriateness of the date of the source, and the scope or level of the material. Reinsfelder rated the first three criteria on a four-point scale, with scope being measured on a three-point scale.[19] And finally, Leeder, Markey, and Yakel developed a taxonomy that assigned specific scores between one and four (based on format) within each of five facets: information format, literary content, author identity, editorial process, and publication purpose.[20]

Assessing Citation Accuracy

Several of the studies mentioned also assessed citation correctness or accuracy.[21] Debbie Malone and Carol Videon measured "citation integrity," where categories ranged from "major mistakes where it was completely unclear what the student had used, to minor errors mainly in punctuation."[22] Clarke and Oppenheim counted the number of citation errors and classified them based on type (if a student omitted all or part of the author's name, for example).[23]

Imposing Requirements for the Bibliography

Judith Lechner observed that students "do not independently distinguish between scholarly and popular articles when choosing sources for their papers."[24] Davis and Cohen documented a tendency for undergraduates to use nonscholarly online resources unless provided with "clear and enforceable guidelines" by a professor or instructor.[25] Robinson and Schlegl noted that the quality of bibliographies improved when faculty supplied students with enforceable guidelines.[26] Middleton found that the greatest influencing factor for her scholarly index measurement was the nature of the assignment and if it necessitated greater use of scholarly journals.[27]

> …the quality of bibliographies improved when faculty supplied students with enforceable guidelines.

Comparing Google and Library Search Tools

In terms of direct comparisons between the quality of sources found via Google and those discovered via library search tools—federated search tools, discovery tools, and individual library databases—the literature is surprisingly scant. Only Jan Brophy and David Bawden compared the quality of Google sources with those found in library resources.[28] The authors searched Google and a variety of library databases using test queries across four different disciplines that were designed to be open-ended and research-based, and to mimic typical student queries. Brophy and Bawden measured quality using Robinson's framework, which considers both the context of sources (relevance, authority, provenance, objectivity), and content (currency, accuracy, coverage).[29] Their findings showed that library resources produced higher quality results, but that Google provided greater accessibility. Mónica Colón-Aguirre and Rachel A. Fleming-May, in their interviews with college students, concluded, "Regardless of their level of comfort with using the library, the majority of respondents recognized that the information sources found in the library are superior to those found using a free online search engine."[30] However, students still relied on Google and *Wikipedia* to conduct their academic research because these tools were easier to navigate and less confusing.

> Google Scholar had better coverage for science and medical databases, open-access databases, and single-publisher databases, and weaker coverage for social science and humanities databases.

The literature comparing Google Scholar with library resources is more abundant. Chris Neuhaus, Ellen Neuhaus, Alan Asher, and Clint Wrede compared the contents of forty-seven different databases with that of Google Scholar, finding that Google Scholar had better coverage for science and medical databases, open-access databases, and single-publisher databases, and weaker coverage for social science and humanities databases.[31] John Meier and Thomas W. Conkling compared Google Scholar with Compendex, the premier engineering database, and discovered that Google Scholar's coverage approached 90 percent of Compendex's for materials published after 1990.[32] Jared L. Howland, Thomas C. Wright, Rebecca A. Boughan, and Brian C. Roberts compared the scholarliness of resources discovered using Google Scholar with that of materials found in library databases. Their analysis showed that Google Scholar yielded more scholarly content than library databases, with no statistically significant difference in scholarliness across disciplines.[33] William Walters, in several studies comparing Google Scholar to library databases, found that Google Scholar indexed the greatest number of core articles for a particular subject, as well as demonstrated greater precision and recall, for both simple and expert searches.[34] Xiaotian Chen questioned the value of library databases entirely, since, as of 2009, 94.4 percent of journals' tables of contents, article abstracts, or both were posted freely on the Internet.[35] More recently, even discovery tools have not fared well when compared with Google Scholar. Focusing on users' assessments, Tao Zhang discovered in 2013 that the relevancy of search results found via Ex Libris's Primo discovery tool was comparable to the relevancy of those discovered via Google Scholar, but that Primo received significantly lower preference and usability ratings.[36]

With the exception of Zhang's study, no other comparison of Google or Google Scholar with library resources has focused on assessing what students find. This study is unique in that it is a side-by-side comparison of the sources undergraduates found via Google and a library (federated) search tool. Since the library has traditionally been the best source for high-quality research resources, how does it actually compare with Google?

Methods

A diverse group of thirty-two Brooklyn College undergraduates participated, across a range of academic years and majors (Table 1, Table 2). However, due to the loss of some of the data files, the sources evaluated for this portion of the study came from thirty students, not the original thirty-two. Participants ranged in age from eighteen to sixty. The average age was twenty-two and a half. The group was almost evenly divided between men and women. The demographics of the study population reflected the undergraduate population of Brooklyn College as a whole.

Students' library experience—both in terms of their use of library resources and how much instruction they had received—also differed widely. These differences were intentional, since the amount of library instruction each undergraduate receives varies widely. The Brooklyn College Library's instructional program focuses on the freshman year, when students are required to complete an online orientation to the library as part of the first-semester freshman composition class and to attend an in-person library research session during the second-semester composition class. Beyond the first year, instruction

is not systematic and depends largely on students' majors and whether their professors request library instruction for specific classes. In addition, transfer students, a significant population at Brooklyn College, may place out of the two freshman composition classes and thus may not receive any formal library instruction. Lastly, most library instruction sessions do not focus explicitly on either the federated search tool or Google. The instructor may reference or briefly show these search tools, but the majority of the class session is devoted to the catalog and to individual library databases. That said, at the time of this study, the Brooklyn College Library subscribed to EBSCO's Integrated Search product, and so the EBSCO interface might have been familiar to several participants. However, the library's Web site did not prominently feature the federated search tool, though a different version of the tool appeared as a search option at the top of the Library's A-Z list of databases and on numerous subject guides. Many students acknowledged that they had never encountered the federated search tool before.

Table 1.
Academic year of the students

	Freshman	Sophomore	Junior	Senior
Number of students	6	8	9	6
Percent	20.7	27.6	31.0	20.7

Note: Due to the loss of some of the Camtasia files, the video data examined for this portion of the study were for twenty-nine students.

Table 2.
Majors of the students

	Arts and humanities	Social sciences	Math and sciences	Business	Double major (cross-disciplinary)	Undeclared
Number of students	2	7	5	5	5	5
Percent	6.9	24.1	17.2	17.2	17.2	17.2

Two-hour appointments were scheduled with each student. At the beginning of each session, the investigator asked the participants to choose a research topic out of a list of six presented to them (Appendix A). Students were advised to consider the topics carefully and choose the one of greatest interest to them, since they would work with that topic throughout the two-hour session.

Once a topic was selected, each student received a set of research tasks—find one relevant book, two articles (one of them scholarly), and one additional source of their choosing—as if they were actually doing research on that topic (Appendix B). The author told them to begin with one of the two search tools, either the Brooklyn College Library's federated search tool or Google.

To avoid bias as much as possible, the initial search screen for the federated search tool was designed to mirror the basic single search-box interface of Google. In an attempt to strike a balance between subject comprehensiveness and search speed, and to provide students with access to both books and articles, the federated search tool included eleven databases across a range of disciplines: the Brooklyn College Library catalog, ebrary, NetLibrary (now EBSCO eBooks), Academic Search Complete, Business Source Complete, General Science Full Text, Humanities Full Text, JSTOR, LexisNexis, Project Muse, and Social Sciences Full Text.

The investigator told students to record references for the sources they found as fully as possible, without any need to follow a particular format or citation style. After participants completed the first set of research tasks, they were then instructed to carry out the same tasks (finding one book, two articles—one scholarly—and one additional source of their choosing) on the same topic, but using the other search tool. To further avoid bias, half the students began using the federated search tool, and the other half started by using Google.

Because this article is the third in a series, the methods presented here are similar to the first and second articles, except for the focus on a different set of data.[37] This article assesses the quality of sources students found via each search tool to determine how effective each tool was for research. Except for the fact that students were generally faster when using the second search tool, results did not vary significantly depending on the search tool used.[38]

Development of Quality Rating Scale

To assess the quality of sources, a rating scale needed to be developed. The faceted rating system developed by Leeder, Markey, and Yakel was the most detailed and structured, and therefore the least subjective.[39] However, relevance was not one of the facets included in the taxonomy. Since students in this study were asked to find material they believed relevant for a selected topic, this element had to be considered.

Each of the criteria that Reinsfelder used (Relevancy, Authority, Appropriate Dates, and Scope) were deemed valuable for this study, and so, as a test, the author began by evaluating the sources students found via both search tools using Reinsfelder's rating scale.[40]

After doing so, the author made a number of modifications to Reinsfelder's scale. Relevancy needed to be more clearly defined and based on the relevancy of a source for

the selected topic (Topic Relevance).[41] The Authority criterion was largely maintained, based on authorship and type of publication. The Scope criterion, however, was altered. Although the author could easily determine when a source was too basic for a college-level research paper, judging a source as too technical or overly complex was more problematic. In addition, students frequently cited materials such as book reviews, but not all reviews were equally appropriate as sources for research papers. A one-paragraph book review, for example, should not be rated as highly as a five-page review, even though both might have been published in scholarly journals. An Appropriateness of Source criterion was thus developed to take into account the appropriateness or level of detail of the content cited. Lastly, because the list of topics covered six different disciplines across the sciences, social sciences, and humanities, the suitability of each source based on its date of publication would naturally vary by topic. The author decided that, to classify sources as "most appropriate," sources published within the last five years would be deemed most appropriate for science topics, and sources published within the last ten years would be deemed most suitable for social science and humanities topics. Nonetheless, even older material could still be valid for any of the topics depending on the context, especially within the humanities. As a result, the Date category was compressed so that it would not be weighted as heavily as the other three criteria (Topic Relevance, Authority, Appropriateness of Source) in determining each source's overall quality score.

> … students frequently cited materials such as book reviews, but not all reviews were equally appropriate as sources for research papers.

With a rating system for Topic Relevance, Authority, Appropriateness of Source, and Date (Table 3) in place, the investigator test-evaluated all of the sources two more times to ensure that the rating system was as clear and objective as possible.

Development of Citation Rating Scale

A citation rating scale was also developed and used. In considering "citation integrity," Malone and Videon counted only the overall percentage of major mistakes and minor mistakes (mostly punctuation).[42] Dykeman and King looked at student bibliographies and gave them a rating of Low, Middle, or High.[43] Gratch used a four-point measurement (ranging from 0 to 3) based on completeness and consistency of format.[44] Because this study did not ask students to use any particular citation style, nor to be consistent in the formatting of their citations, the investigator assessed references only for completeness (Table 4).

To ensure that the citation completeness rating scale was clearly defined and usable, all sources were test-evaluated twice. Once both rating systems were finalized, the author officially rated each of the sources students found via Google and the federated search tool and assigned a total quality score and a citation completeness score.

Table 3.
Quality rating scale

Topic relevance

1. Not at all relevant.
2. Partially relevant.
3. Mostly relevant.
4. Completely relevant.

Authority

1. Author or publisher has little to no accountability (self-published or vanity press), or no author identified.
2. Authors identified but authority questionable or information presented is biased (information provided by businesses or advocacy groups, for example).
3. Popular, journalistic, or trade.
4. Scholarly or academic (including government information).

Appropriateness of source

1. Too basic, not enough detail, or not appropriate as a source, for example, blog post, very short book review, About.com article, self-published work.
2. Acceptable, but should be complemented by sources with more detail, more rigor, or both (for example, Web site, encyclopedia article, newspaper article, short magazine article, long book review).

Results

Books

Using Google, twenty-nine students (96.7 percent) found a book they deemed relevant to their research topic (Table 5). One student (3.3 percent) named an article published in a scholarly journal, rather than a book. Of the twenty-nine participants who had correctly identified a book, only ten provided complete citations (author, title, publisher, year). The average citation completeness score was 3.07 (out of 4).

Using the federated search tool, only twenty students (66.7 percent) found a book they deemed relevant to their research topics (Table 5). Four participants (13.3 percent) provided citations to scholarly journal articles, three (10 percent) gave references to book reviews, one student supplied a citation to a government document (a U.S. Geological Survey fact sheet), one (3.3 percent) could not find a book and provided no citation, and one (3.3 percent) submitted a reference so incomplete the source could not be identified. Of the twenty students who had correctly identified a book, only three provided complete citations. The average citation completeness score was 2.55 (out of 4).

Table 4.

Citation completeness rating scale

1. Incorrect or very incomplete, missing key information (source not findable).
2. Partially complete, source includes one or two elements (source findable).
3. Mostly complete, missing one or two elements (source findable).
4. Complete citation, all important elements included.

Table 5.

Books found via Google and federated search tool

	Google	Percent	Federated search tool	Percent
Books	29	96.7	20	66.7
Journal articles	1	3.3	4	10
Book reviews	-	-	3	10
Government document	-	-	1	3.3
Unable to find book	-	-	1	3.3
Unidentifiable source	-	-	1	3.3

Evaluating each book citation for Topic Relevance, Authority, Appropriateness of Source, and Date, the average total quality score of the books found via Google was 13.03 (out of 15) (Table 6). The average total quality score of the books uncovered via the federated search tool was 13.00 (out of 15).

Articles

Students were asked to find two articles related to their research topic of choice, one of which had to be scholarly. The other article could be from a newspaper or magazine (Appendix B).

Looking at the articles students found via Google, it was clear that they took a broad view of what constituted an "article."

Looking at the articles students found via Google, it was clear that they took a broad view of what constituted an "article" since, along with articles in newspapers, magazines, and journals, students turned up book reviews in magazines and journals, encyclopedia articles, and articles published

Table 6.

Quality of sources found via Google and federated search tool

		Topic relevance (4)	Authority (4)	Appropriateness of source (4)	Date (3)	Total quality score
Google	Book	3.55	3.48	3.55	2.45	13.03
	Articles	3.44	3.55	3.16	2.32	12.47
	Additional source	3.37	3.37	3.00	2.26	12.00
	All sources meeting format criteria	3.45	3.47	3.24	2.34	12.50
	All sources	3.42	3.48	3.22	2.31	12.43
Federated search tool	Book	3.10	3.75	3.75	2.40	13.00
	Articles	3.12	3.78	3.25	2.60	12.75
	Additional source	3.20	3.67	3.03	2.47	12.37
	All sources meeting format criteria	3.14	3.73	3.34	2.49	12.70
	All sources	3.18	3.76	3.27	2.52	12.73

(or posted) on various Web sites, including university sites, and sites such as About. com and ezinearticles.com.

Given the difficulty in making strict format distinctions for material found online, and the fact that students were not technically incorrect in considering such sources "articles," this broader definition was accepted. As a result, fifty-seven (95 percent) of the sixty sources students found via Google could be considered articles (Table 7). Two of the sources were books (3.3 percent), and one item was an exhibit description on a museum's Web site (1.7 percent). Of the fifty-seven citations to articles, only twenty-five were complete (author, article title, journal title, volume, issue, date, and page numbers). The average citation completeness score was 3.15 (out of 4).

Looking at the articles found via the federated search tool, they more closely adhered to a traditional definition of an "article." Most of the citations were to articles or book reviews in newspapers, magazines, or journals. Of the sixty sources that participants found via the federated search tool, fifty-seven (95 percent) could be considered articles. The remaining three sources (10 percent) were government documents (specifically, presidential comments, testimony before a House committee, and a geological survey). Of the fifty-seven citations to articles, thirty-six were complete. The average citation completeness score was 3.57 (out of 4).

Twenty-six (86.7 percent) of the thirty students met the requirement for "at least one scholarly article" using Google, where "scholarly article" was one published in an academic or scholarly journal. Twenty-four (80 percent) of the thirty participants met the "at least one scholarly article" requirement using the federated search tool.

Evaluating all the articles students found via Google, the average total quality score was 12.47 (out of 15) (Table 6). The average total quality score of all the articles discovered via the federated search tool was 12.75 (out of 15).

Additional Sources

In addition to one book and two articles, students were asked to find one additional source related to their chosen research topic. The investigator told participants that this additional source could be in any format, as long as they believed it a valuable addition to their research bibliography.

Via Google, twenty-nine students (96.7 percent) found an additional source that they deemed relevant to their research topic. One participant repeated the citation of one of the articles that she or he had found previously, so this could not be counted as an additional source.

Because of the open parameters, these additional sources covered a wide variety of formats (Table 8). Thirteen students (43.3 percent) cited articles in newspapers, magazines, and journals. Six participants (10 percent) listed books or book chapters. Two (6.7 percent) named films, one (3.3 percent) named a video posted on YouTube, and one (3.3 percent) listed a television series. Three students (10 percent) gave citations for Web sites, and one student each (3.3 percent) referred to a government document, an image, and an interview. Only twelve participants provided complete citations to these additional sources, however. The average citation completeness score was 3.03.

Table 7.

Articles found via Google and federated search tool

	Google	Percent	Federated search tool	Percent
Newspaper, magazine, or journal articles	45	75	51	85
Articles on Web sites	9	15	-	-
Book or film reviews from magazines or journals	2	3.3	5	8.3
Encyclopedia articles	1	1.7	1	1.7
Books	2	3.3	-	-
Government documents	-	-	3	5
Web sites	1	1.7	-	-

Table 8.

Format of additional sources found via Google and federated search tool

	Google	Percent	Federated search tool	Percent
Articles	13	43.3	18	60
Books or book chapters	6	20	6	20
Book reviews	-	-	3	10
Government documents	1	3.3	-	-
Conference papers	-	-	1	3.3
Videos, films, or TV series	4	13.3	-	-
Web sites	3	10	-	-
Images	1	3.3	1	3.3
Interviews	1	3.3	-	-
Advertising features	-	-	1	3.3
Duplicate citation of previously cited cited source	1	3.3	-	-

Via the federated search tool, all thirty students were able to find an additional source that they believed relevant to their chosen research topic. Eighteen participants (60 percent) cited articles in newspapers, magazines, or journals (Table 8). Six (20 percent) named books or book chapters. Three students referred to book reviews (10 percent), and one student each (3.3 percent) listed a conference paper, an image, and a corporate-sponsored "news article" that was actually advertising. Of these thirty participants, fourteen provided complete citations. The average citation completeness score was 3.23 (out of 4).

In evaluating the quality of the additional sources found via Google, the average total quality score was 12.00 (out of 15) (Table 6). The average total quality score of the additional material discovered via the federated search tool was 12.37 (out of 15).

> … a handful of the explanations were more nuanced and expressed an understanding of authority, scholarliness, the importance of including a variety of source types or points of view, and the importance of including primary sources …

Students were asked to record why they had selected this additional source (Appendix B). In most cases, the explanation was similar to "it's relevant to my topic" and provided little insight as to why the student had selected it. However, a handful of the explanations were more nuanced and expressed an understanding of authority, scholarliness, the importance of including a variety of source types or points of view, and the importance of including primary sources (although no students used the phrase "primary source" to describe such material).

One student explained the choice of a book found via Google:

The source I found is a book titled In the Shadow of the Holocaust: The Second Generation. The author, a clinical psychologist and himself a child of survivors, draws upon his own experiences and the experiences of other second generation children to "piece together" the psychological realities faced by these children. I think that this book is relevant to my research topic because it would help me understand the points of view of the Second Generation and give me some insight from a psychological perspective—so I could "get a sense" of who I'm writing about. [Topic #4]

Another student commented:

I located sources from several different locations. BBC News and The Times were used because they provide quick access to information on my topic. Also, the text is written in a manner that is easier for the general public to understand. The scholarly article is also good because it offers a higher level of analysis, albeit it is more difficult to read. Both types of sources are important to any type of research. [Topic #3]

Yet another student remarked, "This is an article that is made by the Associated Press, their articles are usually reliable and the information in this article is related to what I'm writing with a different view." [Topic #6]

One student commented on an article discovered via the federated search tool:

> This was a scholarly article I found. It discusses the issue of how humans have triggered climate change, and because it's a "Mathematical, Physical, and Engineering" journal, there's a lot of science-based evidence that explains how climate change came to be. In addition it assesses the consequences of climate change, and predicts different scenarios as to how our lives would be affected by the climate change. [Topic #6]

Another student explained:

> The source is a review of books. It may be relevant because rather than me reading each book, I can read an interpretation of each book from someone who is educated on the topic and gain an understanding of Faulkner that way too. [Topic #2]

Scholarliness of Sources

Via Google, 70 sources out of a possible 120 (58.3 percent) were rated as scholarly (book chapter or book from a scholarly or academic press, government document, peer-reviewed article). Via the federated search tool, 90 sources out of a possible 120 (75 percent) were rated as scholarly.

Dates of Sources

Via both search tools, students cited sources from a variety of years and did not limit themselves to only the most recent scholarship. Via Google, the oldest item given was from 1963, the newest from 2011. Via the federated search tool, the oldest source cited was from 1962, the newest from 2011.

Citation Completeness

Via Google, only 49 citations out of a possible 120 (40.8 percent) could be considered complete, including all of the elements necessary. The average citation completeness score for all sources found via Google was 3.1 (out of 4).

Via the federated search tool, 59 citations out of a possible 120 (49.2 percent) could be considered complete. The average citation completeness score for all sources found via the federated search tool was 3.23 (out of 4).

Overall Quality of Sources

In tabulating the overall quality score for only those sources that met the format criteria (one book, two articles, and one additional source), the average total quality score for the sources found via Google was 12.50 (out of 15). The average total quality score for the materials uncovered via the federated search tool was 12.70 (out of 15) (Table 6).

In tabulating the overall quality score of all materials that students found, regardless of whether they met the format criteria, the average total quality score of the sources discovered via Google was 12.43 (out of 15), and the average total quality score of the sources found via the federated search tool was 12.73 (out of 15).

Repeatedly Cited Sources

Via Google, four sources were cited more than once, by different students. Via the federated search tool, nine items were given more than once by different participants. One undergraduate named the same article twice (found via both Google and the federated search tool).

There was little overlap of sources between the two search tools. Only three sources were cited both by students using Google and by students using the federated search tool.

Discussion

Books

Google much more easily led students to books, many of them scholarly. Students experienced difficulty using the federated search tool to find books and explicitly said so, despite that the Brooklyn College Library's catalog, ebrary, and NetLibrary (now EBSCO e-Books) were all included.[45] There are several possible reasons for these difficulties. At the time the study was conducted, EBSCO's Integrated Search product did not label citations by source type, nor was it possible to limit searches to books. Students had to interpret a citation on their own, or understand that if the Library Catalog, ebrary, or NetLibrary was the database, the citation would likely be a book.

> **Google much more easily led students to books, many of them scholarly. Students experienced difficulty using the federated search tool to find books and explicitly said so …**

Students using the federated search tool also had a hard time distinguishing between a book and a book review when looking at results lists. In some cases, when participants cited a book review, they may have intended to refer to the book itself. On occasion, these book reviews were lengthy and detailed enough to be considered appropriate sources for their research topics. In most cases, however, the book reviews were short, not substantive, and therefore not appropriate as sources for an undergraduate research paper.

The situation now is vastly improved. EBSCO's Integrated Search product has begun labeling citations by source type (book, review, and the like) and, of course, discovery tools have made it significantly easier for students to identify books (and documents in other formats) via labeling and to limit their searches (via the faceting of results) to books. Despite these marked improvements, however, some of the terminology used by vendors may still make it difficult for students to determine exactly what they are seeing. For example, EBSCO's Discovery Search product uses the term "periodical" to identify an article from a popular magazine or newspaper, or "review" for a book review (as opposed to a review article).

Furthermore, a student still needs the ability to correctly interpret citations, because the display of citations within both discovery tools and federated search tools (and individual databases) is not foolproof. In fact, participants using the federated search tool had a more difficult time citing books correctly, despite their high use of the Cite

feature. Google offers no such feature, and yet students had an easier time providing more complete references to books.

What is of greatest interest, however, is that the books discovered via Google were of slightly higher quality overall than those found via the federated search tool. These conclusions would also apply to discovery tools since, even though they make it much easier for students to find books (via the faceting of results), the content of discovery tools is no different from that of federated search tools (or individual library databases).

When using Google, students in this study frequently visited commercial sites such as Amazon to search for and find books.[46] If, ultimately, the quality of the book citations students found via commercial sites is actually slightly higher than those discovered via the library's collections, what issues does this raise? On the one hand, if students use only Google to do all of their research, it is encouraging that they can still be led to sufficiently high-quality books. On the other hand, sites such as Amazon may do better guiding students to books than do the meta-search tools for which libraries pay significant amounts of money. Librarians should directly acknowledge this in the classroom, admitting that for-profit sites and search tools are familiar and easy to use and thus will be consulted for that reason. We should nevertheless emphasize the use of the library's catalog or discovery tool as a way for students to move forward in the research process: to get to the full text of a particular book for free, and from there, to further explore what the library's collections have to offer. Instructors should also emphasize to students the presentation of library collections as a curated selection of books purchased by librarians for their value and authority, especially because this is a service that Google and Amazon do not provide. (The picture is complicated by academic libraries subscribing to a growing number of large e-book packages, the content of which is not necessarily selected by librarians, but it is arguably still "selected" in some way.)

More participants in this study visited Amazon to look for books (48.3 percent) than Google Books (37.9 percent).[47] If students are going to use Google to search for books for their research papers, then we should urge them to go directly to Google Books since these books were digitized from significant research libraries' collections and thus may lead students to titles published by academic and scholarly presses. As a next step, we should encourage students to use the "Find in a library" option that searches WorldCat and thus may lead them to a copy in their own library, rather than the more prominently displayed "Buy this book" option.

> **Instructors should also emphasize to students the presentation of library collections as a curated selection of books purchased by librarians for their value and authority, especially because this is a service that Google and Amazon do not provide.**

> **…teaching students to be smarter users of free search engines will prepare them for research beyond the university, when they will no longer have access to all the search tools, databases, and "free" content that the library provides them.**

Some librarians may take issue with such "teaching the tool" recommendations, but smarter use of freely available (and much-used) search tools is important. For one, students in this study frequently made use of whatever features were available to them within a given search tool's interface—anything that would allow them to focus or refine their search.[48] In addition, teaching students to be smarter users of free search engines will prepare them for research beyond the university, when they will no longer have access to all the search tools, databases, and "free" content that the library provides them.

Of course, while promoting "smarter" use of Google by our students, we should also acknowledge that such search engines are primarily commercial in purpose. Indeed, one of the things that students disliked most about Google was that it displayed ads and often led them to commercial sites that urged them to buy something.[49] This aversion presents a perfect opportunity for discussion about information as commodity.[50]

Articles

With articles, the quality gap was slightly wider, with the federated search tool coming out ahead. This result is not surprising, given that the federated search tool and, by extension, most library databases—including discovery tools—are comprised primarily of citations to articles, many of them peer-reviewed. When using Google to look for articles, participants in this study frequently visited informational sites such as About. com, Questia, and HighBeam.[51]

Despite the use of such sites, however, Google still enabled students to find sufficiently high-quality, relevant articles, many of them scholarly. Google easily led many students to Google Scholar, and then to results within library databases such as JSTOR. Google suggested Google Scholar results because students often used format terms (article, scholarly article, journal) in their search queries, which Google interpreted as a preference for scholarly sources.[52] Google has perhaps made this so easy that more students were able to meet the "at least one scholarly article" requirement via Google than via the federated search tool. As with Google Books, we should encourage students to go directly to Google Scholar when looking for scholarly articles (and to set up Library Links within their Google Scholar settings), and to go to Google News when looking for newspaper articles.

…librarians should promote Google as a tool to be used in tandem with, or as a supplement to, library search tools since Google can potentially lead students to find and cite a greater variety of sources in their research papers, including important primary source materials.

Additional Sources

The widest gap in quality was with the additional sources found. The federated search tool led students to cite mainly articles, many of them scholarly, as their additional source, along with books and book chapters. In short, though the citations contained within the federated search tool (and by extension discovery tools and library databases) may be good quality, they led students to list a more homogeneous set of sources.

Via Google, students still found and cited books, book chapters, and articles, but they were led to find and reference a wider variety of materials such as Web sites, videos, films, interviews, television shows, and images. Several of these sources could be considered primary and therefore of potentially great value to a research paper (though not a single participant used the phrase "primary source" to describe a selection). The majority of additional sources, however, were popular sources of a lower overall quality than the less varied material students found via the federated search tool. In light of this, librarians should promote Google as a tool to be used in tandem with, or as a supplement to, library search tools since Google can potentially lead students to find and cite a greater variety of sources in their research papers, including important primary source materials.

Overall Quality and Scholarliness

Taking into account all the sources turned up via each of the search tools, including those that met the format criteria (at least one book and two articles), and all the sources found (regardless of whether or not they met the format criteria), the federated search tool came out ahead of Google in terms of quality. Understandably, students found and cited a greater number of scholarly materials via the federated search tool than they did via Google.

Variety of Sources

Despite the enormous number of sources indexed by each search tool, numerous students found and cited the same items in their bibliographies. Via Google, four different participants listed one particular book about artificial intelligence (for Topic #3: Computer Science) (Appendix A). Via the federated search tool, five different students referred to one particular scholarly article about the children of Holocaust survivors (for Topic #4: Anthropology).

One likely explanation lies in undergraduates' search behaviors. Students in this study relied heavily on natural language and simple keyword or phrase queries. As a result, the terminology of their searches almost exactly mirrored the language presented to them on the list of topics (Appendix A), and they rarely moved beyond the first page of results.[53] It makes sense then that similar student searches ("you just type in what you are looking for") and behaviors would yield similar results and, subsequently, duplicate citations.[54] This is good reason to advocate deeper investigation and analysis of research topics and subsequent keyword selection, because sameness in searches will lead to sameness in results and, ultimately, sameness in source selection. This may, in turn, lead to a lack of variety in papers, especially a research assignment that asks students to choose from a list of topics presented by their professor.

> **Students in this study relied heavily on natural language and simple keyword or phrase queries.**

It would have been interesting to see what students would have cited had they not been given any format criteria whatsoever. Charles Oppenheim and Richard Smith concluded that, without any format guidelines, undergraduates referred to more Internet sources and fewer journals.[55] Mill discovered that, without guidelines, "Students did

not limit their citations to newer publications, but cited relatively old articles as well."[56] Mill's finding is in keeping with the results of this study, in which publications ranged in age from 1963 to 2011 (via both search tools). Students did not use date limits in either search tool, nor did they include dates as terms within their search queries, even when researching time-specific or time-sensitive topics.[57] This omission is interesting given that currency has long been mentioned as an important criterion for selecting a source, often outweighing other criteria such as quality and authority.[58] As a result, it may be helpful to guide students into thinking explicitly about timeliness as a criterion that is dependent both on the topic and the discipline, and currency (or recency) as a separate, but equally legitimate, criterion.

> **Students did not use date limits in either search tool, nor did they include dates as terms within their search queries, even when researching time-specific or time-sensitive topics.**

Faculty should supply students with some basic guidelines or criteria when selecting sources for their papers—beyond topic relevance or the more standard "just find the best sources on your topic"—and explain their pedagogical purpose in doing so. Librarians could provide faculty with some sample criteria, or ideally, develop such criteria with them. Robinson and Schlegl found that student bibliographies improved when professors supplied enforceable guidelines for citations.[59] Davis and Cohen advised, "Professors ought to be more prescriptive with the type of literature that they would like to see consulted."[60] Alex P. Watson, in his evaluation of student-cited Internet sources, concluded that, while avoiding high- and low-quality citations, students settled on mediocre ones.[61] Colón-Aguirre and Fleming-May observed that when instructors require that students provide evidence of having consulted "credible" and "reliable" information sources, students were more selective.[62]

Indeed, had participants been given entirely free rein in this study, all their sources might have been similar to the additional sources they found, where the quality gap between the sources turned up via Google and those found via the federated search tool was widest. Put another way, without any format restrictions or guidelines, Google will lead students to lower-quality results.

> **We should encourage students to compare, contrast, and question the purpose of each tool, and to use each tool optimally and for its strengths.**

Perhaps because some basic criteria *were* provided, both search tools led students to satisfactory results, even though they were not sophisticated searchers.[63] This study thus confirms that undergraduates do not have to be good at research to get "good enough" results.[64] It also means that, even by just using Google, undergraduates can potentially create a bibliography of sufficiently high-quality sources for a college-level research paper. Librarians must acknowledge this truth both at the reference desk and in the classroom. We should encourage students to compare, contrast, and question the purpose of each tool, and to use each tool optimally and for its strengths. The strengths of Google include its flexibility in handling natural

language searches, its speed and ease of use, its convenience for students (and scholars), its greater variety of sources that may in turn lead to a more varied bibliography, and its ability to guide students to digitized primary source materials. The advantages of library search tools include their ability to lead students to vetted content—books selected by librarians and peer-reviewed journal articles—and, more importantly, to the full text of content at no cost to our users. And, last but not least, library search tools can help students find sources that are, overall, more scholarly.

Another necessary outcome is the continued improvement of search algorithms used by meta-search tools—including discovery tools—to generate results. When students use Google, what often comes up first is what they regard as best.[65] In other words, students believe that top-ranked results are an indicator of quality.[66] As librarians well know, Google (and Google Scholar) use search engine optimization to push to the top those results that are most popular or most heavily cited. How do we explain to our students that such optimization of results may make information seeking easier, but privileges a certain kind of content that leads to heavily biased and limited results? In direct opposition to this, librarians need to acknowledge that the results that come up first in library search tools are, quite intentionally, *not* the most popular. Nonetheless, what comes up first in meta-search and discovery tools could still be better, especially for basic keyword searches.

> **When students use Google, what often comes up first is what they regard as best.**

Citation Completeness

As for the citations themselves, via both search tools, fewer than half the participants were able to provide a complete citation. This result is in keeping with Malone and Videon's study, which concluded that less than half of students' references were rated as consistently clear.[67] This lackluster performance occurred despite that the federated search tool (and many library databases and discovery tools) provide a Cite feature, which participants in this study used frequently. Indeed, the feature does not generate perfect citations, often omitting important elements, or labeling the citation in a confusing manner.

Here is an example of a book citation generated by the Cite feature in the federated search tool:

Houghton, J. T. (n.d). Global Warming : The Complete Briefing. Retrieved from EBSCO*host*.

Citation features provide an opportunity to discuss the process of citation itself—what it is, why we do it, and how. By exploring the missing elements, librarians can demonstrate the importance of viewing these citations—having been generated by a computer—as ready for proofreading rather than as final copy. We can then encourage students to consult style manuals and citation Web sites to compare the search-tool-generated citation with the preferred style.

Even with such Cite features, along with the labeling and faceting of results by format, undergraduates still do not know what comprises the major elements of a cita-

tion. Participants in this study had trouble identifying sources and explicitly stated that they wanted the search tool to do it for them, rather than having to decipher a citation on their own.[68] Nonetheless, in all cases except one, students provided enough reference information for the source to be found.

> **Participants in this study had trouble identifying sources and explicitly stated that they wanted the search tool to do it for them, rather than having to decipher a citation on their own.**

Limitations

Students did not have time to find the full text of their sources and investigate them further, the way they would have if they were writing an actual paper. Furthermore, they were not asked to actually apply each source, or even to qualify why they had selected it, except for the additional source of their choosing. Without context—meaning, with neither an explanation nor an actual research paper required of them—it is difficult to determine how students would have used each source and whether they would have done so appropriately. Students found materials about climate change, for example, that, though older, might have been suitable if they had provided a historical context. As Bonnie Gratch pointed out, "Without reading the paper, we can't know if the sources listed in the bibliography are sufficiently current, or if they represent more than one side of the issue."[69] Students might score highly in terms of finding high-quality resources and still not apply them appropriately within a research paper.

Even though format criteria were stipulated, therefore ensuring some variety in the sources students selected, the Quality Rating Scale (Table 3) used in this study did not explicitly take into account the need for variety, nor how different kinds of materials can complement and inform one another. Is an encyclopedia article (based on its lower rating for scholarliness) truly less valuable a source than a journal article? What if a Web site such as YouTube leads you to a video of a first-person account that could be considered a primary source?

Another element to consider is that only the author rated the sources found in this study. A panel of raters and an evaluation of reliability among raters might have provided for the more reliable assignment of scores.

Young and Ackerson recommended that raters should "develop specific criteria for rating papers in distinctly different disciplines."[70] Given that students were allowed to choose from a list of six topics from six different disciplines, this procedure would have necessitated a different rubric for each topic. Though this method might have been ideal, it would also have been incredibly time-consuming and therefore impractical. Nonetheless, future studies might take this recommendation into account.

Quality is, of course, subjective, as reflected by the fact that so many professors refuse to give their students criteria for selecting sources. As Reinsfelder pointed out, "The use of a rating scale can be helpful in trying to objectively measure the quality or appropriateness of information sources used by students. Yet, there is still significant room for subjective interpretation, as it is not always clear which category a source should be assigned."[71] Certainly, the refinement of evaluation criteria is essential, and something that we are still working toward. This study was by no means perfect in its objectivity.

Conclusions and Future Research

This study suggests that Google can lead students to content that is fairly comparable in quality to that found in library meta-search tools, including discovery tools, especially if they are given some format criteria. As Connaway and Dickey point out, "More digital resources of all kinds are better," and so if Google is better at leading students to discover and incorporate a wider variety of digital content into their research papers, including primary sources, we should acknowledge this superiority and teach accordingly.[72] Indeed, even among humanities scholars, as Max Kemman and his coauthors report, "Google has a central role" within their research practice, where scholars use it to search for text and images, to find other search tools, and to identify relevant keywords.[73] In addition, Google continues to index more open-access publications

> **This study suggests that Google can lead students to content that is fairly comparable in quality to that found in library meta-search tools, including discovery tools, especially if they are given some format criteria.**

and more content in institutional repositories (IRs), though there have been issues with incompatible IR metadata. Some writers have argued that overall indexing of IRs by Google Scholar has been low.[74] Despite these arguments, Google Scholar has become one of the most popular search tools for scholars and has prompted PhD students to use more literature than ever before.[75]

For libraries, quality has always been our trump card. But if the quality of sources found via Google is pretty good, and if even scholars use it out of convenience, then how do we negotiate these truths with our students? Do we argue that Google is a for-private company that is different from the for-profit database vendors with whom libraries work? Do we discuss privacy, which database vendors respect, and Google does not? Do we argue about filter bubbles and the biases and limitations of search engine optimization and page ranking? Or do we continue to stress that content found through library search tools and collections, as Jerry Gray and his coauthors say, "undergoes some level of scrutiny, either by peer review, editorial process, or selection standards, ensuring a level of accountability for the quality of what is presented."[76] Some have gone even further, as Kevin O'Kelly recently did in conversation with Xiaotian Chen about the merits of Google Scholar. O'Kelly stated, "Quite bluntly, we don't know how Google does what it does, and even the people at Google don't seem to know entirely what they're doing."[77]

The picture of "finding quality" is thus a complicated one for undergraduates, one in which Google, meta-search tools, and individual databases perhaps all have their place within the research process. In addition, because convenience is such an important criterion for scholars and students alike, acknowledging this need in the classroom is essential, along with a discussion about the consequences of convenience, even if we only see students at the desk or for one class session.

Moving forward, more nuanced and realistic discussions about when and how to use each search tool will be necessary. Even though the overall quality of sources was fairly high using both search tools, there was room for improvement. With discovery tools now offering an even more convenient or Google-like approach to library resources, the

focus can shift to what Dianne Cmor and Xin Li call "the iterative process of research—to search and evaluate, to 'get a feel,' narrow or broaden or shift focus, and then to search again based on what students have learned from the searching process itself."[78]

Along with the first two parts of this study, the three articles together present a big-picture look at undergraduates: their preferences and perceptions, their search habits and behaviors, and the quality of the sources they are able to find, both via Google and a library search tool.

> **Moving forward, more nuanced and realistic discussions about when and how to use each search tool will be necessary.**

In summary, students preferred the federated search tool over Google for doing research and expressed "an understanding that the general quality and scholarliness of the results in the federated search tool were uniformly higher" than those they found via Google.[79] Undergraduates believed themselves to be sophisticated searchers, yet their search behaviors did not support this belief.[80] Despite their lack of advanced information-seeking skills, students still tracked down sufficiently high-quality sources both via the library and Google. Both search tools led students to comparable high-quality books. The gap in quality was wider for articles (with the federated search tool coming out ahead), and the widest gap in quality was seen when students were given license to choose a source in any format.

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Appendix A

Research Topics

Start by choosing ONE of the following topics. You will be working with this topic throughout the session, so please choose the one that's of greatest interest to you.

Topic #1: Business

In your Business class, your professor has asked you to do research on the American auto industry and how it's faring during the current economic recession.

Topic #2: American Literature

In your American Literature class, your professor has asked you to do research on a significant theme in the novels of William Faulkner.

Topic #3: Computer Science

In your Computer Science class, your professor has asked you to do research on the ethics of artificial intelligence.

Topic #4: Anthropology

In your Anthropology class, your professor has asked you to do research about the children of Holocaust survivors.

Topic #5: Education

In your Education class, your professor has asked you to do research on the acquisition of English-language skills within immigrant families in the United States.

Topic #6: Environmental Studies

In your Environmental Studies class, your professor has asked you to find scientific evidence that either proves or disproves climate change.

Appendix B

Doing Research Using Google and the Brooklyn College Library Search Tool

Using Google and the Brooklyn College Library Search Tool, complete ALL of the following research tasks for the topic you've selected. If you have any questions at any point, please ask.

Research Tasks

(1) Find ONE BOOK that will help you write a paper on your topic. You don't have to find the full book, just the citation.

Write down the complete citation for the book you found. If it's easier, you can cut and paste the information here:

(2) Find TWO ARTICLES that will help you write a paper on your topic. At least one of these articles must be scholarly (published in an academic journal). The other article can be from a magazine or newspaper. You do not have to find the full text, just the citations.

Write down the complete citation for Article #1. If it's easier, you can cut and paste the citation information here:

Write down the complete citation for Article #2. If it's easier, you can cut and paste the citation information here:

(3) Locate the full text of the scholarly article you found.

(4) Find ONE OTHER SOURCE that will help you write your paper on your topic. The format of the source is your choice.

Write down the complete citation for this source. If it's easier, you can cut and paste the information here:

What type of source did you find? Why do you think it's relevant to your research topic?

When you have finished all of the above tasks, let the supervisor know. Thanks!

Helen Georgas is a reference librarian and assistant professor at Brooklyn College of the City University of New York (CUNY); she may be reached by e-mail at: HGeorgas@brooklyn.cuny.edu.

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