Systematic Literature Searching and the Bibliographic Database Haystack

Douglas Page
Graduate School of Management, Southern Cross University, Australia.
DPage20@scu.edu.au

Abstract: Researchers performing literature searches are increasingly using bibliographic databases as their initial and dominant resource. While the increasing number, volume and ease of access to academic and other databases potentially speeds searching, researchers require a rapidly evolving set of skills to do this efficiently. Current literature on this topic and research organisations developing techniques in this area are discussed. Aspects to be considered when designing search filters to extract relevant literature are also detailed. Further method development by the author performed during a systematic literature search on the topic of Barriers and constraints for women leaders is additionally examined.

Keywords: search filter, literature review, meta-analysis, database, Boolean algebra, women, leadership, social research

1. Introduction

The volume of material available to the academic researcher in bibliographic databases and other online sources continues to expand at an exceptional rate (Arms et al 2006, Needham 2000, Petticrew & Roberts 2006). While the increasing volume and ease of availability of information has seemingly made the researcher's task of accessing relevant literature quicker and easier, it has also created a new set of challenges (Han & Kamber 2001, Crawford 2006, Matthews et al 1999).

The literature on the effective and efficient access to this rapidly evolving information medium has lagged markedly behind it's growth. (Grayson & Gomersall 2003, Taylor Dempster & Donnelly 2003) The effective and systematic searching of the variety of databases available to in particular the social and business researcher is however an area of increasing interest and the focus of this article.

2. Online and offline literature searching

The interrogation of online databases and other electronic searching still forms only part of a comprehensive literature search strategy. While the ongoing need for the use of more traditional search and inquiry techniques is still vital (Stroup et al. 2000), the growing wealth of information available from this source demands increased attention and skills development (Creaser, Hamblin, & Davies 2006). Many current research reports fail to demonstrate that electronic information sources have been fully exploited indicating a hit-and-miss approach rather than a systematic search methodology (Han and Kamber, 2001, Petticrew & Roberts 2006, Jenkins, 2004).

This article details the electronic search strategy taken by the author performing a systematic literature review. Two aspects of this research project both heightened the importance and increased the difficulty of a comprehensive and targeted literature search.

- Studies of interest and other relevant literature are spread through a variety of sources.
- The author's use of the meta-analysis methodology requires a systematic and comprehensive literature search for specific quantitative studies
- A variety of largely un-standardised terms are used in describing and classifying this literature both generally and within electronic sources.

3. Narrative and systematic literature reviews

To varying extents across fields of research the deficiencies of the traditional narrative literature review is increasingly being examined. Narrative reviews attempt to synthesize the primary literature and explore the heterogeneity within it descriptively. The technique relies heavily on the reviewer's judgment and viewpoint especially when reconciling conflicting results or when assessing the merits of confirming or confounding information (Petticrew & Roberts 2006). The larger the literature base on a topic, the more pronounced these problems can become. Despite these difficulties the narrative review continues as an important vehicle of academic discussion, dissemination and debate.

Reference this paper as:
Page, D. "Systematic Literature Searching and the Bibliographic Database Haystack." *The Electronic Journal of Business Research Methods* Volume 6 Issue 2 2008, pp. 171 - 180, available online at www.ejbrm.com

A variety of approaches and methods have been developed to either compliment or as an alternative to the traditional narrative review. To address the authors research question a range of systematic methods were examined to asses their suitability. One of the more established methods which the author has chosen to use is meta-analysis. This choice was largely driven by conflict, contradiction and uncertainty within the literature under examination. A preliminary literature review revealed that much of the original research and consequent analysis was contradictory, ambiguous or speculative. Meta-analysis requires the systematic identification and combination of quantitative studies examining the issue or issues of interest. This is seen by the author as a suitable method to both contrast and where possible reconcile the much larger literature base of qualitative research on the topic.

While much of the discussion below is driven by the needs of a systematic literature review, the literature search techniques detailed can similarly strengthen or, if neglected compromise, all varieties of literature searching and review.

4. Meta-analysis and literature searches

Meta-analysis has gained a firm standing in both the review and synthesis of quantitative research. It shifts much of the assessment burden from the reviewer's judgment to a set of assessment and statistical tools. It is also highly dependant on a comprehensive and exhaustive literature search.

A number of groups interested in meta-analysis also have a particular interest in highly targeted and systematic literature searching. While the meta-analysis methodology is used broadly, it is most codified and understood in medical research (Taylor Dempster & Donnelly 2003). The Cochrane Collaboration established in 1993 has specifically worked to develop and standardise the methodology applied to medically related research. This is an international not-for-profit organisation providing up-to-date information about the effects of health care. The group has a strong guiding role in the methodology development and increasingly features in the literature on it. It also takes a leading role in the production of systematic reviews across medical research updating these reviews as new primary research is completed.

Many of the principals and practices detailed in this medically focused literature can and have been adapted to other areas of research. Reacting to this need a sibling organisation to the Cochrane group known as the Campbell Collaboration was formed in 1999 (http://www.campbellcollaboration.org/). This group focuses on the systematic review of social, behavioural and educational research and is part of the wider American Institutes for Research organisation that focuses on behavioural and social science research (http://www.air.org/). Another major group with a focus on systematic review and social research is the UK based Economic & Social research council (ESRC) (Bradshaw, 2005).

While the Campbell and ESRC groups have both identified and generated literature on systematic searching strategies and methods there is still much development work being carried out. One issue noted within this literature is the additional challenges faced by systematic reviewers working outside of the medical field (Jenkins, 2004). Medical researchers can rely heavily on the Medline database and a highly standardised terminology usage. The social or business researcher often has a wide range of possible databases to examine and a much looser terminology usage within the literature. Other features of the range of databases within these disciplines include, poor indexing, lack of consistent abstract structure, lack of standardisation of terms used, and a variety in design of database structures with subsequent varying search fields and layouts (Grayson and Gomersall 2003, Taylor, Dempster and Donnelly 2003, Bradshaw, 2005).

5. Commonly described electronic search strategies

The typical search description found in recent meta-analysis studies that were examined as possible instructional examples for the author's study consisted of the following :

1. Definition of research problem and types of studies to be sought.
2. Scope of search (within a discipline, topic, language, region etc.) and specific variables being examined.
3. The time period of target studies included in the search (i.e. relevant studies completed in a defined period, generally set from a time close to the undertaking of the systematic study looking back typically 5 to 10 years depending on the topic).
4. Databases used in the search.
5. Key words or phrases used for the search.

6. Assessment criteria for including or culling the usual high number of studies that this technique typically produces (although this is often incomplete or not described).
7. Follow-up searching using authors' names taken from relevant studies found in the above stages.

Additional methods to ensure that a search has been comprehensive include –

1. Use of manual searching – Examination of reference lists from relevant studies obtained in searches, qualitative studies, review articles or relevant journal or book searches. Manual examination of relevant journal indexes.
2. Direct correspondence with authors found in the above processes for additional information or studies that they may have been involved with or know of.
3. Wider internet searches for sources of "grey literature"(Government, educational and other institutional reports, research organisation sites, conference proceedings and papers, dissertations, etc.).

6. Typical description of the search process in a meta-analysis study.

From an examination of a range of systematic studies similar in content or structure to the author's study the following description was generally contained within them:
To identify published and unpublished studies that investigate the relationship of ABC to XYZ…., these were searched using the keywords "X" or "Y" or "Z" in databases A, B and C…. These databases were searched again using the authors' names from relevant studies found in the initial search. The reference sections of each of the identified studies were then examined as well as existing reviews of the literature. Finally, e-mail requests were sent for help in identifying unpublished research to authors who had published relevant studies…. To be included in the analysis, a study needed to report on or examine ABC and its effect on XYX…….

Applying these criteria furnished a set of 'n' number of studies that were included in the meta-analysis.

7. Research experience

Performing a pilot search for studies to include in the author's meta-analysis, it was found that the methods generally described by other researchers or detailed in many texts or papers on the topic required further development. Most electronic search strategies described or suggested used single words or short phrases. Attempting to use this strategy for the authors topic with a variety of databases generally produced thousands of matching studies with the majority being unsuitable. The sheer numbers produced effectively made working through their abstracts impossibly unproductive.

8. Search filters

To overcome these problems a search filter was developed. The aim of a search filter is to extract studies and articles of interest from a database. A simple search filter can consist of singular or combined words entered into one or more search fields available within a database's search facility. Further parameters can be added such as, categories of literature to be searched, words that will exclude search extraction, restrictions on date ranges, etc.

Within many search fields, Boolean algebra can also be used to form relationships between words or phrases to further refine the output of search requests. The most commonly used Boolean functions are AND, OR and NOT functions to define the relationship between search words or phrases. These operators can generally also be used to form relationships between search fields and are largely self-explanatory in their operation.

The usage of standardised search filters is becoming well established in the medical meta-analysis literature. A range of generic filters have been developed for medical researchers performing searches in the Medline database. These standard search filters can be applied directly but are generally adapted by researchers for their specific projects. (Haynes et al 2005)

8.1 Developing a search filter

Compared to the systematic medical researcher, the social or business researcher has a much more difficult task to develop an effective filter (Grayson and Gomersall, 2003). Generic filters do not presently exist and

filters need to be developed for each application from scratch by the researcher. The mention of the use of search filters outside medical research is still very rare.

Using a cyclic development approach suggested by Petticrew & Roberts (2006) the following filter was constructed for the author's use:

(Barrier* OR Constrain* OR Imped* OR Obstr* OR hind* OR block* OR difficult* OR career path OR attrition) AND (survey* OR Quantitat* OR Data) AND (Women* OR Gender* OR Female OR Feminist) AND (Leader* OR Manage* OR direct* OR board member*)

Broken by the AND function and bracketed, each aspect of the literature search requirement can be seen within the filter. The first bracketed section sought the constraints or barriers aspect, followed after the AND by the requirement for a quantitative study. The examination in terms of gender is next covered followed finally by leadership (including the ascension to and manifestations of) requirement.

While many databases will consider plurals and other word suffixes as a match automatically, the use of the wildcard asterisk increased sensitivity and reduced reliance on this being performed in the same way by varying databases.

8.2 Application of the filter to a range of databases

The filter needed to be easily adapted to a range of databases (Robinson & Wusteman, 2007). The approach taken was to focus on the use of the 'search all text in all documents' field. Most databases encountered by the researcher contained this or an equivalent field. Alternately the filter can be used for a search on 'Title and abstract only' but where available the full text search increased the number of studies found (or improved it's sensitivity as defined below). The filter was designed to be used within these fields on a singular basis rather than using a variety of fields in one database and then having to make adjustments depending on field availability in other databases. The only other field required was the 'date range', which was used to delimit the searches to the years 1995 to 2007.

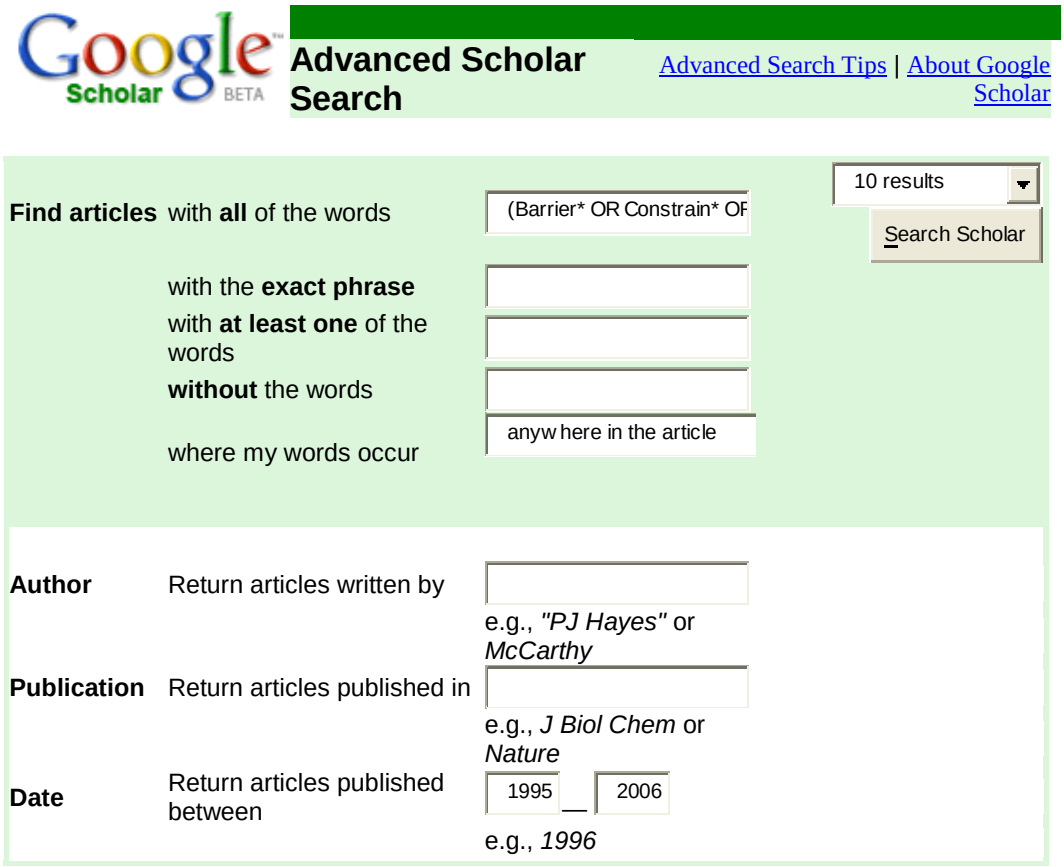

Figure 1: Generalist search databases such Google Scholar accept the filter directly. (Though appearing truncated above, the whole filter fits within the first field)

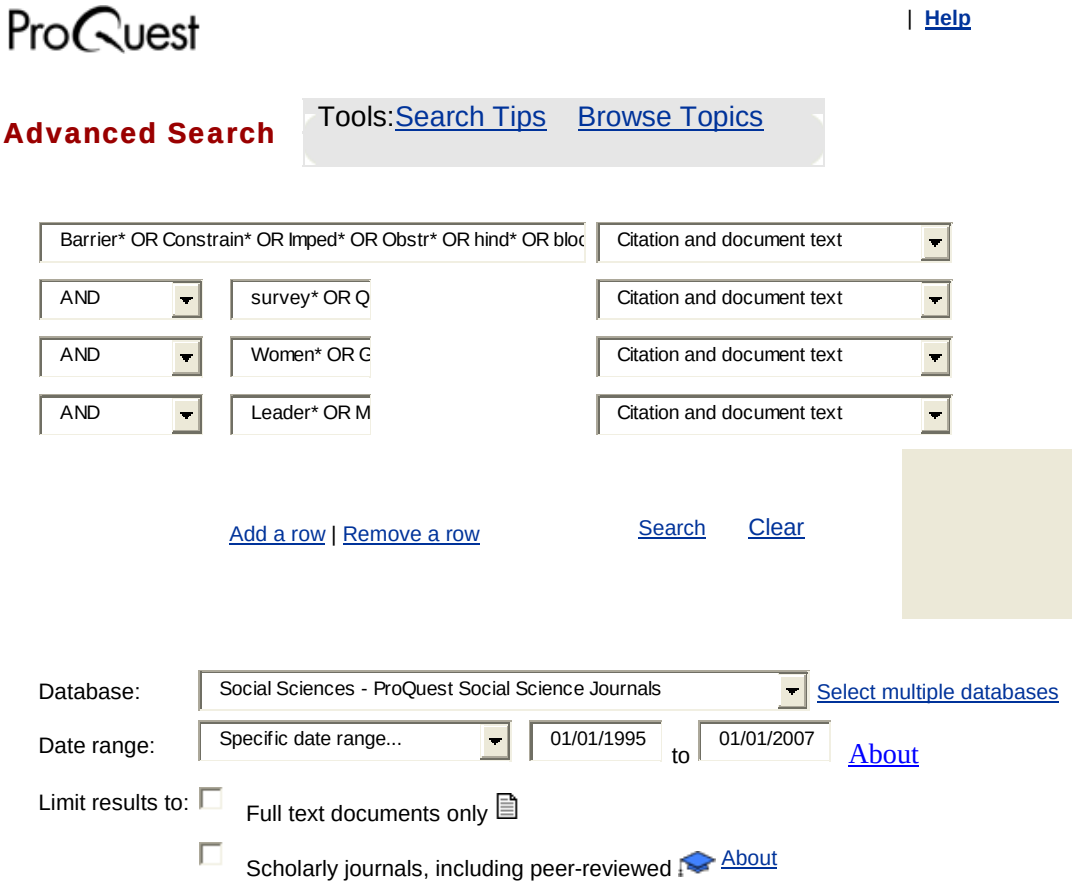

Figure 2: Here using Proquest the filter is split into its four parts. As with the Google search the search is date range but also now also content limited to Social Science.

8.3 The filter's ability to efficiently extract the desired material

Two aspects need to be considered and balanced when designing and developing a search filter. These are generally referred to as sensitivity and precision (Taylor et al. 2003, Popay et al. 2004, Vaughan, 2004). Sensitivity is the ability of the filter to find all relevant material in the database and precision is its ability to reject irrelevant material. A filter with a high emphasis on sensitivity will tend to include less and irrelevant material where a higher precision will tend to reject some potentially relevant information.

The author's approach was to initially develop a filter with a high sensitivity and then make further adjustments toward a desirable level of precision. Relevant material in search listings obtained from early versions of the filter was closely examined. Common and key terms used within this material (and used in relevant cited literature) was incorporated to develop the filters sensitivity along with the wildcarding of some terms.

The subsequent precision adjustment was made by examining common categories of irrelevant material returned by the now somewhat more developed filter. After some experimentation this adjustment was primarily made by changing the structure of the filter, in particular the usage and placement of the AND operators and bracketing of the OR functions. The additional use of the NOT operator to exclude any irrelevant categories was tested but not required. In practice the combination of the four requirements linked by the AND operator largely excluded irrelevant material to a workable level.

Another obvious aspect of such a filter is that it will only find material on the topic written or translated into English. For practical and resource limitation reasons this was the author's intent.

8.4 Filter development stages

A number of general databases such as Proquest, Firstsearch and Social Science Citation index were used in the development of the filter that progressed through the following preliminary and development stages:

1. Search definition. A clear and well-considered definition of exactly what the filter is to extract is vital to guide the construction of it.
2. Taking the key words, phrases or concepts from this definition an initial development filter or filters can be written and tested.
3. Examination of results can then be used to make changes to and retest the filter. (Too many irrelevant returns from a search can be used to make changes to increase the filter's precision while too few indicate changes required to increase sensitivity.)
4. Further iterations of steps 2 and 3 can take place, preferably using a range of databases, until the desired sensitivity and precision balance is achieved.

It is to be noted in relation especially to stage 3 above that excess irrelevant returns provide clear feedback on the performance of a filter and subsequent changes to it. However non-extraction of relevant material is much more problematic. Kennedy et al (1999) warn of the 'false focus' from an overly precise instrument where relevant material is not extracted. This non-extracted material is hidden to the researcher who may believe that they have an effective search tool.

8.5 Use of the filter

The filter could be relatively easily applied to all the databases used with the largest complication being that it was too long to fit within the character limit of some databases' search fields. This was relatively easily addressed by the filter being split roughly in half at the second AND operant or broken down further if required in a similar fashion. The then two or more fields, were then both set to search the 'full text of all documents' within the database, were then used with the fields being linked with an AND. With some databases the filter was more effectively applied to the 'basic' rather than 'advanced' search filter fields. In rare cases the wildcard asterisks needed to be removed for the filter to be accepted.

Bachmann et al (2002) investigated search filter improvements (for use in Medline) and suggested that a 10 to 15% precision for a filter of acceptably high sensitivity is a reasonable aim. With some variation across databases the author's filter performed somewhat below this figure though it peaked at approximately 20%. Most databases list extracted citations in order of 'relevance' assisting with the manual assessment of a highly sensitive filter. This relevance is usually determined on quantity of matches of the terms being searched for within an item, i.e. the higher the number of matches the earlier an item appears in the search result listing. The structure of the authors filter tended to support this measure as a measure of relevance assisting the search listing examination process. Other search filter designs may not necessarily lead to this level of relevance order listing.

8.6 Databases used

The filter was applied to a range of topic specific and more general academic databases.
A listing of the databases producing relevant material follows :

8.6.1 General Academic Databases

- Academy of Management http://apps.aomonline.org/ArticleRetrieval/
- Blackwell Publishing http://www.blackwell-synergy.com/search/advanced
- EBSCO Host http://search.ebscohost.com/
- Elsevier's Scirus www.scirus.com
- Emerald Full text database http://www.emeraldinsight.com/info/products_services/AtoZList.jsp
- Firstsearch http://www.oclc.org/firstsearch/
- Google scholar http://scholar.google.com/advanced_scholar_search?hl=en&lr=
- Intute: Social Sciences http://www.intute.ac.uk/socialsciences/search.html
- ISI web of knowledge http://isiwebofknowledge.com/
- Networked Digital Library of Theses and Dissertations http://www.ndltd.org/serviceproviders/scirus
- PROQUEST http://www.proquest.com/
- Proquest digital thesis http://www.proquest.com/products_pq/descriptions/pqdt.shtml

8.6.2 Topic specific databases or searches limited to a specific journal.

While many of the above listed databases hold data from a range of sources limiting searches to specific journals within them provided the additional precision and resultant material.

- Academy of Management Perspectives http://www.aomonline.org/aom.asp?ID=204
- Educational Management Administration & Leadership http://ema.sagepub.com/
- Equal Opportunities International http://www.emeraldinsight.com/info/products_services/AtoZList.jsp
- Executive Development http://www.blackwell-synergy.com/search/advanced
- Journal of Management http://jom.sagepub.com/
- Psychology of Women Quarterly http://www.blackwell-synergy.com/search/advanced
- Studies on Women and Gender abstracts http://www.tandf.co.uk/journals/titles/1467596x.asp
- The Sociological Review http://www.blackwell-synergy.com/search/advanced
- UK Resource Centre for Women in Science, Engineering and technology http://www2.shu.ac.uk/nrc/section_2/2.3.cfm
- Women in Management Review http://www.emeraldinsight.com/info/products_services/AtoZList.jsp
- Women's Studies International Forum http://search.ebscohost.com/

9. Gray literature searching

As described above the filter was developed primarily using and was subsequently applied to a range of academically oriented databases. The filter also had limited success in finding relevant studies and material in the wider grey literature. Gray literature is generally considered to be any documentary material that is not commercially published and can consist of technical reports, working papers, business documents, conference proceedings, etc. Limited indexing, lack of editorial control and consequent uncertainty in regard to authenticity and reliability of material in this realm add additional challenges when searching 'Gray' sources and assessing retrieved material.

Sources of such material include general and technically oriented internet search engines and databases maintained by primarily commercial or governmental organisations. The first following listing of sources provided either directly applicable or otherwise helpful material, while the second listing of sites did not but may be useful to other researchers. The applicable material returned from searching these sources was as could be expected much more sparse than for the academically oriented sources discussed earlier.

9.1.1 Databases providing useful material

- British Library http://www.bl.uk/
- Google www.google.com
- National Technical Information Service http://www.ntis.gov/search/
- Yahoo www.yahoo.com

9.1.2 Databases not providing useful material

(Listed as they are generally useful databases that either didn't produce any relevant material and in some cases also didn't accept the filter without major modifications)

- Ask.com www.ask.com
- CiteSeer: Scientific Literature Digital Library http://citeseer.ist.psu.edu/
- GrayLIT Network http://graylit.osti.gov/
- Search Adobe PDF Online http://searchpdf.adobe.com/
- The Virtual Technical Reports Centre http://www.lib.umd.edu/ENGIN/TechReports/Virtual-TechReports.html
- Vivisimo http://vivisimo.com/

10. When to stop searching

Repetition of material retrieval is one indicator that a search is reaching its end point. Fall off in performance of a filter in either lack of returned hits or lack of relevant hits can indicate that the search is straying beyond

the bounds of relevance. Individual database search listings provided in order of 'relevance', if applicable, can be used to halt examination of search listings at a point where further examination is unfruitful. While each of these factors need to be judged on a case-by-case basis, in most instances in the author's experience, this was fairly clearly self-evident.

Generally the assessment of relevance is carried out by a brief examination of an items abstract for the purposes of the search. For the assessment of relevance and determination that a study is applicable for inclusion into a systematic review a detailed examination of each study is required. Using this combination of assessment approximately 40% of extracted studies based on an assessment of the abstract only fulfilled the full requirements to be included in the study.

11. Conclusion

In addition to the increasing volume and comprehensiveness of content within bibliographic databases and other electronic sources, access to them is becoming easier, faster and less expensive. The casual observer may then believe that the goal of the researcher wanting to substantially identify relevant literature has been drawn closer. Without a range of up-to-date skills and tools for this task however such a goal may in practice be more distant.

The expanding use of and requirement for systematic identification of relevant literature requires increasingly sophisticated tools and research skills. As databases expand in volume and search capabilities these skills will continue to expand. The complexity, structure and method of application of search filters, now in its infancy, needs to continue to develop along with these skills.

The usage of these tools and skills is becoming increasingly important not only for systematic reviewers but for any researcher embarking on or progressing a project needing to efficiently and accurately identify the depth and breadth of knowledge in their chosen area.

References

Arms, W.Y., Aya, S., Dmitriev, P., Kot, B., Mitchell, R. and Walle, L. (2006) "A research library based on the historical collections of the internet archive", *D-LibMagazine*, vol. 12, no. 2, Feb.

Bachmann, L.M., Coray, R., Estermann, P. and ter Riet, G. (2002) "Identifying Diagnostic Studies in MEDLINE: Reducing the Number Needed to Read", *Journal of the American MedicalInformatics Association* ;9: 653-658

Bradshaw, J.R. (2005) *Methodologies for socially useful systematic reviews in social policy*, Economic and Social Research Council Research report, Swindon, UK.

Crawford, J. (2006), "The use of electronic services and information literacy: a Glasgow Caledonian University study", *Journal of Librarianship and Information Science*, vol. 38, no. 1, pp. 33-44.

Creaser, C., Hamblin, Y. and Davies, J.E. (2006) "An assessment of potential efficiency gains through online content use" *Program: electronic library and information systems*. Vol.40, Iss. 2

Grayson, L., and Gomersall, A. (2003) "A difficult business: finding the evidence for social science reviews", London; ESRC UK Centre for Evidence Based Policy and Practice, [online], http://evidencenetwork.org/cgi-win/enet.exe/biblioview?1258

Han, J.M. and Kamber, M. (2001) *Data Mining: Concepts and Techniques*, Morgan Kaufmann Publishers, San Francisco, CA

Haynes, R.B., Kastner, M. and Wilczynski, N.L. (2005) "Developing optimal search strategies for detecting clinically sound and relevant causation studies in EMBASE", *BMC Medical Informatics and Decision Making*, 5:8 doi:10.1186/1472-6947-5-8

Jadad-Bechara, A.R. (1994) *Meta-Analysis of Randomized Clinical Trials in Pain relief*, Balliol College, University of Oxford, Oxford, 1994.

Jenkins, M. (2004) "Evaluation of methodological search filters – a review", *Health Information and Libraries Journal,* vol. 21, no. 3, p. 148 September 2004

Kennedy, L.; Cole, C. and Carter, S. (1999) "The false focus in online searching: the particular case of undergraduates seeking information for course assignments in the humanities and social sciences", *Reference and User Services Quarterly*, vol. 38, no. 3, pp. 267-73

Lewandowski, D. and Mayr, P. (2006), *Exploring the Academic Invisible Web*, Dr. Dirk Lewandowski – Publikationen, Durch Denken, viewed 28 Jan 2007 [online], http://www.durchdenken.de/lewandowski/doc/LHT_Preprint.pdf

Matthews, E.J., Edwards, A.G.K., Barker, J., Bloor, M., Covey, J., Hood, K., Pill, R., Russell, I., Stott, N. and Wilkinson, C. (1999) "Efficient literature searching in diffuse topics: lessons from a systematic review of research on communicating risk to patients in primary care", *Health Libraries Review* , vol. 16 no. 2, pp. 112-120.

Morley, S., Eccleston, C. and Williams, A. (1999). "Systematic review and meta-analysis of randomized controlled trials of cognitive behaviour therapy and behaviour therapy for chronic pain in adults, excluding headache", *Pain*, vol. 80, pp. 1-13.

Murray, E. (2002) "Challenges in educational research", *Medical Education*, vol. 36, no. 2, pp. 110-2.

Needham, G. (2000) *Research and practice: making a difference*, in Gomm R. (ed.) Using evidence in health and social care, London: Sage,

Neufeld, L.M. and Cornog; M. (1986) “Database history: From dinosaurs to compact discs”, *Journal of the American Society for Information Science*, vol. 37, no. 4, pp. 179-278.

NHSCRD, *Undertaking Systematic Reviews of Research on Effectiveness*: CDR Guidelines for Those Carrying Out or Commissioning Reviews, 4, York, 1996.

Petticrew, M. and Roberts, H. (2006) *Systematic Reviews in the Social Sciences: a practical guide*, Blackwell, Oxford.

Popay, J., Roberts, H., Sowden, A., Petticrew, M., Arai, L., Roen, K.. and Rodgers, M. (2004) *Guidance on the conduct of narrative synthesis in systematic reviews*. Draft report from ESRC Methods Programme. Lancaster: Institute for Health Research, University of Lancaster.

Robinson, M.L. and Wusteman, J. (2007) “Putting Google Scholar to the test: a preliminary study” *Program: electronic library and information systems*; Volume: 41 Issue: 1

Russell, J.M. (2001) “Scientific Communication at the Beginning of the Twenty-First Century”. *International Social Science Journal* (NWISSJ) 53 (168), 271-282.

Stroup, D.F., Berlin, J.A., Morton, S.C., et al. (2000) “Meta-analysis of observational studies in epidemiology. A proposal for reporting”. *JAMA*, vol. 283, pp. 2008-2012.

Taylor, B.J.; Dempster, M. and Donnelly, M. (2003) “Hidden gems: systematically searching electronic databases for publications for social work and social care”, *British Journal of Social Work*, vol. 33, no. 4, pp. 423-39.

Vaughan, L. (2004), “New measurements for search engine evaluation proposed and tested”, *Information Processing and Management*, Vol. 40 No. 4, pp. 677-91.

