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Reference Question Data Mining

Joshua Finnell

Colgate University, jfinnell@colgate.edu

Walt Fontane

McNeese State University

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Reference Question Data Mining

A Systematic Approach to Library Outreach

**Joshua Finnell and
Walt Fontane**

Joshua Finnell is Humanities Liaison Librarian, William Howard Doane Library, Denison University, Granville, Ohio. **Walt Fontane** is Reference Librarian and Assistant Professor of Library Science, Frazar Library, McNeese State University, Lake Charles, Louisiana. Submitted for review December 3, 2008; revised and accepted for publication April 21, 2009.

This exploratory study investigated the feasibility of using reference questions as an important tool in the construction of study guides, instructional outreach, and collection development at a small, four-year university in Lake Charles, Louisiana. The premise for the study was based on the assumption that the content of the reference question and class from which the question came provide more valuable information than the metadata normally captured within reference classification systems (e.g., directional, research). Reference question subjects received at the reference desk were recorded over six months by the reference staff. The authors then analyzed and classified the data to discover patterns in collection use. The resulting report was then disseminated to the reference, collection development, and instructional outreach departments. The findings reveal that this method of reference data classification and timely reporting provides an excellent reference for planning in these library departments.

A 2002 survey conducted by the Association of Research Libraries (ARL) revealed a steady decline in reference transactions (125,103 in 1991 to 67,697 in 2002).¹ Faced with concrete numbers elucidating this trend, academic librarians and college administrators

are expressing a need for new modes of displaying the usefulness of reference services in a continually changing environment. The ARL report also revealed a general lack of confidence on the part of librarians in current data collection. Traditional data-collection techniques (e.g., classifying reference questions into categories such as directional, ready-reference, specific search, and research intensive) allow librarians to analyze workflows and compare the institution to peer organizations. However, an essential component of the data-capturing process has been left out: the subject matter of the question. In 1981, White quipped, “If librarians go to the trouble of keeping such statistics, they ought to get something out of them locally.”²

McNeese State University is the ideal size to conduct a study like this. It is largely a commuter school servicing about eighty-one thousand students. It offers seventy-five associate, baccalaureate, and graduate degree programs. The Reference Department at Frazar Memorial Library includes five librarians that manage the reference desk for seventy-seven hours per week. Library instructional outreach at McNeese has led to a large increase in information literacy sessions in the past two years. The bulk of the instruction sessions are

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completed shortly after midterm exams, allowing ample time for the reference librarians and the Library Instruction Committee to analyze assignments, classes, and reference questions to discover patterns, problems, and trends, as well as plan future actions.

The current study began during the development of subject-specific resources guides, which included famous events and persons broken down by decade. Subsequently, the investigators decided to record all research-oriented questions with the twofold purpose of (1) collecting data to target specific courses for information literacy instruction and (2) identifying gaps or weak spots in library resources. Along with changes in the goals of this study, we also changed the method to better capture the reference questions and mine them for data in pursuit of the study's three goals: study guide creation, instructional outreach, and collection development. At writing, the current method has been in place for more than six months and supports these three goals.

LITERATURE REVIEW

There is a paucity of library literature dealing with systematic approaches to capturing category-specific reference questions. An analysis of the 2002 collected reference logs compiled by the ARL revealed that only ten out of seventy-six institutions surveyed (13 percent) record the subject category of each question.³ One possible reason for this may be the time required to analyze reference transactions; time and human resources are precious commodities. Additionally, very few studies made an attempt to link the subject of each reference transaction to the course in which the student is enrolled.

Classification from Course Catalogs and Professors

Traditionally, collection development has relied upon faculty and subject bibliographers to identify gaps in the collection. In 1969, Durand of the University of Southwestern Louisiana embarked upon a project to classify the university catalog to ascertain the needs of the curriculum and identify gaps in the collection. Several catalogers correlated the courses listed in the university catalog with the Library of Congress (LC) classes. Major obstacles to success were the poor course descriptions and the subsequent interpretation. As Durand noted, "No numbers were assigned to a subject not explicit in that course description. This, of course, meant that many large blocks of class numbers

would not appear in our final list."⁴ In 1974, a similar study was conducted at the Gene Eppley Library at the University of Nebraska at Omaha (UNO), and the researchers discovered that often "the LC schedules did not contain specific classification numbers for the subject treated in the UNO courses."⁵

In 1980, Whaley, then reference bibliographer at the University of North Carolina, Charlotte, suggested having individual professors—not librarians—assign LC classes that reflect the materials covered in their classes. Bibliographers then analyzed the professor-assigned LC classes against the general collection and identified gaps and made suggestions for purchase. To supplement the deficiencies of both course descriptions and the LC classes, professors were asked to use "free terms" to describe their courses and supplement the LC classes. These "free terms" were then translated into the closest LC subject headings (LCSH). Again, the bibliographer compared the subject headings against the collection and located gaps for purchase suggestion. Whaley concluded that this procedure, which included input from both professors and librarians, helped to establish and maintain a useful collection that serves the needs of its patrons.⁶

Classification from Syllabi

In 1982, Rambler underscored the importance of syllabus study as a proactive approach to academic librarianship. Examining The Pennsylvania State University's syllabi for library-related projects, she noticed that the overwhelming majority of courses come from the upper divisions. "These findings suggest that the development of systematic library instructional programs should be explored for students other than entering freshman and transfer students."⁷ In 1985, Sayles extended the outcomes of syllabus study to include collection development, subject guides, anticipatory reference, instruction, and overall course improvement.⁸ Syllabus studies are still a popular method of proactive library services.⁹ However, both Rambler and Sayles noted issues with the methodology. Rambler writes, "Since there is a gap between knowledge about the requirement stated in any syllabus and the actual activity a student will follow to complete the requirement, an argument could be made that this study is arbitrarily assigning library use."¹⁰ Much like the earlier studies conducted on course descriptions, course syllabus studies leave out the most essential element: student input. The collaboration of faculty and librarians is a necessary, though not sufficient, element in improving

academic library service. As Sayles points out, “There is a difference between what students need and what librarians think they need.”¹¹

Classification from Random Sampling

In a 2006 meta-analysis of libraries using the statistical sampling method to capture reference statistics, a process that involves collecting reference statistics various times throughout the year, only Central Michigan University (CMU) classified the subject of each reference transaction by course.¹² Using Statistical Package for the Social Sciences (SPSS) software, reference librarians at CMU coded several variables of all reference transaction for the 1988–89 fiscal year (gender, request date, subject, status of inquirer, and so on). They concluded that the inclusion of subject matter can assist in collection development and the inclusion of courses can assist in program marketing and long-term planning.¹³

In 2007, Henry and Neville conducted a study of classification systems, with the understanding that library “resources” include various electronic and technological items. They concluded that a “skill or strategy-based approach, rather than a system based on resources used or time allocated per question, leads to more consistent classification and provides a more accurate reflection of today’s reference desk activity.”¹⁴ Following this trend, the current study suggests a classification system based on the subject of each reference question.

The Reference Department is uniquely situated to collect student input. Transactions at the reference desk reflect the information needs of students at an academic institution. As can be seen from this literature review, classifying course descriptions and syllabi have been the means through which collection development, subject guides, and outreach have been and are being executed. Given the aforementioned trend of reference statistics providing useful feedback for reference librarians to improve the service of the library to patrons, a new classification of reference data that adapts and builds upon the methodology of syllabi and course description studies is needed.

METHOD

We asked Reference staff, including paraprofessionals and librarians from other departments assisting at the reference desk, to briefly summarize (1) the subject matter of the question, (2) the class for which the question applied, or (3) the professor of the class for which the question applied. Because of the varying degrees of

technological expertise among the reference staff, data was recorded using a notepad and pencil. If the librarian did not record a class, or was interacting with a nonstudent patron (administrator, faculty, or public), they would record the class as “community.” We considered other labels for this vague category, including “public,” “other,” and “faculty-staff”; however, these labels could lead to theoretical and practical problems. We felt uncomfortable classifying patrons as “other” or “unknown.” We chose “community” because everyone who approaches the reference desk shares basic social bonds through location (reference desk, Frazar Library, and McNeese State University), interests (scholarship), and events (requiring assistance). On the practical side, this study did not seek to correlate patrons with resources, but rather to determine which resources merited strengthening through increased expenditure of the library’s money, personnel, and time.

Ideally, the information recorded for each interview would result in subject terms and class designations or course numbers. At the start of each month the investigators meet to review the previous month’s entries. We looked for patterns that might identify weaker areas of the collection, high-use areas (collection development), classes that may require an instruction session on library resources (instructional outreach), and areas of general confusion for both librarians and patrons (study guides).

The reference staff were responsible for recording the subject matter of each reference transaction succinctly, similar to Whaley’s idea of “free terms.” These keywords aided the analysis, which sought patterns in reference questions that indicated certain areas of library resources (especially the general collection) that receive frequent use. Analysis was made easier by assigning Library of Congress Subject Headings (LCSHs) to many of the free terms. Reference shares the monthly reports of this study with the circulation and collection management departments, whose staff are frequently evaluating the general collection. Upon viewing the monthly reports from this study, those departments can focus their evaluations on specific areas that are in high demand.

An example of the procedure is appropriate. “Maya Angelou” is a surprisingly broad topic; patrons rely on the reference staff to narrow the topic to something like “literary criticism,” “works of,” “biography,” and so forth. This narrowing down is akin to the “free terms” concept. Frazar Library has a large collection of literary criticism resources. However, despite the apparent interest in Maya Angelou, circulation and in-house statistics reveal

that these resources receive little use. Catalog hits for Maya Angelou include areas in the following LCSHs: American Biography, U.S. History—African Americans since Emancipation, American Literature, African-American Literature, and Literature-General-Biography. On the basis of the reference interview, the reference staff may direct students to any call number ranges covering these topics. While examining this data collected from the interviews, we saw similar demand for other African American authors, including Toni Morrison, Langston Hughes, and lesser-known authors like Ernest Gaines and Sterling Brown. By studying the questions, we realized that most of the patrons inquiring about these authors were in ENG 101 and ENG 102. Furthermore, a pattern emerged showing that they did not want literary criticism or history materials. The Collection Management Department increased the acquisition of materials in History of American Literature—Negroes/African-Americans/Blacks (PS 153 .N5) as well as reviewed History of American Literature—Biography (PS 125.5 .A–Z to PS 153 .A–Z) with specific attention given to African American authors. In formulating subject guides for ENG 101 and ENG 102, the reference staff highlighted these LC call number ranges for browsing, mentioned some of the other relevant areas in the collection, focused on appropriate databases, and suggested search terms such as “African Americans in literature” and “African American authors” because the few books on Maya Angelou and Toni Morrison circulate quickly. The process of relating the raw data to LCSHs is not as easy as it appears in the case of Maya Angelou.

Ideally, the subjects would correspond to controlled vocabulary for LC classification. Because they are not controlled vocabulary terms, it is necessary to convert these free subject terms into LC call number ranges. There has been discussion as to the usefulness of designating LCSHs to the subject of the reference questions. It is easier to note that a collection is lacking materials on abortion instead of converting it into “Medicine—General—Medical Philosophy—Ethics.” The key reason for this process is the construction of subject guides. Instead of assigning materials for certain classes, the reference staff at McNeese advises students to browse call number ranges. This is especially relevant when the McNeese OPAC does not return many favorable hits. Students also are likely to find books (as a required percentage of resources for an assignment) by browsing a small call number range. Staff will show patrons how to use the OPAC and give them titles or call numbers, but the staff also encourages students to browse

the shelves for their subjects.

Linking the free subject terms to LC classes is done by entering them into both the Indiana University Catalog (IUCAT) and Ohio University’s library catalog (Alice). In continuing with the example of Maya Angelou, both catalogs will return hits in many different call number areas. Using the free subject terms recorded by the librarians, we hope to identify the essence of the question, such as literary criticism, biography, civil rights, and so forth. In this way, we seek to determine if the students are seeking more material on African Americans since emancipation (E. 184.5 to E. 185.98) or African American authors (PS 153). Sometimes we encounter free subjects that do not readily connect to LC classes. Examples include “abortion,” “healthcare,” and “hippies.” In these circumstances, we search for the terms and “assign” the free subjects to the LC classes in which the two catalogs return the greatest number of hits. Consequently, “hippies” is assigned to Social Sciences—Family/Marriage/Women—The Family/Marriage/Home—Youths/Adolescents/Teenagers (HQ 793 to HQ 799.2).

Data was entered by the authors into a simple Excel spreadsheet, correlating classes with the subject of each question. Compiled monthly charts were then analyzed for trends and disseminated to Reference, Collection Management, and the instruction librarian. The charts omit the instructors’ names. As patterns were discovered, such as classes that might benefit from specialized instruction, the instruction librarian consulted with the authors to identify the instructor in question.

A PILOT STUDY IN MANY FORMS

When this study began in November 2007, we used the North American Title Count (NATC) and the McNeese OPAC to correlate each entry into a matching category. Collection Management uses the NATC when compiling reports for collection analysis. The NATC includes 688 LC and National Library of Medicine call number ranges. Ultimately, the NATC was deemed unsatisfactory for this project. Although the NATC offers a large scope of call number ranges, it is not consistent with the goals of this project. Many reference questions pertain to the social sciences and education. The NATC classification scheme is not sufficiently specific to offer much detail for subject guides or collection development in these areas.

For example, several English 102 sections write papers on utopian societies. The NATC classifies “utopia” under “socialism and communism.” It would serve no purpose for the reference staff to

make subject guides for socialism and the Collection Management to acquire communist resources on the basis of such a classification. Beginning in April 2008, we decided to use the LCSH classification schema. The full range of LC classes is better able to pinpoint patron demand, develop study guides, and aid in collection management. It was felt that using LCSH would give greater authority and uniformity in the current study and in subsequent studies.

Prior to the move to the LCSH, we used a system of footnotes as supplemental information added to the Microsoft Excel spreadsheets. For example, there were footnotes beside the “socialism and communism” NATC class, indicating that the essences of the reference questions were utopian societies. We stopped using footnotes in the spreadsheet with the conversion to Library of Congress. However, there are a few occasions when information was added in brackets to the LOC call number ranges. One example is Medicine—Internal Medicine—Neurosciences—[Amnesia]. The addition of the occasional bracketed material does not interfere with creating study guides or collection management—the LC class is narrow enough to accomplish both of these project goals. The bracketed material is data specifically for collection management staff that need to justify expenditures.

The limitations for the McNeese OPAC became evident after unsuccessful searches for topics such as “bovine reproductive strategies,” “achondroplasia,” and even something as esoteric as “Spanish Inquisition.” In the spring of 2008, the authors adopted the LC OPAC. This change allows for greater reliability and validity. However, we quickly encountered difficulties in using the LC OPAC. Sometimes the LC produced no clearly discernable results. One example is “hairstyles in the 19th Century.” The investigators conducted a search on Amazon to find likely books and then searched for those books in the LC OPAC or in OCLC Worldcat. This roundabout way was needlessly time-consuming. We also were encumbered with the LC’s timed sessions; we were frequently booted out before the five-minute session ended. Another inconvenience with the LC OPAC was the annoying lack of call numbers for items not in their possession but listed in their catalog. For these reasons, we abandoned the LC OPAC.

We began using IUCAT and Alice soon after we began using LCSH (March 2008). The choice of IUCAT and Alice came about through using OCLC Worldcat for searches that produced unsatisfactory results in the LC OPAC. When prospective matches were found, we consulted the “libraries

that own this item” link and found that both IUCAT and Alice were among every search. One of the investigators remarked that using Alice was a pleasant experience.

Many of the concerns and problems affiliated with the method of this project were satisfactorily addressed with the move to LCSH, IUCAT, and Alice. Since then, the greatest difficulty encountered in this project has been the lack of recording of patrons’ classes. The goal of targeting specific classes for library instruction sessions depends upon accurately recording the classes of interviewees. Reference questions via e-mail, instant message, and telephone frequently do not include class numbers to plot. As a result, we began placing such questions into a class titled “community.” The resulting large “community” class can help with formulating study guides, supporting collection management, and perhaps identifying patterns in patron use, but it weakens one of the more demonstratively successful aspects of this undertaking.

RESULTS

This preliminary study, in only a few months, provided both guidance and justification in the assembly of study guides, library instruction, and collection development (see table 1). To date, eleven study guides have been created as a result of this data analysis. Although most reference librarians were familiar with the topics assigned in English 102 courses, several trends emerged from relatively unknown classes and subjects. For example, in September 2008 the reference desk recorded more than thirty questions from students seeking information on Louisiana history, ranging from coastal erosion to labor unions, for History 301: Louisiana History. The reference staff was justified in creating a Louisiana history study guide for the course. Additionally, the instruction librarian contacted the professor of History 301 and was able to provide strong justification for inserting a library research session into the syllabus. Reference data mining has proven useful in targeting professors for library instruction. Again, English 102, which requires a library session, provided the strongest outreach for library instruction. However, with the collection, classification, and analysis of reference transactions, the instruction librarian has increased library instruction to nineteen new courses over the last year, many of them upper division courses. Thus this study gave justification and guidance in developing systematic library instruction for students other than freshman, as Rambler had asserted.

The library as a whole has responded in different forms to this project. For example, the large volume of ENG 101 students was surprising to the English faculty. The curriculum is designed to foster writing skills in ENG 101 and research skills in ENG 102. Until the authors and the instruction librarian presented the monthly figures to the faculty, they saw little reason to bring ENG 101 classes for an instruction session. However, the English faculty, while acknowledging a problem, were reluctant to bring their ENG 101 classes. The library sought a compromise by offering ENG 101 professors the opportunity to reserve a library computer lab with a reference librarian to help students as they did both their writing and rudimentary research for ENG 101. Another example is the creation of the Book-A-Librarian initiative by co-author Josh Finnell. One class in which students routinely have research difficulty is PHIL 251: Decision Making and Ethical Choices. Until this study, no member of the reference staff was aware of this class. Not only did Reference succeed in luring the class to the library for instruction sessions, but the new Book-A-Librarian program allowed students to approach the more knowledgeable librarian in a specific field for personalized help. Other librarians joined the program and received an enthusiastic response, not just from PHIL 251 students, but other courses—especially HUMN 201 and several political science courses.

In the 2006–07 school year, Reference performed twenty-one specialized instruction sessions (outside the English department) for professors, with nine of those classes focusing on government documents. A majority of the courses taught were 200-level or below. Since collecting data on the numbers of students seeking reference services and meeting with faculty, there has been a large growth of instructional outreach venues, especially with upper-division classes. In the 2007–08 school year, Reference performed twenty-eight specialized instruction sessions (outside the English department) for professors, ranging from electrical engineering to philosophy. Eleven of the courses were 300-level or above.

In addition to instructional outreach, the library created ten new study guides in 2007–08.

The created study guides (see appendix) give mostly call number ranges, subject terms, and database suggestions, but they help both the students and the librarians, which otherwise feel the same apprehension and anxiety as students when researching subjects such as heat transfer and cooling towers, sand density for construction, and even positive reinforcement in college classrooms. The education philosophy in use with the study guides is empowering the user to locate information needs. Consequently, the call number ranges and subject terms encourage the patrons to conduct their research and consult the reference staff if they are still unable to locate relevant sources. It is in cases such as these that correlating question subjects to the LC call number ranges is invaluable. If there are not direct hits in catalog or database searches, patrons are often left with little recourse but to browse the collection or learn to use OCLC Worldcat and interlibrary loan.

Finally, Collection Development has utilized the reference data as one of several criteria used in acquisitions. Identifying the course materials with high library use, collection development can identify gaps in the collection and fill as needed. Additionally, collection development mines the reference data to prioritize purchase suggestions from faculty. Again, justification for a purchase

Table 1. Library Response to Collected Reference Data

Class	Collections Added	Outreach/ Instruction	Study Guides
AGRI 604	None	Yes	Yes
BIOL 105	3 books	Yes	Yes
EDLD 600	3 books	No	No
ENG 101	None	Yes	No
ENG 102—Decades	2 databases and 1 print series	Yes	Yes
ENG 102—Utopia	3 books	Yes	Yes
ENGR 481/581	3 books	Yes	Yes
ENSC 312	1 database	Yes	Yes
HIST 301	3 books	No	Yes
HUMN 201	None	Yes	Yes
NUFS 470	2 DVDs	Yes	No
PHIL 251	1 reference book	Yes	Yes
PHSC 300	None	Yes	Yes

can be provided through the need reflected in the reference data correlated with purchase requests from faculty.

FUTURE RESEARCH

The investigators plan to continue this research because they believe it has the potential to dramatically improve library services. One tangent study might be to expand the relationship between circulation statistics and the current project. Such a comparison has obvious benefits; however, the volume of circulation statistics makes that unfeasible for the current parameters of this study. Even the brief analysis of circulation and in-house use on literary criticism and select African American authors was nearly as time-consuming as correlating the monthly reference questions to LC call number ranges.

Another possible venue for research is to try sampling reference question data mining.¹⁵ The size of McNeese State is ideal for a study such as described above, but the volume of reference questions and patrons at larger institutions would make a study such as this virtually impossible because of the time necessary to correlate the data. Another study might seek to determine whether multiple librarians are consistent in correlating the reference questions. When the current project was reported at a regional conference of librarians, several attendees remarked that such a study could be adapted for administrative purposes by recording students' year in college (freshman, sophomore, etc.). They suggested this information could better track information literacy skills and library use in relation to discipline and course level.

An additional direction for further study would be to analyze the "community" group. As previously stated, this category refers to nonstudent patrons (faculty and public) as well as a general category for reference questions wherein the librarian did not record class or instructor. Several categories of use, for example, "medical and nursing," are evident. Further inquiry could pinpoint classes, teachers, and refinements of collection management. As a final consideration, the primary users of

several Reference Department standing orders are the general public. Further data could lead to discussions regarding the retention of expensive materials. Certainly there are boundless opportunities for further research using this method—all libraries can benefit from this type of information.

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APPENDIX. PHYSICAL SCIENCES 300 STUDY GUIDE

Physical Science 300—Donahoe—Spring 2009—Library and Research Instruction

Where can you get help?

- Instant Message—Screen name on AIM, Yahoo IM, and MSN IM: McNeeseLibrarian
- E-mail—reference@mail.mcneese.edu
- Phone—337-475-5725
- Walk-In
- Book-A-Librarian—<http://book-a-librarian.blogspot.com/>
- Breanna Weston—bweston@mcneese.edu, 562.4248, IL@MSU—IM
- Writing to Excellence Center—Writing Help

Brainstorming Tools

- Quintura—www.quintura.com
- Bubbl.us—www.bubbl.us
- Clusty—<http://clusty.com>
- Subject Specific Encyclopedia—Library Reference Desk

Reference Materials

- *McGraw-Hill Encyclopedia of Science & Technology: An International Reference Work in Twenty Volumes Including an Index.* (2002). New York: McGraw-Hill. Q121 .M3 2002 REF
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- Woodhead, J. A. (2001). *Earth Science.* Pasadena, Calif.: Salem. QE28 .E12 2001 REF

Books = Catalog: Click on “Find Books, etc., in the Library”

- QC1-999 Physics
- QC1-75 General
- QC81-114 Weights and measures
- QC120-168.85 Descriptive and experimental mechanics
- QC170-197 Atomic physics
- QC221-246 Acoustics. Sound
- QC251-338.5 Heat
- QC350-467 Optics. Light
- QC474-496.9 Radiation physics (General)
- QC501-766 Electricity and magnetism
- QC501-721 Electricity
- QC770-798 Nuclear and particle physics. Atomic energy. Radioactivity
- QC801-809 Geophysics. Cosmic physics
- QC811-849 Geomagnetism
- QC851-999 Meteorology. Climatology
- QD1-999 Chemistry
- QD1-65 General

FEATURE

- QD71-142 Analytical chemistry
- QD146-197 Inorganic chemistry
- QD241-441 Organic chemistry
- QD450-801 Physical and theoretical chemistry
- QD901-999 Crystallography

Access Library Resources Off Campus

- User ID: banner id + 02
- Pin: CHANGEME

Advanced Searching Techniques

- *Subject Searching*—Determine subject headings for your topic, then search for those terms and in dropdown menu next to search box; choose subject or descriptor. [Subject headings are an established list of preferred terms from which a librarian must select when describing the content of an item (i.e., book, article)].
- *Advanced Search*
- *Using Limiters and Feature of Databases*
- *Boolean Search*—Use “AND” to combine two different concepts (e.g., “poverty AND crime”). Use OR to combine two synonyms (e.g., “college OR university”).

Articles = Databases: Click on “Find Journal Articles, by Databases, etc.” Then List

- Academic Search Complete (EBSCOhost)
- Agricola
- Biological Abstracts
- BioOne Abstracts & Indexes (CSA)
- Environmental Issues & Policy Index
- Health Source: Nursing/Academic Edition
- JSTOR
- Medline (EBSCOhost)
- PubMed
- SciFinder Scholar (ON-SITE LIBRARY USE ONLY. Ask at Reference Desk for details.)
- Webfeat

Evaluation of Internet Resources

Library Homepage-Tips & Guides/Library Tutorial—
<http://library.mcneese.edu/search/evaluate.htm>

- Is the author qualified to write this document?
- Does the writer list his or her qualifications?
- What goals or objectives does this document meet?
- How up-to-date is the information?
- Is the information accurate and cited correctly?

Government Websites

- U.S. Environmental Protection Agency
- U.S. Food and Drug Administration—Library of Chemistry Information
- Science.gov—Chemistry and Chemicals
- Laboratory of Bioengineering and Physical Science
- IPL—Chemical Sciences
- IPL—Earth Sciences
- IPL—Physics