

Searching the Chemical Literature: a Brief Guide to a Comprehensive Literature Review (with particular reference to analytical chemistry)

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Summary

A literature review yields good knowledge of prior work on a topic and is essential to efficient working and publication of current work in a fair and transparent manner. There have been many advances in access to the literature in recent years and it appeared timely to the authors to offer some up-to-date guidance. Thus, a brief systematic four-stage process is outlined in order to produce a comprehensive, transparent and accurate review of all relevant earlier work prior to any discussion of claims of originality of concepts or of applications in publications of recent research findings.

Introduction

For researchers, a good knowledge of prior work in one's field is essential to efficient working and publication of current work in a fair and transparent manner. There have been many advances in access to the literature in recent years and it appeared timely to the authors to offer some up to date guidance.

A systematic four-stage process is outlined to find and obtain the materials in order to construct a comprehensive, transparent and accurate review of all relevant earlier work prior to the discussion of the originality of concepts or applications in reports for publication of recent research findings with particular reference to analytical chemistry. The recent publication by Currano and Roth¹ gives advice with regard to chemists in general including patent, structure, physical properties, commercial availability, safety and hazards, reactions, sequence similarity searches. However no advice is given in Currano and Roth to deal with material published pre *Chemical Abstracts*.

Guidance

Access to the major scientific literature databases in academic and other large institutions is by paid subscription. However there are open access alternatives that increasingly merit attention even when the former are also available. All of the sources mentioned below may be found by entering the italicised terms in any of the major internet search engines.

- a **The first action** is to search *SciFinder*², by topic and by authors known to have worked on the subject of interest, thus covering most of the literature from 1907 to date.

Since not every journal with material of interest to chemists is included in the *SciFinder* database, and also due to human errors in the era of manual data inputs, a few papers from journals that are normally fully abstracted have been found to be missing so it is advisable to search additional databases. For analytical chemistry, *Analytical Abstracts* provides a good cover of the literature from 1954 to date³. Assistance for those with specific interests in analytical methods for foods may be found in the *Food Science Technology Abstracts*⁴.

If one's interest is in a specific chemical compound, *Beilstein* (organic)⁵ and *Gmelin* (inorganic)⁶ are also very appropriate compilations to search in addition to *SciFinder*.

The *Science Citation Index*⁷ and *Scopus*⁸ databases are useful as "insurance" for completion of retrieval of publications and also to access materials cited by an author of interest noted in earlier searches, to assist completion of a current search by addition of material previously regarded as relevant to the topic.

- b **The second action** is to expand the literature survey time frame to include 19th century material. This, in practice, can be difficult because authors often published multiple versions and translations of the same paper in different journals. The best tool for identifying these variants is the Royal Society of London's *Catalogue of Scientific Papers*⁹. This catalogue covers scholarly papers for all sciences except medicine and surgery. They are listed by author and this is helpful in locating a large part of the chemical literature pre-1907. Separate subject indexes were planned but unfortunately that for chemistry was not produced.

*Chemisches Zentralblatt*¹⁰ and *Poggendorf*¹¹ are, in addition, important resources for finding historical chemical and related publications, although for non-German readers they are challenging to use.

Prior to the establishment of formal indexing services, some of the major journals¹² regularly published abstracts of papers selected to be of interest to their readers, these are often of use when making assessments of the contemporary impact of innovations close in time to their initial publication.

- c **The third action**, if considered essential, is to complete the literature review back in time to include the alchemical and pre-scientific periods of chemistry. Sources for this activity are the specialised bibliographies by Bolton¹³, Ferguson¹⁴ and Cole¹⁵.
- d **The fourth action** is to obtain copies of articles identified by the various searches. Once an article of significance has been identified, search your library catalogue

and/or the *WORLDCAT* database for holdings of the journal or periodical. Much of the early content exists only in printed form, although retrospective digitisation is ongoing in both the open access and the publisher-subscription spheres. In many cases hot-links in a *SciFinder* search will lead directly to content in journals to which the library subscribes. *JSTOR*¹⁶ has substantial back-files of digitised historical and modern journal contents and may avoid the need/cost for inter-library loans. In addition *Scopus*, *Google* and individual journal web-sites can, on occasions, provide free access to papers.

The access to a free copy on the internet does not mean that the copy is legal for all purposes. For academics, as their work is non-commercial, this is rarely an issue. For chemists in the commercial sphere this may be relevant for copies other than those from publishers' websites.

Copies of papers from journals for which a subscription has not been taken out can always be obtained by means of a payment per paper, facile now with electronic payment, and provides almost instant access to the material.

Open Access

Not all researchers have access to major University library facilities and yet will need to survey the prior literature. Some, in large private sector institutions will have access to the facilities mentioned above and perhaps a more limited range of journal subscriptions. Useful web sites include *Google Scholar* (covers a wide field of material, is intuitive to search, results can be saved, and search results include articles that cite the material as well as links to articles available by open access). Other useful sources include *Pubmed* (material from *Medline*), *Pubchem* (database of chemical molecules and their bioactivity) and *ScienceResearch.com*.

Open access to individual articles in peer reviewed journals is increasingly common and JAPA online is a valuable example of this. Membership of the Royal Society of Chemistry confers access to a number of journals many of which are of interest to the analytical chemist.

Some have found membership (free) of *ResearchGate*, a social networking site for scientists and researchers, to be of advantage in obtaining access to the published literature and to receive alerts of newly published material in their field. Finally, the time honoured method of approaching the corresponding author of a paper for a personal copy is seldom refused.

Conclusions

Searching the literature is a valuable asset to problem solving and essential if current work is to be efficiently carried out and published. There are increasing electronic avenues for literature searching and herein the main, including open access, means have been briefly

summarised. For those who need to review the earlier, pre-electronic literature guidance has also been summarised.

Acknowledgements

Helpful discussions with Tony Holmes and Chris Torerro are gratefully acknowledged.

References and Notes

- 1 JN Currano and DL Roth, "Chemical Information for Chemists", RSC Publishing, Cambridge, (2013)
- 2 SciFinder is the successor database to Chemical Abstracts (CAS) and contains the full contents of the latter back to 1907 when CAS began publication. It is available via subscribing University libraries to members of staff and registered students. The pre-1967 indexing is not as thorough as post-1967. In general the older the record the more minimal is the metadata. CAS has retrospectively indexed a number of pre-1907 journals including JACS, J Phys Chem, Chemical Society journal archives (now the RSC) 1841-forward including J Chem Soc Abstracts 1871-1925, US patent records from 1808-1906 and machine-translated records from Chemisches Zentralblatt 1897-1906¹⁰.
- 3 *Analytical Abstracts* is a focussed in scope database which commenced monthly publication in 1954 and from 1980 became available on-line via subscribing libraries. Articles are selected from over 100 source journals, covering not only analytical chemistry but also food and environmental chemistry. The classification is by analyte, matrix and measurement concept. The forerunner to *Analytical Abstracts* which started in 1944 was *British Abstracts, C: Analysis and Apparatus*. There will be a lot of duplication with a *SciFinder* search but a few papers appear in only one of the two data bases.
- 4 The *Food Science Technology Abstracts* is a database that includes analytical methods from 1969-forward.
- 5 The Beilstein database owes its origin to the basic and supplementary series of the multi-volume *Beilsteins Handbuch der Organischen Chemie* first produced by Friedrich Konrad Beilstein in 1881, covering the literature of organic chemistry fairly comprehensively from 1779. The indexing is by chemical structure and reactions. An on-line version has appeared under numerous names; the current version is owned by Elsevier and available by subscription via "Reaxys" and can be searched by author.
- 6 The Gmelin database which follows on from the various editions of the multi-volume *Gmelins Handbuch der Anorganischen Chemie* first produced by Leopold

Gmelin in 1817; it contains data and information on inorganic and organometallic compounds going back to 1772. The print version ceased in 1997, prior to 1982 the volumes are in German. The content is arranged by chemical element and compound, there is no print author index. The electronic version, available via subscription to the Elsevier platform “Reaxys”, allows bibliographic searching of the *pre-1967* volumes.

- 7 *Science Citation Index* (SCI), created by Eugene Garfield in 1964, indexes articles and books from all time periods that have been cited by other authors, listed under the original author’s name. Initially in hard copy, it is now available on-line via the *Web of Science* (WOS), a subscription-based platform owned by Thomson Reuters, with a multidisciplinary cover of over 50,000 books, 12,000 journals and 160,000 conference proceedings. Conducting a CSI search allows verification of papers, books and patents from 1900-date, however the title abbreviations retrieved may require updating to conform to current formats.
- 8 *Scopus* is a bibliographic database containing abstracts and citations for academic journal articles. It covers nearly 22,000 journals in the scientific, technical, medical and social sciences and it has a more in-depth coverage than WOS from 1966. Owned by Elsevier, available on-line via subscribing libraries.
- 9 The Royal Society, *Catalogue of Scientific Papers*, vol 1-6 (First Series) 1800-1863; vol 7-8 (Second Series) 1864-1873; vol 9-11 (Third Series) 1874-1883; vol 12 Supplementary volume 1800-1883; vol 13-19 (Fourth Series) 1884-1900. Vol 13-19 have imprint Cambridge University Press.
- 10 *Chemisches Zentralblatt* is the first and oldest abstracting journal in the field of chemistry with content comparable to that in CAS. It was founded by Gustav Theodor Fechner in 1830 as *Pharmaceutisches Central-Blatt*, later, from 1850-1855 as *Chemisch-Pharmazeutisch Zentralblatt* and from 1856 as *Chemishes Zentralblatt*. It ceased publication in 1969, but has since been digitized by FIZ CHEMIE Berlin, converting 40 meters of bound volume, weighing about 3 tons into 2 terabytes of data, available via Wiley-VCH. The coverage of German chemistry until World War II is regarded as superior to that of CAS.
- 11 JC Poggendorff, *Biographisch-Literarisches Handwörterbuch zur Geschichte der Exakten Wissenschaften*, Volumes 1-VII, JA Barth, Leipzig, (1863-1967). Material arranged alphabetically by author, biographical data and lists of journal publications updated, volume to volume, as needed. Volume VIIb in 9 parts covers 1932-1962.
- 12 These include:
Annalen der Chemie, 1832-1860
Annales de chimie et de physique, 1789-1870
Bulletin de la Société Chimique de France, 1857-forward

Chemical News, 1859-1932

Chemische Berichte, 1880-1896

Journal für Praktische Chemie, 1834-1873

Journal of Physical Chemistry, 1896-1906

Journal of the American Chemical Society, 1879-1890

Journal of the Society of Chemical Industry, 1882-1925

The Analyst, 1884-1953

- 13 HC Bolton, *A Select Bibliography of Chemistry 1492-1892*, Smithsonian Institution, Washington, (1893), Kraus Reprint, New York, (1966). *First Supplement 1492-1897*, (1899). *Second Supplement 1492-1802*, (1904), Kraus, (1967). In sections: bibliography; dictionaries; history; biography; chemistry, pure and applied; alchemy; periodicals. The bulk of the content is in the sections on pure and applied chemistry; papers are listed by author but can be searched by subject index. This gives access to some very detailed bibliographies e.g on ozone, nitrogen estimation, adulteration of cereals, electrolysis, beeswax, honey etc.
- 14 J Ferguson, *Bibliotheca Chemica*, J Maclehose and Sons, Glasgow, (1906), reprinted D Verchoyle, London, (1954). Deals with the alchemical and the period up to late 18th Century. Contents by person name, alphabetically, with main publication, and in some cases more publications and brief biographies.
- 15 WA Cole, *Chemical Literature 1700-1860, a Bibliography with Annotations, Detailed Descriptions, Comparisons and Locations*, Mansell, London, (1988). Follows on from the material in Ferguson, similar in arrangement by author and with very complete descriptions of books.
- 16 *JSTOR* is a digital library founded in 1995. Originally it contained back issues of journals but now it contains books and current issues of almost 2000 journals from more than 50 disciplines. Access is normally via subscription but some early material is now free to the public.

Reviewing the literature is the first step in implementing EBP and identifying practice. Barriers to the implementation of best practice in the clinical setting. Lack of research experience Unsure about how to locate research Unfamiliar with the critical appraisal process. Unsure of the process to apply research to practice. Purpose of a review. Wildcard characters -Can extend a search to multiple words with the same root by adding the database's wildcard character to a truncated word Different databases / software packages use different wildcards, such as * or \$ Example: nurs* would search for nurse, nurses, nursing. Chemists of all types need to be able to identify with certainty the substances they have made, extracted from a source, or sampled in some manner. In some cases, the species they are testing exist for very short periods of time as intermediates in chemical reactions. Whether they are trying to determine the sequences and structure of biomolecules with molecular weights in the hundreds of thousands or attempting to detect minute quantities of a small molecule that is present as a few parts per billion Abstracts (millions) Chemical Literature Why a course in chemical literature? huge: Chemical Abstracts: indexes 10,000 journals currently 50,000 journals since 1907 > 39 million abstracts > 89 million. peer reviewed not magazines Conference Proceedings lectures presented at conferences in book form usually reviewed by a single editor Dissertations (Ph D), Theses (Masters), Grant Reports not as easy to find Secondary Treatises multi-volume on a single subject; comprehensive detailed bibliography over a long period Multigraphs and Monographs multiple or single authored book on one topic usually smaller. Reviewing the Literature: A Short Guide for Research Students. In brief: Reviews of previous literature in a thesis or research paper are not summaries of every article you have read, but rather an exposition of the existing knowledge and reasoning which led you to believe that what you did was worth doing in the way that you did it, written so as to convince the reader of these things. Writing about the literature is not just part of "what you have to do", it is a valuable way to learn the literature, to get it off the page and into your head. And that is essential if you are to be able to