BEME Guide No 3: Systematic searching for evidence in medical education

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Summary

Searching for evidence to inform best practice in medical education is a complex undertaking. With very few information sources dedicated to medical education itself, one is forced to consult a wide range of often enormous sources – and these are dedicated to either medicine or education, making a medical education search all the more challenging.

This guide provides a comprehensive overview of relevant information sources and methods (including bibliographic databases, grey literature, hand searching and the Internet) and describes when they should be consulted. The process of constructing a search is explained: identifying and combining core concepts, using Boolean algebra and search syntax, limiting results sets, and making best use of databases' controlled vocabularies. This process is illustrated with images from search screens and is followed by numerous examples designed to reinforce skills and concepts covered. The guide has been developed from the ongoing experience gained from the systematic searches conducted for the Best Evidence Medical Education Collaboration, and concludes by looking ahead to initiatives that will shape future searching for medical education evidence.

Introduction

"Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it." Dr Samuel Johnson, Boswell, Life of Johnson, 18th April, 1775.

Like other teachers, trainers and researchers, medical education professionals are increasingly expected to base their practice upon best evidence - yet this evidence is located in a bewildering number of diverse and incompatible sources. Those who set out to search for evidence are frequently not convinced that they have been looking in the best sources, much less that they have found the most relevant and useful papers. The explosion of information over the last decade has produced an enormous challenge for those seeking to navigate the evidence base quickly and effectively – but it has also produced enormous opportunities for those who do learn how to search effectively.

Evidence to support best practice is found in many formats and sources. *Database*s are nearly always the most abundant resource, so this guide concentrates on this medium. However, this guide also covers accessing the *grey literature*, searching subject gateways and the web at large, as well as other search methods and sources to ensure that a search is as comprehensive and cohesive as required.

There are many reasons to consult the evidence base: to answer a specific question, to identify experts to consult or work with, to determine what evidence already exists before starting research, or to keep current with what is being practised. Recent developments in medical education, such as the focus on student centred learning and the increasing attention given to research and scientific method (General Medical Council, 2003), have increased the importance of empowering the individual to find the evidence they require by themselves.

Individual queries range from simple to complex. This guide covers the wide range of skills and sources required to answer simple individual questions quickly and appropriately, but its larger aim is to provide guidance for systematic and comprehensive retrievals of evidence. The Best Evidence Medical Education (BEME) Collaboration (BEME Collaboration, 2003) is an international group producing systematic reviews for medical education. It is through the experience gained by

BEME's efforts that this guide has been produced to help the researcher overcome the challenges that are faced when searching for evidence in medical education.

The Challenges

"It is a very sad thing that nowadays there is so little useless information." Oscar Wilde (1854 - 1900)

The foremost challenge in searching for evidence in medical education is that there are very few comprehensive sources dedicated to the profession. For most queries, *bibliographic database*s are the medium likely to contain the majority of evidence, yet there is no indexed database for medical education. Whilst keyword databases do exist, these lack the relational *subject heading*s that enable accurate and consistent searching. Instead, one must turn to either medical (e.g. Medline) or educational (e.g. ERIC) databases – neither of which adequately collects or indexes medical education content.

*Database*s index publications with descriptors (or *subject heading*s) that describe the concepts central to each of the individual documents. Often *bibliographic database*s are focused on either medicine or education, they are frequently inadequate for retrieving citations in medical education; even when adequate subject headings for medical education do exist they are incorrectly and/or incompletely used because these databases' emphasis is (understandably) focused on meeting their own objectives – namely describing medicine or education.

A BEME Case Study

"It is in fact nothing short of a miracle that the modern methods of instruction have not yet entirely strangled the holy curious of inquiry. It is a very grave mistake to think that the enjoyment of seeing and searching can be promoted by means of coercion and a sense of duty." Albert Einstein (1879 - 1955)

The BEME Group FEENASS (<u>fee</u>dback <u>in ass</u>essment), which is researching the use of feedback in medical education, provides an interesting illustration of the challenges in retrieving medical education information. Searches designed to *scope* their topic, "feedback in assessment", were conducted in spring 2001 to determine the extent of the evidence available across the major *database*s. These were measured for search *sensitivity* and *specificity*.

Sensitivity (or *recall*) measures what percentage of the total number of known citations on a topic was actually retrieved by the electronic search (the total, or gold standard, is determined by *hand searching* the journals). Sensitivity ranged from 6.5 to 19.6%, depending on the database. This means that even in the database with the highest sensitivity, four-fifths of relevant citations were not appearing. As atrocious as these results are, those experienced in medical education searching will hardly find them extraordinary.

Specificity (or *precision*) measures what percentage of the search results was actually relevant to the query (i.e. the positive predictive value). For the FEENASS group specificity across the databases came in at 17.5%, about average for BEME pilot groups which ranged from 6 to 34% (Haig, 2001). Clearly, all groups were finding that most results were irrelevant, but the negative impact for the BEME pilot

groups' time and other resources was exacerbated, given that they had to look at the collective results of many databases – often totalling over 10,000 results.
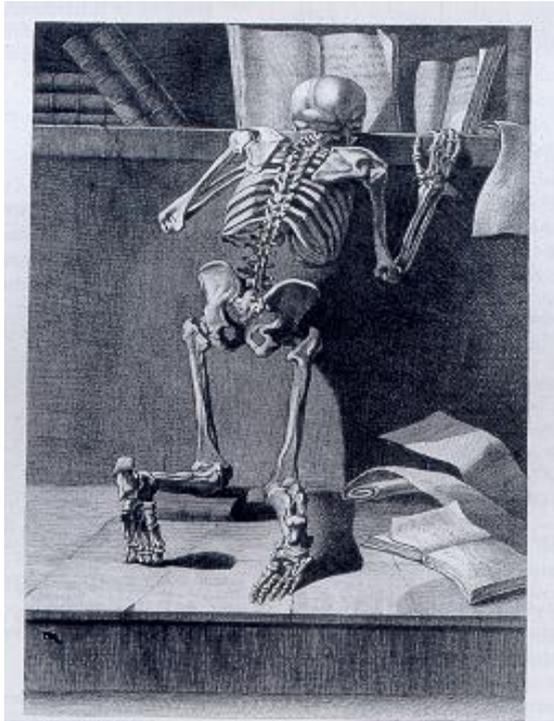

Figure 1: One possible obstacle to systematic searching in medical education: mortality. *Jacques Gamelin (1738-1803) Nouveau recueil d'osteologie et de myologie. Toulouse, 1779.*

It is trying enough for an individual conducting a quick search to find their best strategy still produces a majority of false *hit*s, but for a systematic search that nets thousands of results the experience can be frustrating and forbidding.

Search strategies can be written to improve *specificity*, but not without sacrificing *sensitivity*. A systematic review group cannot afford to miss results, and with the growing emphasis on evidence based practice, other groups and individuals are becoming less able to do so. Before we examine how to improve search skills to reduce these difficulties, it is important to understand how they arise.

The failings of *subject heading*s examined

A closer look at how the world's largest medical *database*, Medline, indexes the concept of feedback clearly illustrates the problems with searching *subject heading*s. The FEENASS Group's concept of feedback is common with that of the medical education profession. When searched as a subject in Medline, feedback maps to these different subject headings: *feedback*; *feedback, biochemical*; and *feedback, psychological*. The *scope* notes define them as follows:

Feedback: A mechanism of communication within a system in that the input signal generates an output response which returns to influence the continued activity or productivity of that system.

Feedback, Biochemical: A mechanism of communication among life processes to co-ordinate development, reproduction, and homeostasis. In humans, feedback loops

are especially important for communication between organs that are spatially separated. Virtually all hormones from the nervous and endocrine systems are under feedback control: by peripheral hormones, cations, metabolites, osmolarity or extracellular fluid volume.

Feedback, Psychological: A mechanism of information stimulus and response that may control subsequent behaviour, cognition, perception, or performance. (From APA *Thesaurus* of Psychological Index Terms, 8th Ed.) (National Library of Medicine, 2003).

Feedback, Biochemical is obviously not relevant as it is used to index records concerning physiology, metabolism, immunology etc. Of the other two possibilities, *Feedback* would appear to relate to mechanical systems and processes, while *Feedback, Psychological* to the learning. However, when *Feedback* is combined with the subject heading *Education, Medical* it finds 367 results while *Feedback, Psychological* locates only four (Ovid Technologies: http://gateway.ovid.com).

Unfortunately Medline's most suitable descriptor, *Knowledge of Results (Psychology)* does not appear when feedback is mapped to the *subject heading*s:

"A principle that learning is facilitated when the learner receives immediate evaluation of learning performance. The concept also hypothesises that learning is facilitated when the learner is promptly informed whether a response is correct, and, if incorrect, of the direction of error."

Despite the suitability of this term, there are only seven citations found when it is searched with *education, medical*. The problems encountered can therefore be described as a mixture of failure of the system to map to the most appropriate term, lexical ambiguity (or overlap) between possible subject headings, and *indexing* with the least appropriate of possible subject headings.

The situation is made more problematic by the fact that the concept of feedback is often not indexed at all. If feedback is searched as a *free-text* word and combined with the *subject heading* Education, Medical (with duplicates using the feedback subject headings removed) over 700 citations are found. The vast majority of these results are relevant to the topic to varying degrees – but often match the topic as well as, or better than, those documents that have been indexed with *feedback* descriptors.

Conclusions from the case study

The problems illustrated by the feedback example are representative of the challenges facing searching for medical education evidence in general. Searches have low *sensitivity* (i.e. many relevant citations are missed) and low *specificity* (i.e. many results that are returned are irrelevant). Nobody embarks upon a search wants to miss key results (least of all for a systematic search), nor does anyone wish to drown in a sea of irrelevant results. It is the purpose of this guide to describe how to improve sensitivity while not compromising specificity.

Covering Multiple Databases

"What information consumes is rather obvious: it consumes the attention of its recipients. Hence, a wealth of information creates a poverty of attention and a need to allocate that attention efficiently among the overabundance of information sources that might consume it." Herbert Simon, Economist

It has been well documented that medical searches must cover multiple *database*s if they are not to risk missing substantial amounts of significant evidence (Avenell et al, 2001; Minozzi et al, 2000; Brettle et al, 1998). In the case of medical education, consulting multiple sources is even more important - for a number of reasons.

As mentioned above, the evidence is not contained in sources dedicated to medical education itself and therefore medical, educational and other specialist sources need to be identified. It is critical that search strategies for each source need to be tailored to the databases' individual specifications.

Researchers will discover that database coverage is patchy. Medline, the world's largest medical database, indexes less than a quarter of existing medical journals. While no similar measure has been taken for medical education, it is reasonable to assume that the figure would be similar, if not worse. For example, neither Education for Primary Care nor Education for Health is indexed in Medline; however, both are indexed in Embase.

In addition, *indexing* is also incomplete. Medline and Embase both index the journals Medical Teacher and Medical Education, but until recently both journals were partially indexed with only selected articles appearing in the databases. Although both journals are now fully indexed, past evidence from these key journals will be missed unless they are retrospectively indexed.

Finally, as the feedback in assessment example proved, even when journals are fully indexed the *subject heading*s often fail to capture the subject requirements of medical education, therefore every effort must be made to perfect search techniques to overcome these problems.

There is an overlap between and within medical, educational and other databases, however despite the potential issue of duplication these problems make it far more advantageous to search all possible relevant sources (duplicates can be eliminated in seconds by bibliographic software anyway).

Review of Information Sources

"Lord Ronald said nothing; he flung himself from the room, flung himself upon his horse and rode madly off in all directions." Stephen Leacock (1869 - 1944), "Nonsense Novels", 1911.

The number of potential sources relevant to a search in medical education is vast and confusing. There exists however a principle core of databases that should be consulted for any comprehensive search, as they are almost certain to contain essential evidence; secondary databases should be employed according to the nature of the search topic, and the time and other resources allocated to the search.

Core Bibliographic Databases

Medline: The National Library of Medicine in Maryland, USA produces Medline (Index Medicus). It contains over 73,000 citations indexed as medical education and over 300,000 additional citations that are considered educationally relevant. It is available through commercial vendors and freely available through numerous websites, notably PubMed.

Embase: This is the second largest medical database and is owned by Elsevier Science, Netherlands. Access is by subscription only. Embase contains over 43,000 citations indexed as medical education and more than 100,000 that are related to education in a health environment. Embase tends to index more European journals, while Medline is more focused on North American research. The database has very strong pharmaceutical coverage and indexes several key titles in medical education not covered elsewhere.

CINAHL: The Cumulative Index to Nursing and Allied Health Literature is the world's largest database for nursing and the professions allied to medicine. Although there are less than 1,500 citations indexed as medical education there are over 100,000 educationally relevant ones that could inform a medical education query. Access is by subscription.

ERIC: The Education Resource Information Centre is the world's largest education database (1,000,000 + records) and is freely available on the web or by subscription. Although the emphasis is on primary and secondary education, there are over 17,000 citations related to medical education. Many more will be relevant in a supporting context, providing evidence in education that could be applied to medical education (e.g. use of multiple choice questions).

BEI: As it has a British focus, The British Education Index is much smaller than ERIC but like its larger American counterpart contains citations that are directly or indirectly relevant to answering queries in medical education. Access is by subscription, but partial free access is available on the web.

PsycINFO: While PsycINFO obviously concentrates on psychiatric and psychological content, there are over 4,000 records indexed as medical education with well over 100,000 concerning education in a broader context, as well as teaching and learning. Access is by subscription.

Note on database access: Most databases are accessed by subscription, with organisations or individuals paying to access the raw data through search software vendors such as Ovid, Dialog, or SilverPlatter. Several key ones (notably Medline and ERIC) are freely available on the web. Paid subscription access, with the possible exception of PubMed, does provide more rigorous and comprehensive searching.

Additional Databases

Additional databases should be consulted when one needs to be as comprehensive as possible (such as for a systematic review), or when the database compliments the search by the nature of the subjects it indexes.

Additional Keyword Databases

There are two keyword databases that collect references in medical education, and both are freely available on the web, and although they lack a professional *indexing* system specific to medical education instead relying on users attempting to match their search terms with keyword lists, this does compromise accuracy. These databases contain thousands of records not found elsewhere and so they cannot be ignored.

Research and Development Resource Base (RDRB) www.cme.utoronto.ca/rdrb

RDRB collects information to assist study of physician performance, programme evaluation, change, and health care outcomes. It collates literature from a broad range of continuing education topics from databases such as Medline, Embase, ERIC and CINAHL. It also contains conference abstracts from sources such as the Society for Academic Continuing Medical Education and the Alliance for Continuing Medical Education. The database is hosted at the University of Toronto.

Topics in Medical Education (TIMELIT) www.timelit.org

TIMELIT contains nearly 50,000 records of direct relevance to medical education covering a broad range of subjects. The database combines references extracted from the major databases with specially selected citations from a comprehensive range of sources. TIMELIT's strength is these latter citations – many of which are not to be easily found by any other means. The database is hosted at the University of Dundee.

Additional Indexed Databases

The following databases will not necessarily be relevant to every search but should be considered for most searches. Medical education evidence is widely dispersed, so this is not an exhaustive list, as less typical searches will require the researcher to consult additional sources. In these instances consulting an information professional is advisable in these cases.

AMED (Allied and Complementary Medicine Database)

The researcher should consider AMED for educational searches in complementary medicine, palliative care and the professions allied to medicine (including podiatry, physiotherapy, occupational therapy, and rehabilitation).

ASSIA (Applied Social Sciences Index and Abstracts)

ASSIA is a social science database of more than 650 English language titles. Although not directly relevant to many medical education searches it does index relevant sociological content not found elsewhere.

BNI (British Nursing Index)

The British Nursing Index is much smaller than CINAHL, but does contain educational material (obviously largely British) not found in CINAHL and the other large databases. An essential source for comprehensive searches in nursing and the professions allied to medicine.

EBM Databases – Cochrane databases, ACP Journal Club and DARE

The various evidence based medicine databases contain full reviews, appraisal of reviews, protocols for research, trials, and commentary. Educational material forms a small but growing proportion of this evidence, though much of this is already contained within Medline which permits more robust searching (use of *controlled vocabulary* and *subheading*s). Though the EBM databases frequently provide no unique content to an educational search they occasionally can provide invaluable material – particularly in the form of commentary/appraisal of research, contacts, and bibliographies (often containing *grey literature – see below*).

HMIC (Health Management Information Consortium)

HMIC is actually the combined files of three separate databases collating health management information. HMIC indexes a surprising amount of medical education material where it meets management. The database is good for *grey literature* and has strong European coverage.

SOCIOFILE

The premier database for sociology, social planning and policy, SOCIOFILE can provide supporting and contextual evidence for medical education searches that have a significant societal dimension.

Other Methods of Searching

SCI (Science Citation Index)

SCI is actually another *database*, but one that utilises a rather different method of searching. SCI indexes abstracts and bibliographic information from nearly 4,000 journals - but its true strength is that it makes possible *cited reference searching* (i.e.. retrieving all citations that reference a particular citation, author, author within a journal, etc.). This cited reference searching, along with SCI's broad interdisciplinary *scope*, reveals relationships between research and disciplines that would otherwise remain undiscovered. Although it is an expensive database (and therefore not always available) and does not permit robust subject searches, SCI should be searched when possible, particularly if your search topic would benefit from evidence across professions.

The ISI Web of Science/Web of Knowledge provides unified access to SCI in addition to the Social Science and Arts and Humanities Index.

Ancestry searching

Ancestry searching is the process of searching the bibliographies of relevant papers to discover references missed by other methods. The Science Citation Index has thankfully reduced this time-consuming task to a few keystrokes for many journals, but there still will be crucial papers not included in the SCI. In these cases bibliographies should be matched with the search results you are compiling.

Hand searching

Hand searching is literally the searching of print (or electronic) journals volume by volume, issue by issue, and article by article. This obviously requires large amounts of time and resources and is an extremely tedious process. However, for a comprehensive search such as is required for a systematic review, hand searching may be necessary.

Medical hand searches have most notably been conducted by the Cochrane Collaboration to identify controlled trials. This work has demonstrated that without hand searches not only large numbers of papers were missed (Hopewell et al, 2000), but specialised non-English journals should be included as well if a search is ever to be comprehensive (Bereczki et al, 2000).

Hand searches conducted by BEME to date suggest a similar situation exists for medical education (Harden et al, 2002; Haig, 2001). While these were subject-based hand searches and not searches for particular study designs, the results

demonstrated hand searches picked up citations not found by *database*s. This was partly due to the inadequate subject *indexing* (mentioned above) by databases, as well as the fact that many crucial medical education titles (notably Medical Education and Medical Teacher) have only recently started to have every article indexed.

Ideally all possibly relevant journals would be hand searched for all queries. However, in practical terms the extent of *hand searching* comes down to the availability of resources (time, labour, funds, and access to the desired journals themselves) to conduct the hand search. Hand searches should be well planned in advance, taking into consideration what resources can be invested, how to integrate results, and which journals to prioritise for searching.

Experts in the Field

Finally, for a search to be truly comprehensive, efforts should be made to contact leading figures with professional experience in the subject. It can be difficult to identify and contact experts, though the *Internet* has made the process much easier. There is no guarantee that experts will have the time or inclination to reply, but can potentially be a very rich source of information that is not easily found by other means.

Grey literature

Grey literature is best defined as:

"That which is produced on all levels of government, academics, business and industry in print and electronic formats, but which is not controlled by commercial publishers." (Fourth International Conference on Grey Literature, 1997)

From this definition it is obvious that a considerable number of publication formats constitute grey literature, including:

Academic papers
Census data
Committee reports
Conference papers
Corporate documents
Discussion papers
Dissertations
Government reports
House journals
Market surveys
Newsletters
Ongoing research
Preprints
Proceedings
Research reports
Standards
Technical reports
Theses
Trade literature
Translations
Working papers

Challenges

The variety of publication types obviously does not make the task of systematic searching any easier. It is essential to remember that "grey" is not a comment on quality, but refers to the medium of (non-commercial) delivery.

Grey literature presents a significant challenge when searching systematically for evidence. While it is a primary source of evidence, it is notoriously difficult to locate, retrieve and manage.

Not only is grey literature diverse in format but it exists in a fluid environment. The large changes that the commercial publishing industry has experienced has also affected grey literature, most significantly the *Internet* and networked personal computers.

The creators of grey literature are often universities, research institutes, industry, or government; because these organisations rarely have the widespread dissemination of information as a primary objective, retrieving the items becomes more challenging. Indeed, grey literature can often be intended for a partially restricted, or even confidential, audience.

Advantages

Grey literature does enjoy many key advantages over commercially produced literature. Most grey literature can be created and distributed comparatively quickly as the process tends to be less structured and formalised. Without lengthy procedural delays, this rapid dissemination allows the evidence to reach the level of practice much more effectively, and grey literature is therefore often a type of evidence that is received and used to inform opinion. While this in itself does not influence systematic searching, it should be noted that grey literature can have strong effect upon policy makers. Grey literature is often excellent for providing context for findings contained in commercial sources. Grey literature can link discoveries and provide insight to the decision-making and the environments in which they occurred. Finally, because this material is frequently in-process, policy-oriented, informal and/or discipline-specific, it is also pivotal for intra-professional communication, since research/scientific policy, protocols, and journalism are nearly always grey.

Grey literature is often valued for being succinct; with very focused content it is often easy to isolate relevant portions of evidence quickly. At the same time the material contained in grey literature is likely to have been thoroughly researched. This is particularly the case with technical reports and government documents; a grey version of a document may contain far more detail than what is made available when the item becomes commercially published.

Another aspect of grey literature that makes its consideration critical is the sheer growth in volume of information contained in grey literature. It has been estimated that the volume of grey literature is currently growing at three to four times the rate of commercially available literature. In 1992 the British Library Document Supply Centre (BLDSC) at Boston Spa held some 3,000,000 items that were considered to be grey literature and these items had been collected over the previous 30 years. However, by 2000 the collection had grown to over 17 million items (Helmer, 2002).

Grey searching can reveal large amounts of evidence not found by traditional searching. One study looked at grey searches across a variety of medical topics and found that 26.1–41.6% of the total evidence base was found by grey searches. A wide variety of types of study design were found, and interestingly one grey search found 33.6% (73) randomised controlled trials – not only the gold standard for most

systematic medical studies, but the type of study design one might assume would be comprehensively covered by conventional means (Helmer, 1999).

Perhaps the most import reason for including grey literature in a systematic search is the impact is has when considered against other types of evidence. A study published (McAuley et al, 2000) found 33% of meta-analyses they examined contained grey literature. In these studies grey literature accounted for between 4.5 and 75% of the total number of studies. Critically, they found that the commercially published studies averaged a 15% larger estimation of effect than the grey literature. Commercially published literature has long been suspected of being more likely to report positive findings, and it is therefore crucial to include grey literature to give a balanced representation.

The *Internet* has had enormous effect on the growth and diversification of grey literature. There are many electronic forms that grey literature appears in, including personal webpages, listservs, *usenet*, *blogs*, digital libraries, and various other types of electronic files. The variety of electronic sources can make identifying and using these sources effectively a time and resource intensive activity, but electronic sources are certainly quicker to access than paper methods.

This diversity of format also occurs in the print form and makes the acquisition, storage and retrieval of grey literature very difficult for libraries. It can be both difficult and costly for libraries to acquire items, given the varying methods by which grey literature is distributed. As a large amount of grey literature is produced by and for conferences it is often necessary to be aware of the event in advance or perhaps even attend it. The distribution of grey literature tends to be limited to a small number of organisations that have been previously identified as being of interest. In terms of the physical storage of grey literature, libraries have difficulty in managing materials that have no standard format or size. Finally, grey literature very often requires original and time consuming *indexing*/cataloguing because the descriptive or bibliographic information required is not available for purchase off the shelf from commercial cataloguing services.

To balance these difficulties, there are a number of factors that have made grey literature more attractive to researchers and practitioners, than commercially published literature. The cost of commercially published literature has been increasing at a much higher rate than inflation for many years; with some individual publishers becoming increasingly dominant through mergers and take-overs within the industry. It has also been argued that publishers have been reticent in adopting new technologies. Grey literature, by contrast, has readily adapted to technological change and appeared in new formats and by new means. Such flexibility is certainly a strength in a rapidly developing market.

Ideally there would be a centralised authority that would store and distribute grey literature in medical education. Unfortunately the prospect of such an authority undertaking this role in the near future is unlikely. One organisation, Grey Net, which looked as if could become a generalised central authority by providing network services, hosting conferences and producing an international journal for grey literature, has recently been shut down. The web does compensate for this to some extent as sites have started to collect and supply grey information more comprehensively. To date, however, this process has tended to be very unevenly distributed with Britain and America making some considerable progress while other countries and regions are hardly represented.

As with all types of evidence, grey literature needs to undergo a rigorous evaluation of quality. Organisations produce copious amounts of grey literature with much of it

being of limited utility; the immediate task one faces when utilising grey literature for research purposes is in discovering the signal from the noise. When evaluating grey literature it can be complicated because grey literature is frequently not in a standard format or design, for example, foreign language items may need to be translated. Finally, because little grey literature is peer-reviewed, quality varies considerably and thorough evaluation process is decisive.

When evaluating grey literature one should consider assessing the statement of findings, testing any hypotheses presented, checking the authors' details and experience, and looking at the source of the item (where was it found?; what are the institutional affiliations?). In addition evaluating the research methodology and data collection procedures is as necessary for grey literature as it is for conventionally available studies.

Sources Including Grey Literature

Many of the *database*s in *Information Sources* list types of grey literature in varying degrees. In addition to this, consider the following sources:

Adobe PDF searchpdf.adobe.com A *search engine* exclusively for Adobe documents – a format in which grey literature often appears.

CHID chid.nih.gov Combined Health Information Database for the American federal government.

ClinicalTrials.gov www.clinicaltrials.gov An index of clinical trials, ongoing and complete. While educational trials are understandably few, there will be some of relevance to particular topics.

CRISP database www-commons.cit.nih.gov/crisp/ Computer Retrieval of Information on Scientific Projects collates US federally funded biomedical research. Its educational content has an emphasis on patient education.

DARE (Database of Abstracts of Reviews of Effectiveness) nhscrd.york.ac.uk A collection of appraised reviews, economic assessments and health technology research hosted by the University of York. Educational content is small, but of high quality.

Dissertation Abstracts wwwlib.umi.com/dissertations/gateway The most recent two years of dissertations and previews. This free version is provided by Digital Dissertations, but the full database and full text require a subscription.

National Guidelines Clearinghouse www.guideline.gov/index.asp Educational guidelines here are almost exclusively public health education. Similar sites exist for other countries e.g. NICE www.nice.org.uk for England and Wales.

National Research Register www.doh.gov.uk/research/nrr.htm A *database* of current and newly completed research projects, the majority of which are funded by Britain's National Health Service.

National Technical Information Service www.ntis.gov/search Provided to search for American government scientific, technical, and business information

OMNI omni.ac.uk An example of a high quality gateway to *Internet* pages in health and medicine.

TRIP www.tripdatabase.com Turning Research Into Practice simultaneously searches over 75 high quality medical sites.

Library Catalogues

The following national library catalogues all index *grey literature*. These can be searched in English, but obviously non-English equivalents can be consulted when needed.

British Library www.bl.uk
COPAC www.copac.ac.uk (A combined catalogue of Britain and Ireland's largest universities.)
Library of Congress catalog.loc.gov/
National Library of Australia www.nla.gov.au/catalogue/
National Library of Canada www.nlc-bnc.ca/7/2/
National Library of Medicine locatorplus.gov
National Library of the Netherlands www.kb.nl/kb/resources/frameset_catalogi-en.html

Government Sites and Professional Organisations

Government and professional websites can be an excellent source for *grey literature* evidence. The following sites are examples relevant to Scotland/Britain, but obviously each relevant country's equivalents should be consulted.

British Medical Association www.bma.org.uk
DOH www.doh.gov.uk/index.html
General Medical Council www.gmc-uk.org
Royal Colleges www.rcplondon.ac.uk/general/gen_links.htm
Scottish Executive www.scotland.gov.uk/pages/default.aspx
Scottish Parliament www.scottish.parliament.uk

Subscription or paid sources

Conference Papers Index - A database that includes the Cambridge Scientific Abstracts.

Health Management Information Consortium - A combined database of health management and health care from the UK Department of Health and Stationery Office.

Index to Theses www.theses.com A complete list of theses and abstracts accepted by British and Irish universities.

Northern Light www.northernlight.com Formerly a free *search engine*, this site is now of potential interest for its Special Collection of paid access documents. Searching is free.

SIGLE www.cas.org/ONLINE/DBSS/sigless.html The System for Information on *Grey literature* in Europe is a large grey literature database produced by the **E**uropean **A**ssociation for ***Grey literature*** in **E**urope.

Web of Science Proceedings   Monthly updates from nearly 5,000 international conferences.

World Cat, Proceedings First www.oclc.org/home The world's largest unified library catalogue.

ZETOC zetoc.mimas.ac.uk A British (British Library) example of a *database* and alerting service from the tables of contents of journals, as well as conference proceedings.

Archives

Biomed Central www.biomedcentral.com An independent medical web publishing house with a variety of free peer-reviewed journals, including medical education (BMC Medical Education).

Netprints (BMJ) clinmed.netprints.org/home.dtl "A repository of non-peer reviewed original research" provided by the BMJ Publishing Group.

PubMed Central www.pubmedcentral.com Unified free access to a number of top peer reviewed journals. Papers will inevitably appear in the databases above, but this site allows free access to the full text.

WEB Searching

Searching the web is an essential part of any systematic search. The benefits of using web searching to identify trials (ongoing or unpublished) have been well-documented in medicine (Eysenbach et al, 2001). Because evidence relevant to medical education can be found in such disparate and numerous locations, a web search is essential if the search is to be considered comprehensive. A web search can be considered an integral part of the *grey literature* search – it can find evidence that is not located anywhere else.

Web searching presents its own challenges and rewards. The most immediate is the sheer size of the web itself. At present there is no accurate measure on the number of pages the web contains. The largest *search engine*s access over 3 billion pages, though the total number of public and private pages is thought to be many times larger still. The sheer volume of pages is a definite obstacle in locating relevant pages from false *hit*s, but the enormous size of the web also means there is relevant material available. And because no search engine covers the entire web (nor is any expected to in the immediate or medium future) one can never assume a search, even across multiple engines, is exhaustive.

The accuracy of search engines has been consistently improving however, and within the last twelve months it has become routine for engines to search files other than only web (.html) pages. Microsoft Word and Adobe Acrobat files are perhaps the two most important file types to be included alongside the usual web pages, as both these formats add a huge wealth of potential evidence stored on academic and other servers.

Searching the web is different from database searching

A *database* search using *controlled vocabulary* is pre-co-ordinated, as searchers select *subject heading*s that have already been created and assigned to the *database* records. A web search is post-co-ordinated, as searchers must select their own terms and leave it to the *search engine* to match the terms to web pages and rank them by relevance. Theoretically a post-co-ordinated search is more flexible

and ultimately more accurate; however, as anyone who as ever searched the web can attest to, this has yet to occur in practice. Web searches produce enormous amounts of irrelevant *hit*s.

While at present the web is too murky and unwieldy to provide clear and succinct searches, ongoing initiatives may make systematic web searches more of possibility in the future. If *metadata* standards such as Dublin Core and IMS are widely implemented, the web in effect would have a more powerful *controlled vocabulary* than most *bibliographic database*s. In the meantime, relevancy ranking of *search engine*s continues to improve, as anyone who has been searching the web over the last few years can informally testify.

'I must've seen it in a USENET posting'; that's sort of like hearsay evidence from Richard Nixon." Blair Houghton

From the beginning questions have been raised about the accuracy and value of much of the evidence found on the web. Evidence found on the web is almost certain to lack traditional quality controls like peer review. While the quality information on health websites is thought to be improving (Pandolfini et al, 2002), it would be wrong to assume this was necessarily the case with evidence relevant to medical education.

The medical world is also further along establishing models for rating website quality. A good example of a guide for judging the quality of medical sites is Wilson (Wilson, 2002). The author outlines a range of tools that can be employed, along with respective costs and benefits. These include: Codes on conduct, Self-applied code of conduct or quality label, User guidance system, Filtering tools, and Quality and Accreditation labels awarded by third parties. While these are only partially applicable to medical education, the broad criteria for appraising websites is interdisciplinary:

1. Authority – are the authors clearly stated and reputable?
2. Precision – does the information appear accurate?
3. Currency – is the material up to date?
4. Scope – does the subject area match your research question?
5. Objectivity – can you detect bias?

Instruments to assess the validity of medical information on the web are not uncommon. One prominent one is the DISCERN Tool (www.discern.org.uk/) created by the University of Oxford and the British Library. While it would have to be adapted to consider the educational context, the principles remain the same.

This now moves from searching to critical appraisal, which is not covered in this guide. It is hoped that the ongoing work of the BEME Collaboration will produce common criteria to appraise websites alongside the array of study designs being examined.

Search engines and sites

The one constant in web searching is change. *Search engine*s rise and fall, as do the techniques they employ. Some points to bear in mind before undertaking a web search:

❑ No single search engine covers the entire web

- Web searches are not "Live" but are searching the stored results of the last sweeping search of the web the search engine has made – only when you click on the results are you making a live connection
- Most search engines offer *Boolean algebra*, though this frequently is not immediately apparent and often only seen in their advanced search options
- Some search engines automatically link words (without Boolean commands) with AND, while others default to OR
- Results are ranked with what are judged to be the lost relevant ones first; every search engine has a different way of doing this, looking at the documents' titles, text, links and associations, and hidden *metadata*
- Some search engines initially offer only paid results i.e. pages that companies have paid to appear when certain keywords are searched
- There are probably fewer search engines now then there were a couple years ago; fierce competition has led to closures and alliances where one search engine merely retrieves results from another (competition has also noticeably improved results)
- The recommendations below will change over time…

Search engines: Recommended

Google

www.google.co.uk

From obscurity five years ago, Google has arguably become the world's most popular *search engine* – with good reason. The first to use an algorithm that analyses what other sites a website links to in addition to its text and titles, Google provides accuracy that very few can rival.

The basic search page is simple and free from clutter. It defaults to a Web search, but can also retrieve Images, News, postings from Usenet, and Directory results.

Usenet is a massive collection of news group forums on nearly every imaginable topic; obviously the vast majority will be irrelevant, but with a *focus*ed query (e.g. "summative assessment") one can quickly cut to the significant *hit*s. Google's Directory is a human created hierarchical collection of subject categories – good for broad subject searches, but not for finding obscure papers.

The Advanced Search page offers (limited) Boolean commands (through text boxes), limits (such as language, file type and date), pages that link to a page, and pages that are conceptually similar to a page. In addition you can focus a search to specific universities webpages (at the time of writing this includes American and Canadian universities).

Google also has cached pages – or stored pages from its previous searches of the web. This store allows users to view web pages that may no longer be accessible.

alltheweb
find it all

www.alltheweb.com

Rivalling Google in size, Alltheweb (also known as FAST) is nowhere nearly as well known but can also rival Google's accuracy. Alltheweb also defaults to a simple Web search, but also covers Images, Audio, Video, News, FTP (file transfer) sites.

The Advanced search allows slightly more powerful Boolean searching than Google, as well as the standard range of limits. In addition there are Word Filters which, most usefully, allow a user to specify what words should occur in the documents. For example, if one was interested in the educational uses of portfolios in general, but specifically in medical education, one might search "portfolios education" in the main box while entering "medical" in the Should Word Filter.

Unfortunately, Alltheweb places paid listings (sponsored pages) to the top of its results list. At the time of writing, the company looked to as if it was to be acquired by another, so changes in the future are perhaps more likely than usual.

TE○MA℠

www.teoma.com

A relatively new *search engine*, Teoma is not nearly as large as Google or Alltheweb. Nevertheless, it is well worth using and watching because it has created a powerful link analysis algorithm that produces extremely accurate results.

Teoma's results fall into three categories Results (standard webpages ranked for relevancy), Refine (suggestions on how to narrow large searches) and Resources ("expert" subject similar pages). While the last two additions are not the primary reason for using this engine, they can often bring surprisingly applicable content to a web search.

Teoma also has an Advanced Search that is comparable to two mentioned above.

Other Choices

WiseNut
Search.Exactly.

www.wisenut.com

A new *search engine* that has shown considerable promise, Wisenut is currently being redeveloped. The engine has a simple interface and largely bases its results on links analysis. With a successful upgrade this engine could become a very significant player.

HOTBOT

www.hotbot.com

In years past Hotbot was an impressive engine in itself. Today however, it searches the four separate engines: Google, Alltheweb, Teoma and Inktomi. While the first three are engines in their own right, Inktomi is not but is a separate massive

collection of web pages that can be accessed by a number of engines. Hotbot is probably the best of these and has a decent array of options in its advanced search page.

uk.altavista.com

While other engines now outperform AltaVista, the engine still provides accurate results and the range of features one would expect of a high-quality search engine. Past research has found AltaVista was very good at *indexing* academic websites.

Meta–Search engines

Meta-search engines do not search the web themselves. Instead, they collect the results from any number of regular search engines and (hopefully) eliminate duplicates and rank them relevantly. In the past these tools were of limited value, particularly because they could not take advantage of individual engines' features. The best meta-engines have now overcome this and have noticeably improved their relevancy ranking.

Recommended

www.profusion.com

Profusion is perhaps the best meta-*search engine*. Not only does it provide very good results, it has a considerable number of features and options including Boolean commands, vertical searching through subject categories and the ability to select from which engines it collates its results.

ixquick.com/uk

Fast and accurate, Ixquick is a good choice, offering relevance scores and the ability to select and search most of the web's top engines.

Other Choices

vivisimo.com

Vivisimo is a clustering engine. It works by retrieving results from the major *search engine*s and uses an algorithm to collate them conceptually and hierarchically. Results are post co-ordinated, as search terms are not fit into existing categories but grouped together after each individual search. Claiming this creates heuristic searches, it does allow for a distinct way for exploring results. Not recommended for specific focused searches, but do consider it for broad conceptual searches.

www.kartoo.com

Kartoo provides good results but is also worth considering for the way it displays them. Rather than textual lists and/or categories, Kartoo collates results visually on a map that the searcher is then free to navigate. It also searches in French, Spanish, Portuguese and German.

"Law of Diminishing Returns: Law stating that if one factor of production is increased while the others remain constant, the overall returns will relatively decrease after a certain point."
The Columbia Encyclopaedia, Sixth Edition. 2001.

Ultimately one does have to decide when to stop searching. This is particularly applicable to web searching, as you are searching what, in practice if not reality, is an infinite resource.

Constructing searches

There is a process of structuring a search query that you should follow before sitting down to search a database. The process can be broken down into three steps, and should ensure that the time you spend searching is more focussed and that the results are more relevant:

1. define and write the issue down in the form of a question or hypothesis;
2. identify and expand the essential concepts;
3. set out the scope of the search query (e.g. inclusion and exclusion criteria).

The process is usually iterative, as you may wish to adjust or refine your search query after you have some database results.
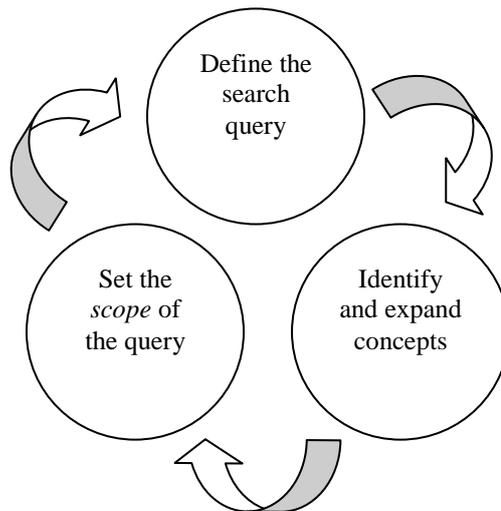
Figure 2: Structuring a search query

Defining the search query

"Before beginning a Hunt, it is wise to ask someone what you are looking for before you begin looking for it."

Pooh's Little Instruction Book, inspired by A. A. Milne

Defining the search query is the first critical stage of literature search. A well-designed question goes a long way to ensuring that the query is answered in a way that is objective, explicit and independently reproducible. All consequent stages will develop from the question's parameters, so attention must be given to breaking the query down into its component parts. Most search queries result in a single question, though multiple or composite questions do arise.

Search queries must be precisely defined. In medicine, evidence-based queries are broken down into the following components: *population*, *intervention*, *comparison*, *outcome* and *study design*. A rough parallel exists in medical education, where it is advantageous to think of the query in terms of the following components: *participants*, *educational aspects* and *outcomes*.

The medical education query "Can an OSCE effectively assess communication skills in undergraduate medical students?" might seek to define its components by asking the following sorts of questions:

Question components	Topic: feedback in assessment
Participants	Who are they? Undergraduates, medical students etc.?
Educational aspects	Is an OSCE appropriate for measuring communication skills?
Outcomes	Are the exam results an accurate reflection of competence?

Figure 3: Setting the scope of the query

Identifying and expanding the essential subjects

Look at your search query carefully and identify the words or phrases that make up the essential subject components of the issue you are addressing.

Examine each essential subject and make a list of any synonyms, alternative spellings, and related terms that you would like included in your results. To do this, it helps to think of formal terms (like myocardial infarction) as well as less formal terms (like heart attack). Be as specific as possible, and where you are interested in a largish area (like heart disease) list **all** the more specific topics (like types of heart disease) that you want to cover. See below for a diagram showing how you might organise your essential subjects and their associated terms.
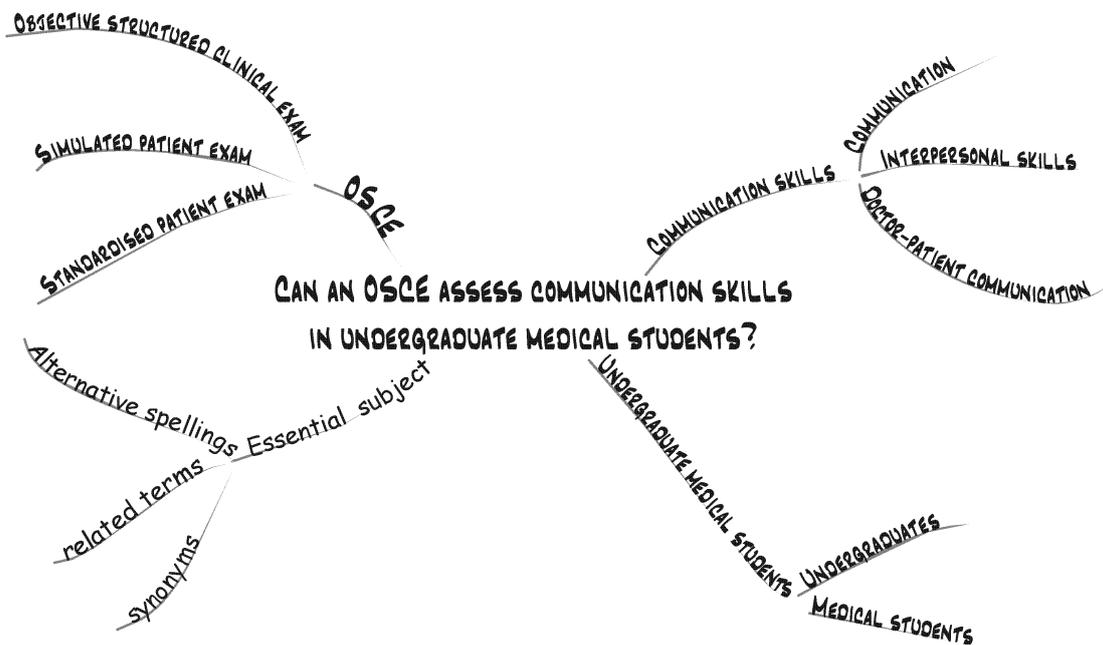
Figure 4: Organisation of essential subjects and associated terms

At this point you should also think about how your essential subjects and associated terms relate to one another in the context of your search query, and therefore how you will be combining them when you search the *databases*:

OSCE	Communication skills	**AND**	retrieves only the records containing all of the combined terms: this example will retrieve records about both OSCE and communication.
OSCE	Simulated patient exam	**OR**	retrieves records containing any of the combined terms: this example will retrieve records about either OSCE or Simulated Patient exam or both. Records are not duplicated in the results.
OSCE / Communication skills	MCQs	**NOT**	retrieves records containing one term but excludes records containing an unwanted term: this example will retrieve records about OSCE, but will leave out anything about MCQs. Use NOT with caution, as it can exclude records which may be useful.
OSCE / Simulated patient exam		**AND & OR**	Use more than one combination to make further refinements: this example will retrieve records about Communication skills and either OSCEs or Simulated Patient exams.

Figure 5: How to combine essential subjects and associated terms in searching databases

These combining commands are based on *Boolean algebra*, created by the English mathematician George Boole (1815-1864). Boole established "symbolic logic" which is the basis for the design of the digital logic of today's computers. Symbolic logic is a simulated language that removes the logical flaws and the lexical ambiguities of natural language and allows procedures to be processed. Fortunately for the *database* user, only a very simplified form of *Boolean algebra* is required to combine *search concepts* to maximum effect.

Setting out the *scope* of your enquiry

To make it so that you have fewer irrelevant results to look through, think about some parameters, or inclusion and exclusion criteria: Do you want to limit the search to a certain study design? Do you want to limit to age or type of learner? What about year of publication – do you need only the very latest, or do you want to cover 10, 15, 20 or more years into the past?

There are two points to bear in mind when setting out the *scope* of your search query:

- you are establishing an important part of your "materials and methods" at this stage, so if you plan to write a literature review you need to note down what inclusion and exclusion criteria you set and why;

- some parameters, like language of publication, do not necessarily ensure that your search results are of greater relevance and of higher quality. Think about which limits really do refine your research question, and which

are arbitrary ways of reducing the number of results you have to look through.

Search strategies often need to be refined, depending on the topic and how complete you think the results should be. Searches can be refined both at a conceptual level with the topic itself, and by utilising the three standard components (as discussed above), or by altering the search terms and language (as discussed below).

You should now have a very clear definition of what you are looking for in the *database*. This will save you a lot of time in the long run.

A sample Medline search

This sample search of Medline will take you through the basic steps in performing a subject search. The goal of this search is to find information to help answer the question; **"Can an OSCE effectively assess communication skills in undergraduate medical students?"** The sample search is intended as an illustration of various techniques and ways of addressing problems associated with literature searching.

To reinforce the techniques described in this example, we recommend that you follow the steps with a live Medline search of your own.

This sample search is illustrated with screen-shots of the Ovid (http://gateway.ovid.com) *search interface* with the kind permission of Ovid Technologies, but the authors do not endorse Ovid, nor recommend it above other database providers. The techniques illustrated are not unique to this interface, and can also be performed with other interfaces to the Medline database.
When you log on, you will be presented with a list of databases to choose from. Medline itself is divided up for convenience into various groups of years, and each group is also called a "*database*".

Subject searching

On the main search page, you can see a reminder of which *database* has been selected at the top, and if you change your mind about year selection, use the icon

Figure 6 The Main Search Page

By default, the Main Search page is set for a *Subject heading* search. Unless you deselect *Map Term to Subject heading*, your search terms will be mapped (or matched) with the index terms, or *Subject heading*s, used by the National Library of Medicine to describe the content of articles. This mapping facility ensures that the records retrieved in your search are more likely to be relevant.

For this search, we've typed "communication skills" into the input line provided and can click on *Perform Search*.

The Mapping Display

Next, the Mapping Display shows a list of the Subject headings that best match "communication skills":

Figure 7: Subject heading Mapping Display

"Communication skills" is not a Subject heading, so a list of alternative or closely related Subject headings is displayed. *Communication* is the closest synonym. To select the Subject heading(s) you want from this list, click in the adjacent box(es).

Alternatively, you could choose the last item in the list, Search as Keyword. This runs a *free-text* search for the phrase "communication skills" in the title, abstract or Subject headings of each article record.

The difference between *Subject heading* and Keyword (*free-text*) searches
Medicine *Subject heading*s (***MeSH***) are "tagged" by professional indexers to articles to describe the content, and should allow you to retrieve articles on your subject no matter what spelling or synonym the author has used in the article. Also, when an author doesn't put important words into the article title or abstract, the Subject headings should make up for the omission. Only with standardised and defined concepts (i.e. a *controlled thesaurus*) can the creators and the users of *database*s consistently employ terminology to maximum effect.

The Keyword search looks for your term regardless of its contextual meaning. The Keyword search in Ovid is a ***free-text*** search, literally looking for precisely the term or phrase in the title, abstract and other available or specified record *field*s. So, for example, if you searched for the word "stress" as a Keyword, you would retrieve articles about stress fractures, dental stress, psychological stress, and more. Problems can also arise from simple errors in keying records. Medline currently has 11 records that mention "prostrate cancer" (*sic*) and 112 for "myocardial infraction" (*sic*) – these errors obviously slip by computerised spell-checkers.

Why use *Subject heading*s?
A Subject heading search will usually bring up a higher proportion of relevant records, provided you have used the most appropriate *Subject heading*. The problem of **polysemy** illustrated above with "stress" should be largely removed. *Indexing* endeavours to establish a balance between **selectivity** (choosing the concepts of greatest utility to the users) and **exhaustivity** (ensuring that all prospective concepts are represented), and effective *indexing* dramatically improves both search *sensitivity* and *specificity*.

*Subject heading*s reduce the problem of **granularity** of terms, *granularity* being defined as the relative size, scale, or depth of penetration of a term. Authors of papers, the people who write abstracts, and the various different users of *database*s can all have different ideas as to what is the *scope* (*granularity*) of a term. For example, problem-based learning citations may not mention "problem based learning" anywhere in the record but instead refer to "active learning", "experiential learning", "problem based curriculum", or "PBL". An indexer would recognise the citation was about problem-based learning, assign the Subject heading "problem-based learning", and any user searching with the *controlled vocabulary* would find all the possible context-specific documents. *Sensitivity* is improved, as relevant documents not containing the literal term "problem based learning" would still be retrieved, while *specificity* would improve, as the false *hit*s associated with *free-text* words would be drastically reduced.

As a rule of thumb, you should begin your searches by finding the most appropriate *Subject heading*s.

When to use a Keyword (*free-text*) search
If there is no appropriate Subject heading – and this can happen if you are searching for something new or rare – then it is best to use a *free-text* search. Free-text searching is also the best way to find the full bibliographic details when you have been given an incomplete reference – you can search with the pieces of information you do have: author name, page numbers, journal title words, etc.

Sometimes, despite there being a matching Subject heading, it still seems there should be more records on the topic. If this seems the case, you can select both the matching Subject heading and the Search as Keyword option and combine them using OR. In addition, for higher *sensitivity*, you could search using a series of free-text searches to cover the various synonyms or spellings that may be used by authors. Special techniques for free-text searching (**truncation** and **proximity commands**) are illustrated in subsequent steps of this sample search.

The Tree Display

Returning to our sample search - to find out more about a Subject heading, such as its coverage, related Subject headings and definition, click on it – in this example (figure 7), we follow the link from the phrase *Communication.*

By clicking on a Subject heading, you are taken to the Tree Display. The Tree Display has several important features:

Subject heading hierarchy
You can see the organisational hierarchy of *Subject heading*s, and by clicking on other *Subject heading*s you can explore the hierarchy to find the most appropriate headings. This allows you to adjust the route of your search at this point if you prefer to take a **broader** or **narrower** approach. You'll have to scroll down the page to see *Communication* (see fig. 8b).

Figure 8a: Tree Display – top

Figure 8b: Tree Display - bottom

You can see how the *Subject heading*s are organised in a hierarchy with *broader* (left) and *narrower* (right) Subject headings. *Communication* is subordinate to the *broader* heading, *Behavior* (not shown in figure 8b), and has its various aspects identified by *narrower*, or more specific Subject headings. As a rule, indexers only apply the most specific possible Subject heading – for example, an article given the heading *Interdisciplinary Communication* would not normally also be given the *broader* heading, *Communication*.

There are some options available from the Tree Display (see figure 8a for the headings to the columns to the right of the Subject headings):

Explode

When you want to search for a Subject heading and include all the *narrower* Subject headings which branch off from it, select the *Explode* option. Here, we have clicked in the boxes for *Communication* and its adjacent *Explode*, so our *search set* will include *Communication* as well as *Communication Barriers* and *Disclosure* etc., as well as any even *narrower Subject heading*s which branch off from the headings subordinate to *Communication*.

Focus

This option will bring up only records of articles in which the *Subject heading* is a primary topic. This reduces the number of articles retrieved. For sensitive searches, the *Focus* option is not recommended.

Scope **Note**

The main reason to use this is that it usually gives you a glossary definition of the *Subject heading* as well as an indication of what other terms are covered (see *Used For* at bottom of figure 9). This is important because the creators of the *database* might attach a slightly different meaning to a term than you would, and you should make sure you are matching the definitions used in the *database*. For detailed searches, it is worth looking for a *Year of Entry* so you know how long the Subject heading has been in use, and what to use if you need to search in prior years.
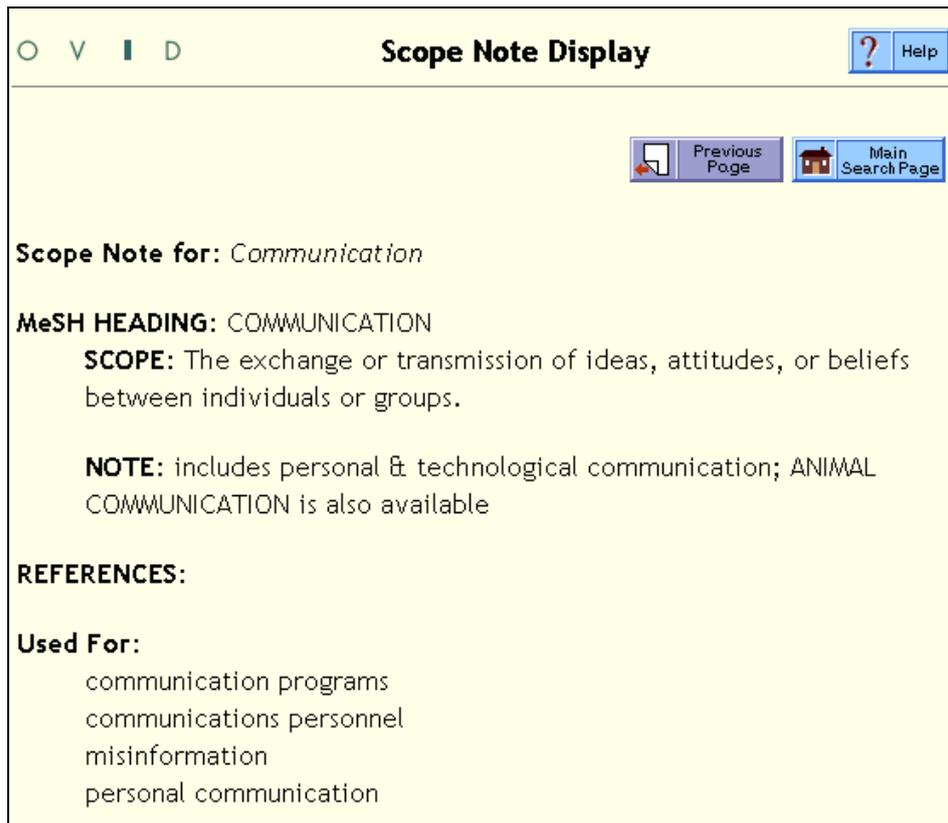
Figure 9: Scope Note Display

We have selected *Communication* and the adjacent *Explode* (see figure 8b) – we are ready to continue (you would click on the green lozenge-shaped button at this point).

Subheading **Display**

Most Subject headings have a number of *subheading*s to which you may limit your search (figure 10). This can be a useful shortcut to a few articles on a particular facet of a Subject heading. Many of these subheadings will not be useful in a medical education search and as a general rule one should always begin a search broadly and apply limits later. Also, for sensitive searches, you should be cautious about using subheadings because they are not consistently applied.
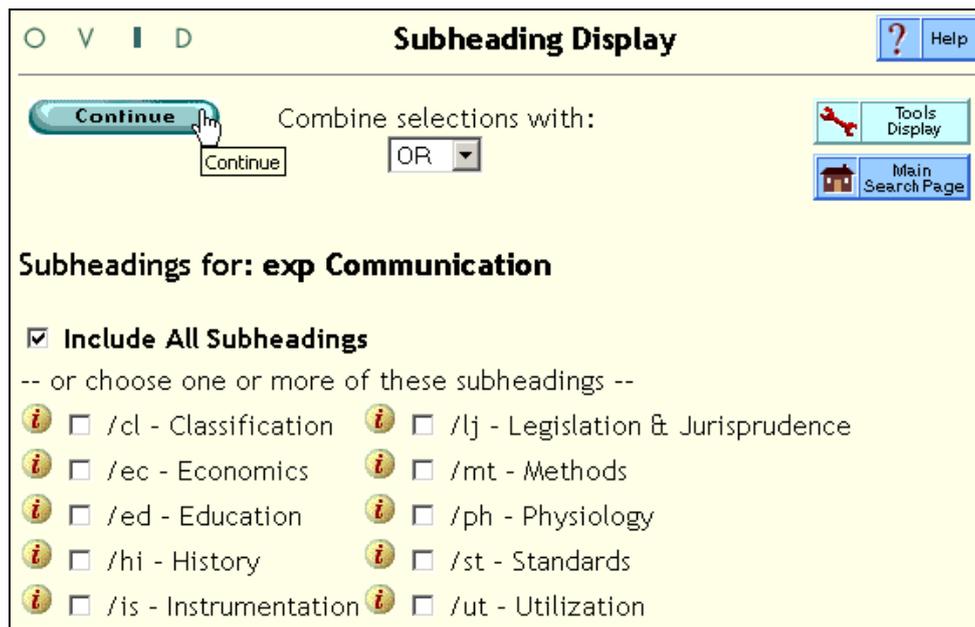
Figure 10: Subheading Display

For this search, we won't limit to any particular *subheading*s.

However, *subheading*s should not be ignored for two main reasons. Firstly, they can significantly qualify educational content; the Methods, Organisation and Administration, Standards, and Trends subheadings all can be of considerable benefit.

The other key utility of *subheading*s is realised by searching them on their own. "Education" itself is a subheading for some *database*s, notably Medline; because Medline's *focus* is medicine and not education, the "education" subheading can be used to extract citations not found by either *controlled vocabulary* searching. Many citations with the education subheading applied to one of the *MeSH* are only educational in a peripheral sense, yet many others are primary education studies. There are 111,110 Medline citations with the "education" subheading and 327,494 are indexed with or beneath the *explode*d controlled vocabulary term "education". Significantly, over 30,000 citations only have the education subheading. In the nursing database CINAHL there are over 8,000 citations in a similar situation. Few medical education searches capitalise on this way of improving the both the *sensitivity* and *specificity* of their results. [See below, Search Examples 9 and 10]

Building the search history, *free-text* searching and proximity commands

We've returned now to the Main Search page (figure 11), and the first *search set* is listed in the Search History. Any subsequent search sets will be added to the Search History. We could look through the results now, but we would waste too much time sifting through records of irrelevant articles.

Figure 11: Free-text searching with the proximity command

The next step illustrated is a search for communication skills as a *free-text* search. Note that we have de-selected the *Map Term to Subject heading* option for this step.

We could search for the phrase "communication skills" but the concept is likely to be expressed in many ways other than in that exact phrase. The command **adj***x* is Ovid's proximity command – where *x* is the number of words that are allowed to be between the terms specified. The search "communication adj3 skills" finds any occurrence of communication within three words of skills (in any order). Proximity commands allow a sort of compromise between phrase searching and the Boolean AND: the exact phrase is too restrictive, and a search for "communication AND skills" would return many results that have those two words somewhere in the searched *field*s but not necessarily linked together conceptually. As a general rule, the closer together two words are, the more likely it is they will be conceptually linked. Bear in mind that proximity commands nearly always ignore stop words such as "the", "and", or "that".
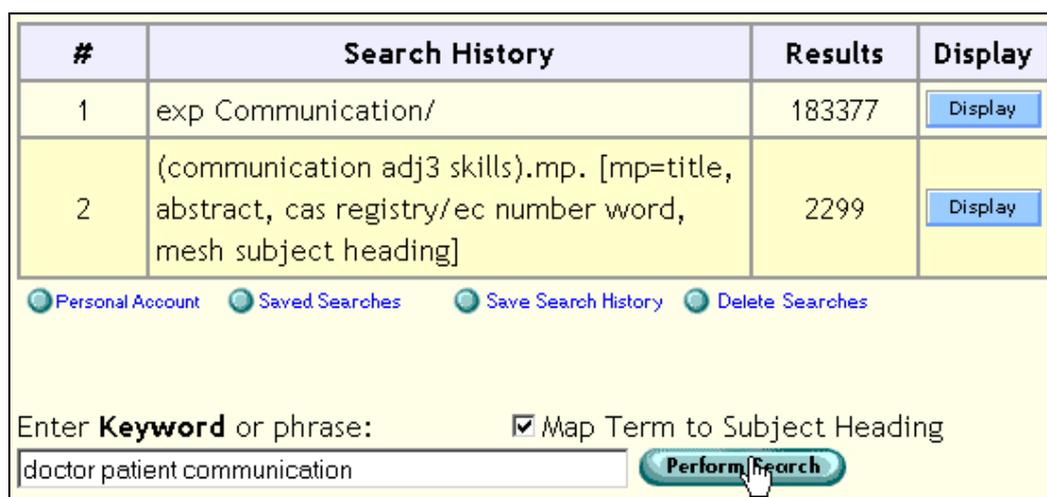

Figure 12: Building the search history with another related phrase

We are now ready to move to another of the related phrases from the list we created at the start. Remember that the *search set*s are not related at all to one another until we combine them using Boolean Commands at a later stage.

We have selected *Map Term to Subject heading* again before executing this new search to take advantage of any suitable *Subject heading*s that may be presented.

Figure 13: Mapping Display for doctor patient communication

Again, "doctor patient communication" is not a *Subject heading* (figure 13), but *Physician-Patient Relations* looks promising, and it was not a heading that we saw under *Communication*. To see its context in the organisation of *MeSH*, we will click on *Physician-Patient Relations* and go to the Tree Display.

Figure 14: Tree Display for Physician-Patient Relations

In the *MeSH* hierarchy, *Physician-Patient Relations* is placed under *Professional-Patient Relations*, which in turn is under *Interpersonal Relations* (figure 14).

In the *Scope* Notes, *Physician-Patient Relations* is defined as "The interactions between physician and patient"; *Interpersonal Relations* is defined as "The reciprocal interaction of two or more persons". *Interpersonal Relations* seems a bit vague, but because of its similarity the commonly used phrase "interpersonal skills" it is probably worth selecting.

It is arguable whether or not at this point we should simply select and *explode Interpersonal Relations* in the same way we did for *Communication*. For this example, we want to illustrate the selection of multiple *Subject heading*s from the Tree Display so we have selected *Interpersonal Relations* and *Physician-Patient Relations* and will continue with those two, which are by default combined with OR (see figure 8a).

Combining synonymous *search set*s

In the previous steps we have tried to illustrate the process of building up a sensitive search history by submitting standard phrases used in discussing communication skills, matching them to *Subject heading*s, and augmenting those with *free-text* searches. Figure 15 shows the search a few steps forward from our selection of the Subject headings *Interpersonal Relations* and *Physician-Patient Relations*. Set 4 shows a free-text phrase search for "doctor patient communication" – note that some *search interface*s require phrases to be surrounded by quotation marks, but it is not required here. Set 5 shows a free-text search for interpersonal and skills within three words of one another, just as we did for communication skills in set 2. The sets in the history are still not associated with one another.

#	Search History	Results	Display
1	exp Communication/	183377	Display
2	(communication adj3 skills).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]	2299	Display
3	interpersonal relations/ or physician-patient relations/	66593	Display
4	doctor patient communication.mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]	295	Display
5	(interpersonal adj3 skills).mp. [mp=title, abstract, cas registry/ec number word, mesh subject heading]	852	Display

○ Personal Account   ○ Saved Searches   ○ Save Search History   ○ Delete Searches

Enter **Keyword** or phrase: ☑ Map Term to Subject Heading
`1 or 2 or 3 or 4 or 5`   Perform Search

Figure 15: Combining a cluster of synonymous search sets with OR

The next step is to combine the sets (this could also wait until the very end). We want articles within any of the sets, so we want to combine using the Boolean command **OR**. We have typed "1 or 2 or 3 or 4 or 5" in the input line – or we could have clicked on the Combine tool at the top of the Main Search page:

If we had wanted to use another Boolean command, we could have typed "1 and 2, etc." or "1 not 2" depending on what is appropriate. Clicking on Perform Search will execute the combination. See set 6 in figure 16 for the results of this combination.

#	Search History	Results	Display
1	exp Communication/	183377	Display
2	(communication adj3 skills).mp.	2299	Display
3	interpersonal relations/ or physician-patient relations/	66593	Display
4	doctor patient communication.mp.	295	Display
5	(interpersonal adj3 skills).mp.	852	Display
6	1 or 2 or 3 or 4 or 5	238145	Display
7	OSCE.mp.	308	Display

Personal Account   Saved Searches   Save Search History   Delete Searches

Enter **Keyword** or phrase: ☐ Map Term to Subject Heading

objective structured clinical exam$ Perform Search

Figure 16: Using the truncation symbol

As shown in figure 16, we have begun to search for terms related to the idea of objective structured clinical examinations. Set 7 in figure 16 shows a *free-text* search for the acronym, OSCE. We found that there is no *Subject heading* specific to the idea of OSCEs, so we are relying on *free-text* searches. If a term has a commonly-used acronym or abbreviation, it is important to include a search for it as well as for the complete phrase.

Truncation **– right-hand and internal**

Free-text searching is more effective if you allow for variations of words by truncating the ending. In figure 16 we have entered "objective structured clinical exam$" to allow for the fact that examination could appear as exam, exams, examination or examinations. When you truncate a word, be sure not to make the root too small (so that you get irrelevant words) or too big (which will restrict the number of relevant variations). The right-hand *truncation* symbol here is $, but it varies from one *search interface* to another (* is a common *truncation* symbol).

Figure 17: Internal truncation

Internal *truncation* can be used within a word to allow for variations in spelling. Figure 17 shows "standardi#ed patient$" in the input line – this search statement will retrieve "standardised" and "standardized".

Set 9 in figure 17 shows a *Subject heading* search for patient simulation – this Subject heading was presented in the Mapping Display when we searched for "simulated patients" and is defined in its *Scope* Note as "The use of persons coached to feign symptoms or conditions of real diseases in a life-like manner in order to teach or evaluate medical personnel". It seems appropriate to our enquiry, so we included it, as well as a *free-text* search for the phrase "simulated patient$" in set 10. As you will have anticipated, "patient$" will retrieve the singular and plural forms of that word.

Figure 18: Entering multiple free-text words

We need to refine our searches for "patient simulation/", "simulated patient$" and "standardi#ed patient$" so that they are somehow related to the idea of examination. Figure 18 shows how multiple words can be entered all at once. This is pretty successful for *free-text* searches when all of the terms are to be combined with the

38

same Boolean command. This is not usually good practice, though, as it doesn't allow you to see what *Subject heading*s would be presented by the *search interface*, nor does it let you see how successful the individual terms are by letting you see the number of results each separate word generated. It does save time, though!

#	Search History	Results	Display
1	exp Communication/	183377	Display
2	(communication adj3 skills).mp.	2299	Display
3	interpersonal relations/ or physician-patient relations/	66593	Display
4	doctor patient communication.mp.	295	Display
5	(interpersonal adj3 skills).mp.	852	Display
6	1 or 2 or 3 or 4 or 5	238145	Display
7	OSCE.mp.	308	Display
8	objective structured clinical exam$.mp.	329	Display
9	patient simulation/	591	Display
10	simulated patient$.mp.	467	Display
11	standardi#ed patient$.mp.	629	Display
12	(test$ or exam$ or assess$).mp.	2292852	Display
13	(9 or 10 or 11) and 12	918	Display

○ Personal Account ○ Saved Searches ○ Save Search History ○ Delete Searches

Enter **Keyword** or phrase: ☐ Map Term to Subject Heading

7 or 8 or 13   [Perform Search]

Figure 19: Using more than one Boolean command at once

Figure 19 shows further development of the search history with the addition of set 13, which shows how to combine sets using more than one Boolean command at once. Just like algebra, the *database* software knows to combine the sets in parentheses first. Set 13 will retrieve records about patient simulation or standardised patients (sets 9 to 11) and also about tests or exams or assessment (from set 12).

It is possible to make more complex combinations by nesting parentheses – for example, "7 or 8 or ((9 or 10 or 11) and 12)" would give us the same results as the combination "7 or 8 or 13".

Combining the groups of synonyms

The last area to search on for our query is to do with the idea of "undergraduate medical students". Two relevant *Subject heading*s are returned when we search for that phrase: *Education, Medical, Undergraduate* and *Students, Medical*. These *Subject heading*s can be augmented by *free-text* searches for "undergraduate$" and "medical student$" (see figure 20).

#	Search History	Results	Display
1	exp Communication/	183377	Display
2	(communication adj3 skills).mp.	2299	Display
3	interpersonal relations/ or physician-patient relations/	66593	Display
4	doctor patient communication.mp.	295	Display
5	(interpersonal adj3 skills).mp.	852	Display
6	1 or 2 or 3 or 4 or 5	238145	Display
7	OSCE.mp.	308	Display
8	objective structured clinical exam$.mp.	329	Display
9	patient simulation/	591	Display
10	simulated patient$.mp.	467	Display
11	standardi#ed patient$.mp.	629	Display
12	(test$ or exam$ or assess$).mp.	2292852	Display
13	(9 or 10 or 11) and 12	918	Display
14	7 or 8 or 13	1215	Display
15	Education, Medical, Undergraduate/	10040	Display
16	Students, Medical/	10180	Display
17	undergraduate$.mp.	8307	Display
18	medical student$.mp.	10464	Display
19	15 or 16 or 17 or 18	28220	Display
20	6 and 14 and 19	138	Display

Figure 20: The finished search history

Set 19 in figure 20 sums up the synonyms for undergraduate medical students.

Now we are ready to combine our three subject areas – this is shown in set 20 (figure 20), where the numbers 6, 14 and 19 represent the synonym clusters for communication skills, OSCEs and undergraduate medical students.

A total of 138 results is not very many to look through – in fact, it is rather a small number of results for a search that intends to be sensitive. We will look a bit later at how we could limit the results by setting some other parameters, but first, we will look at some of the results to see how relevant they are.

Search results and how to use them to refine your search

It is always worth looking at search results at intermediate stages of *database* searching to see if they are the sort of results you were looking for, and how you might refine your search to make it more specific or more sensitive, or both. We have not looked at results yet in this sample search in the interests of space, but the following points would be useful for looking at results at any stage.

Figure 21 shows the first handful of results from the search – they look promising, and most even have "communication skills" in the title. The *Complete Reference* is a valuable source of additional information about the article – we will look at the complete reference for the first article (complete reference does not mean the full text of the article).

Figure 21:Search results in Title Display

The Complete Reference gives full bibliographic details about the article, but many records also have an abstract and other useful *metadata*, or descriptive information.

```
Authors
      Wiskin CM. Allan TF. Skelton JR.
Institution
      Department of Primary Care and General Practice, Medical School, University of Birmingham,
      Edgbaston, Birmingham B15 2TT, UK. C.M.Wiskin@bham.ac.uk
Title
      Hitting the mark: negotiated marking and performance factors in the communication skills
      element of the VOICE examination.
Source
      Medical Education. 37(1):22-31, 2003 Jan.
Abbreviated Source
      Med Educ. 37(1):22-31, 2003 Jan.
NLM Journal Code
      mz3, 7605655
Journal Subset
      IM
Country of Publication
      England
MeSH Subject Headings
      Analysis of Variance
      Clinical Competence / st [Standards]
      *Communication
      *Education, Medical, Undergraduate / mt [Methods]
      *Educational Measurement
      England
      Female
      Human
      Male
      Patient Simulation
      Reproducibility of Results
Abstract
      INTRODUCTION: Communication skills assessment is complex. Standardised patient use is
      widespread, but anxiety exists around the use of role players as assessors of competence in high
      stakes examinations. This study measures the level of agreement between scoring examiners and
      role players, and considers their influence on each other. Examiner status and question choices are
      analysed as variables. METHOD: The valid oral interactive contextualised examination (VOICE) is a
      general practice examination styled as an objective structured clinical examination (OSCE) of
      six 15-minute stations, which include two role-played consultations with professional role players.
      The examination candidates are final year medical students. Clinical components are examined
      by a general practitioner (GP). Communication skills are assessed by these examiners in
      conjunction with the role players, through a process of negotiation. Descriptive
      professionalism/attitude bandings are used as percentage-scoring guidelines. Checklists are not
      used. For this study, the initial (independently) perceived marks of the two scoring groups and
      their agreed final (awarded) marks were recorded, along with other variables including gender,
      performance factors, demographics and the nature of the question. Data represents 512 students
```

Figure 22: The Complete Record

The Complete Record lists the *Subject heading*s that have been assigned to that article by the indexer, and if you find an article that is useful for your search query, then having a look at the *Subject heading*s in its *database* record could give you some additional search terms to find more articles on the same subjects. The record in figure 22 has the potentially useful *Subject heading*s *Clinical Competence* and *Educational Measurement* listed – terms which might give good results when combined with the idea of communication skills. The Subject headings that have asterisks next to them are "*Focus*" ones (see figures 8a and 8b).

The abstract is another potential source of search terms: this one mentions an exam specific to communication skills that would be worth following up. Note also that the phrase "role players" is used as a synonym for standardised patients.

You may also be able to identify why irrelevant records have appeared – for example, are any of the search terms consistently retrieving records wide of the mark, making it so that you want to remove the terms from your search? *Free-text* searches are particularly guilty of this. Alternatively, you might be able to pinpoint irrelevant topics that you could exclude from your results by using NOT to combine them with your useful search terms (remember to use NOT with caution).

Refining tools: Limits and *search filter*s

Limits
There are various parameters or limits you might consider when designing a query – *search interface*s have various easily applied limits. Date limits are routinely available, but can be marginally more complicated to use if the database differentiates between the date when the citation was published and the date when it appeared in the database (the former usually being of most utility). Geographic limits can be used to isolate population groups or areas of publication but limiting a search by geographic area is usually only possible by the combination of *Subject heading*s and *free-text* searches described earlier.

Figure 23: Limits

Figure 23 shows Ovid limits available for Medline, and just to illustrate what happens, we have selected various *Review* publication types.

19	15 or 16 or 17 or 18	28220	Display
20	6 and 14 and 19	138	Display
21	limit 20 to (review or review, academic or review, multicase or review, tutorial or review literature)	7	Display

Figure 24: Limit results

The search results are now reduced to seven – really too few for a search aiming to be sensitive, but for a quick search intended to retrieve a sample of what is available, limiting like this is a useful tool.

Search filters

A *search filter* is a series of search commands designed to retrieve a particular type of result. Filters might be created to locate a particular type of study (e.g. controlled trials) or query specific (participants, educational aspects, outcomes) studies (e.g. undergraduate students, OSCEs, or competencies). Many filters exist on the web, though these are primarily of use to pure medical searches. Once you have created your own successful strategies, you might want to save them and rerun them when you need to filter future searches.

Search Examples

Though these examples are based upon Medline searches done via Ovid, the exact syntax displayed has often been simplified. Each example shows:

- the search query
- the search strategy
- a text description of each line of the strategy.

The examples have been constructed to illustrate aspects discussed in the guide - refinements and alternative approaches are obviously possible.

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Search Example 1: Find citations about the OSCE.

1   osce [*free-text*]
2   objective structured clinical exam$ [*free-text*]
3   1 or 2

1   OSCE is not a *MESH*. When it fails to map to Medline's *subject heading*s, a *free-text* search must be conducted.

2   When searching an acronym, the full term should also be searched. A search for one or the other alone with almost certainly miss citations. The term examination is truncated to exam$ to find all possible alternative suffixes (exam, exams, examination, examinations, etc.)
3   The Boolean **OR** combines the sets, and retrieves any results found in both.

- Note: Ovid assumes a *free-text* search is a phrase search. Use Boolean logic if it is not.

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Search Example 2: Locate records that *focus* on teaching hospitals that were written between 2001 and 2002.

1   *Hospitals, Teaching/
2   limit 1 to yr=2001-2002

1) There is a *MeSH* for teaching hospitals. Because an emphasis on the term is desired (rather than any mention of teaching hospitals) the *focus* (*) is used. The *Focus* box should be ticked when the *subject heading* is selected.
2) Time limits can be easily specified.

- Note: *Focus* is up to the discretion of the individual *indexing* each record – which unfortunately means it is not always objective or consistent:
    - Use *Focus* to reduce large sets to smaller, more specific ones.
    - Do not use *Focus* when you need every possible record.

- Note: Some *database*s allow two types of time limit: date of publication (as above) and date of entry (i.e. the year the citation was indexed in the *database*).

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Search Example 3: Find citations that have been indexed as being about both medical education and role play.

1   exp education, medical/
2   Role Playing/
3   1 and 2

1) This is the *MeSH* for medical education. It is *exploded* (exp) as there are many relevant subordinate terms that should be included.
2) There is a *MeSH* for role play; *exploding* is not required as there are no subordinate *MeSH*.
3) The Boolean **and** combines the two sets.

- NOTE: An added *free-text* search for role play will potentially yield more results, but will almost certainly include more irrelevant results.

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Search Example 4: Find citations regarding curriculum and palliative care. The results should have an emphasis on curriculum while discussing any aspect of palliative care.

1   *curriculum/
2   Palliative Care/
3   1 and 2

1) Curriculum is a *MeSH*. Because an emphasis on curriculum is required the term is *focused* (*). It is also *exploded* (exp) to broaden the possible number of results. An examination of the *exploded* terms subordinate to curriculum shows they are relevant.
2) Palliative care is also *MeSH*. There are no subordinate terms to palliative care, so *exploding* is not necessary. Because any article that mentions palliative care is wanted it is not necessary to *focus*.
3) The Boolean **and** combines the two sets.

■■

Search Example 5: What citations exist on the use of the *Internet* and distance education?

1   Education, Distance/
2   distance adj2 (learn$ or teach$ or educat$) [*free-text*]
3   1 or 2
4   *Internet*/
5   3 and 4

1) Distance education is a *MeSH*, but as the term has no subordinates no exploding is unnecessary.
   − This *free-text* search finds results that *indexing* has missed.
   − It will frequently become apparent that the *controlled vocabulary* is missing terms (low search *sensitivity*). If you suspect this, add a *free-text* search.
   − The parentheses (nesting) around the three *truncated* terms ensures that these are found first (i.e. any possible ending of the words *learn*, *teach*, or *educate*) and the Boolean **or** ensures that any record that contains any one of them is included.
2) The nested search results are then found anywhere within two (adj2) words of distance.
3) It is also possible to have searched the truncated/nested terms separately before combining.
4) The Boolean **OR** combines the first *search set*s.
5) *Internet* also is a *MeSH* without subordinate terms.
6) Both concepts are combined.

- Note: A simple exclusion strategy can be used to determine whether a *free-text* search is needed to supplement a *controlled vocabulary* search. In the example above, searching 2 not 1 would create a set that contains everything that the *free-text* search retrieves that the *MeSH* search doesn't. By looking at the results one can gauge whether to include (or refine) the *free-text*.

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Search Example 6: Locate citations that discuss trends in telemedicine.

1   exp *TELEMEDICINE/td [Trends]
2   exp *TELEMEDICINE/
3   exp Forecasting/
4   2 and 3
5   future.ti.
6   2 and 5
7   1 or 4 or 5

1) Telemedicine is a *MeSH*.

- Exploding the term broadens the search to reach subordinate terms, while it should be *focus*ed to ensure that telemedicine is discussed in enough detail to be relevant.
- While most *subheading*s in Medline are not relevant to medical education, in this instance the *subheading* '*trends*' is relevant.
- However, if the search is to be more comprehensive alternative steps should be taken:

2) The telemedicine *MeSH* without the *subheading*.
3) *Trends* is not a *MeSH*, but the *MeSH Forecasting* is a good synonym.
4) The Boolean AND combines 2 and 3.
5) Another option is to look for the word 'future' in the title *field*.
6) The title search is combined with the *explode*d and *focus*ed telemedicine search.
7) All three strings are combined with OR.

- Note: Exclusion strategies (e.g. 4 not 1, 7 not 1, 4 not 7, etc.) would reveal that there are relevant citations to the topic in each

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Search Example 7: Any citations in Medline that mention the GPAS (General Practice Assessment Survey).

1   General Practice Assessment Survey [*free-text*]
2   gpas
3   grade point average$
4   gastroprotective agent$
5   genetically prone to audiogenic seizure$
6   3 or 4 or 5
7   2 not 6
5   1 or 7

1) *Free-text* search for the full wording. There is no *MeSH*.
2) Because the subject is frequently referred to by its acronym, this must be searched as well.
3) Unlike the OSCE search (above) the GPAS acronym search retrieves many false *hit*s. By scanning the results of this line other uses of the GPAS acronym can be found. Grade point average(s) is one.
4) gastroprotective agent(s) is another
5) All three (lines 3-5) require *truncation* ($) to pick up possible plural forms
6) The false *hit*s are combined with the Boolean OR.
7) The false *hit*s are eliminated from the GPAS total.
8) The improved results from the acronym search are combined with the *free-text* phrase search.

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Search Example 8: A *free-text* search for multiple choice questions within medical education.

1   (mcq or mcqs)
2   (multiple adj choice adj (test$ or question$ or exam$))
3   exp education, medical/
1   (1 or 2) and 3

1) Finds the singular and plural for the acronym
2) A complex line:
   - The double parentheses are searched first; in this case the truncated version of question and its synonyms are searched
   - The software then searches left to right (multiple beside choice beside question/synonyms)
   - It uses the adjacency (adj) command to indicate the words must be beside one another (rather than adj3, which would allow them to be three words apart)
3) Retrieves *explode*d medical education citations
4) (1 or 2) and 3

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Search Example 9: Create a broad strategy to locate any possibly relevant educational citations within Medline.

```
1      exp Education/
2      exp Learning/
3      ed.fs.
4      1 or 2 or 3
```

1) It is critical to *explode* education because there are so many smaller terms beneath it and tens of thousands of citations would be missed without the explosion.
2) Learning is not subordinate to Education and needs to be searched (and *explode*d) separately.
3) There is also a floating *subheading* for education, and this command will find all citations that have been affixed with that *subheading*.
4) The lines are combined. Many (tens or hundreds of thousands) educationally relevant citations only have one of these headings/*subheading*s. See how many yourself by running exclusion strategies e.g. 2 not 1, 1 not (2 or 3).

- Note: This search could be considered a *search filter*. It could be run and then combined with a subject search.

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Search Example 10: A comprehensive search for problem based learning within dental education.

```
1      Problem-Based Learning/
2      experiential
3      active
4      case based
5      problem based
6      pbl
7      exp EDUCATION/
8      exp LEARNING/
9      ed.fs.
10     6 or 7 or 8
11     10 and (2 or 3 or 4 or 5 or 6)
12     1 or 11
13     exp Dentists/
14     dentist$ or dental
```

15   13 or 14
16   12 and 15

1) Problem based learning is a *MeSH*, but does not need to be *explode*d (no subordinate terms) or *focus*ed (wanting anything on the concept).
2) *Indexing* for the *MeSH* is not comprehensive and *free-text* must supplement the first search command. Users can decide upon their own synonyms and/or see the Used For terms from the *Scope* notes.
3) A second synonym.
4) A third
5) problem based learning does an automatic phrase search for the *free-text*
6) Finally, pbl is a frequently used acronym that appears in citations that are exclusive of the options above. Unfortunately PBL can also mean 'peripheral blood lymphocytes', amongst other things, and this line needs to be qualified to ensure the context is educational.
7) exp EDUCATION/ or education uses the *explode*d *MeSH*
8) learning or exp LEARNING/ uses the *explode*d *MeSH* and the *free-text* in addition
9) Searching ed.fs. finds all citations with the floating education *subheading*.
10) Combines all broad descriptors for education/learning.
11) The education/learning descriptors are combined with the ambiguous pbl and the synonyms.
12) Combining these lines identifies all relevant problem based learning citations.
13) The *explode*d *MeSH* for dentists (dental education is covered by the explosion in line 8)
14) A *free-text* search for dental as well as dentist, dentistry, etc. in case no *subject heading* has been assigned
15) The dental components are combined with OR
16) The final two sets are combined with AND.

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Search Example 11: Any use of portfolios for assessment in an educational environment.

1   portfolio$ [*free-text*]
2   exp education/
3   exp learning/
4   1 and (2 or 3)
5   exp Educational Measurement/
6   assess$ [*free-text*]
7   evaluat$ [*free-text*]
8   apprais$ [*free-text*]
9   5 or 6 or 7 or 8
10   4 and 9

1) Portfolio is not a *MeSH* and must be searched as *free-text*. The *truncation* identifies both singular and plural for the noun.
2) As any education environment is desired, the *MeSH education* should be *exploded*.
3) *Learning* is a *MeSH* that is not subordinate to *education* and is relevant to the search. (*Note: Depending on the search query, learning should be considered as an addition to education *MeSH* as it can improve *sensitivity* significantly.)
4) The nesting ensures either of the *MeSH* are searched first; the results are then combined with the *free-text* search.

5) Searching for assessment in Medline is problematic. There is a *MeSH* that covers the concept (*Education Measurement*), but unless the user knows this already the term they enter is unlikely to map to the correct *MeSH*. Furthermore, *indexers do not always use Education Measurement* and in order to be comprehensive a *free-text* search must complement the *controlled vocabulary*.

6) Assess$ picks up all the variations of assessment e.g. assessor, assessed, assessing etc.

7) The various permutations of evaluation must also be searched. The definition of assessment can differ between authors, abstracters, indexers, and geographical areas and synonyms for assessment must be searched.

8) Appraisal and its derivatives should also be searched. Adding the *free-text* steps 6,7, and 8 will decrease overall search *specificity*, but it is necessary to improve the inadequate search *sensitivity* from educational measurement.

9) The Boolean OR combines the *MeSH* with all *free-text*.

10) The assessment concepts are added to the statements that identified portfolios within education or learning.

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Managing Information

Bibliographic management software is a valuable tool for anyone regularly reviewing the literature or collecting references and information sources in specialist subject areas. Essentially, bibliographic management software is personal *database* software purpose-built for organising bibliographic references to information resources, whether the resources are journal articles, book chapters, websites, or in other formats.

These are personal *database*s that allow (with variation between products):
- easy searching, sorting and extracting of relevant references;
- importing of records from *database*s like Medline;
- removal of duplicate references (very useful for compiling search results from multiple *database*s, e.g. Medline and ERIC);
- insertion of references during writing, without re-keying or copying and pasting citations;
- automatic formatting of citations in styles required by publishers

Some of the most well known commercially available products are EndNote (http://www.endnote.com/), ProCite (http://www.procite.com/) and Reference Manager (http://www.refman.com/) (all of which are now owned by the Institute for Scientific Information). Shapland (1999) has produced a comparison of Papyrus (http://www.researchsoftwaredesign.com/) with these and other products which is helpful in assisting prospective users to choose a suitable package.

Recent releases or add-ons of some bibliographic management products allow users to make their personal *database*s available to others via the web in a searchable format (the Association for Health Information and Libraries in Africa and WHO have used this facility to provide access to the African Index Medicus (http://whqwings.who.int/RIS/RISWEB.isa/).

Most bibliographic software is client-based – that is, installed on a computer (or local network drive), but there is a trend toward remote server-based software that is accessible via the *World Wide Web*. This is of benefit to those who move regularly between computers and have reliable and inexpensive access to the *Internet*. Two

products in this format are RefWorks (http://www.refworks.com/) and WriteNote (http://www.writenote.com/). Functionality of these server-based products is limited compared to client-based software, but this is an area worth watching.

A BEME Approach to Searching

"The real voyage of discovery consists, not in seeking new landscapes, but in having new eyes." Marcel Proust (1871 - 1922)

Too many people search in the patterns and methods they are used to; consulting the same sources in the same way they have always done. For BEME a search needs to be flexible. BEME's *inclusive* approach to research and practice is also reflected in its evidence searching methods. Any systematic search requires a number of sources to be consulted, but this guide has illustrated how important it is for medical education to consult a wide variety of sources. These sources span not only education and medicine/health, but also cross professional boundaries within education and health. Search strategies must be broad and *inclusive*, and potential evidence not dismissed either because of its source (be it peer-reviewed or *grey literature*) or the methods by which it was found (*database*, web search, or word-of-mouth).

A notable difference between BEME's search methods and that of systematic medical searches is illustrated by the use of *search filter*s. These pre-constructed searches are frequently employed in medical searches to help answer clinical problems. Originally these filters were based on work done at McMaster University (Haynes 1994), and they have been widely implemented and adapted. Depending on the type of clinical question (aetiology, diagnosis, prognosis, and therapy) a filter is selected to retrieve the type of study design deemed to be most suitable for these clinical questions. With medicine's emphasis on methodologies, there are also filters to extract particular study designs.

However, from its onset, the BEME Collaboration has favoured an *inclusive* approach with regard to study design, and consequentially has not required searches to isolate particular methodologies. Not only is medical education research broadly dispersed across all types of study design, quantitative and qualitative, but the ongoing work by such groups as the BEME Collaboration indicates that *inclusive*ness may serve medical education better than exclusion. In fact, given that medical education research design is not as rigidly defined and implemented as in medicine, it might not even be presently possible to design comparable filters - even if it were desirable.

A Look Ahead

A consistent theme throughout this guide has been the difficulties presented by lack of standardisation – of information sources, publication formats and search methods.

Figure 25: *Tower of Babel, Pieter Bruegel, 1563.*

Relief, however, may not be too far off in the future. International standards for *metadata* are currently being established by groups such as IMS (www.imsglobal.org/) and Dublin Core Metadata Initiative (http://www.dublincore.org/). As standards become available and are adopted, many of the current time-consuming and frustrating experiences faced will be alleviated whether searching *database*s or the *Internet*.

The technical *metadata* initiatives mentioned above would set the frameworks for interoperability, but medical education still requires interpretative (descriptive) metadata. This interpretative metadata would define the concepts and processes unique to medical education, as well as the concepts and processes shared with other professions. The Medical Education *Thesaurus* Research Organisation (METRO) (http://srv1.mvm.ed.ac.uk/metro/index.asp) has already set out to do this. Sponsored by LTSN-01 (www.ltsn-01.ac.uk/) and NHS Education for Scotland (www.nes.scot.nhs.uk), the group aims to have identified, created and/or mapped relational descriptors for medical education within Britain, with the ambition to then extend and apply the work through international collaboration.

While comprehensive searching for medical education presents difficulties that are tangible (though hopefully this guide prevents them from seeming insurmountable!), the progress towards standardisation offers great promise. Standardisation will not mean assimilation. Instead it will allow the exchange of the rich and diverse ideas and experiences between medical education's dispersed professionals and practitioners.

"Opinion is that exercise of the human will which helps us to make a decision without information. " John Erskine

Yet retrieving the information is just one step in evidence based practice; information retrieval is followed by appraisal and synthesis. At time of press, the first Topic Review Groups of the BEME Collaboration are completing their systematic reviews which will begin to be published in the latter half of 2003. As their work is reviewed and shared, one can hopefully look forward to future BEME guides that further enable medical educators to base their practice on best evidence.

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Glossary

Ancestry searching	The process of searching the bibliographies of relevant papers to discover references missed by other methods.
Bibliographic database	A database containing bibliographic information about publications, like title, author and so on, but not usually the full text of publications.
Blogs	"Web logs". Individuals' chronological personal writings and collected links.
Boolean algebra	AND, OR and NOT are combining commands that you can use to combine search terms and therefore refine your results. Boolean algebra is also known as 'Boolean logic' and the commands as 'logical operators'.
Broader	In the context of Subject headings, means a Subject heading that is more general in scope or at a higher level in the hierarchy of the Controlled thesaurus.
Concepts, search	The subject(s) of a search. Search concepts can be ideas, theories, outcomes, interventions or populations.
Controlled thesaurus [or index or vocabulary]	A controlled thesaurus is a list of standard subject terms from which indexers select subject headings to describe the content of articles or other publications in a consistent manner.
Database	A structured electronic information file, maintained to facilitate the retrieval of information.
Database fields	A logical defined unit of data e.g. author, subject heading, year
Exhaustivity	The level of subject detail to which publications are described by indexers – ideally, a Controlled thesaurus should be comprehensive enough to allow to a
Explode	Exploding a subject heading retrieves all its smaller subordinate terms. In general, it is always a good idea to Explode to ensure a search is comprehensive.
Focus	When you search a subject heading with Focus, that subject heading will be an essential concept to all results retrieved. This reduces the number of the results and may result in missed items, but increases the relevance.
Free-text search	A search that will look for a term or phrase in all specified or available fields, regardless of contextual meaning.
Granularity	The degree of description or detail; related to the scope of terms, particularly with regard to the level of detail indicated by Subject headings, where high granularity is equivalent to a very narrow subject heading and low granularity is equivalent to a broad subject heading.
Grey literature	That which is produced on all levels of government, academics, business and industry in print and electronic formats, but which is not controlled by commercial publishers. (4th International Conference on Grey literature, 1997)
Hand searching	Hand searching is literally the searching of print (or electronic) journals volume by volume, issue by issue, article by article.
Hit	A search result – referring to the records matching your search term.
Html	Hypertext mark-up language – most web pages are written with this.
Hyperlink	A link that takes your web browser to another location.
Inclusive	Encompassing all the concepts described. Synonymous with

sensitive.

Indexing	The process of classifying an item (for example an article) with subject descriptors to make it easier to retrieve.
Internet	The worldwide network of computer networks.
MeSH	Medical Subject heading – the terms in the Controlled thesaurus created by the National Library of Medicine and used by indexers to describe the content of articles indexed in Index Medicus (and therefore PubMed and Medline).
Metadata	Descriptive information, like bibliographic details, but also subject headings, publication type, language, etc. A bibliographic database like Medline is full of metadata, but not usually the full-text articles (that is, the data itself).
Methodology filter	A 'ready-made' search of terms that will retrieve specific types of reports, e.g. cohort studies, controlled trials, diagnostic use, etc. Filters are not usually subject specific – they are meant to be applicable to any subject search.
Narrower	In the context of Subject headings, means a Subject heading that is more specific in scope or at a subordinate level in the hierarchy of the Controlled thesaurus.
Polysemy	Polysemy occurs when a search term has multiple meanings, e.g. simulation, which could be about computer simulations, heuristics, the Markov Processes, role-playing, or patient simulators. Polysemy is one cause of irrelevant results from free-text searches.
Precision	In database searching, means the proportion of hits that are relevant. A search with high precision has few irrelevant results, and is also described as having high 'specificity'. A danger with highly precise search techniques is that some relevant information will be missed because it wasn't well described by the author or indexer.
Proximity operator	Proximity (or adjacency) operators are used when one wants to find two or more terms within a certain distance of one another and can usually only be employed in free-text searching. The operator varies between search interfaces e.g. 'adjx' (Ovid), 'nearx' (Silverplatter), where 'x' refers to the number of words apart the search terms may appear; or 'same' (Web of Science) which requires the words to be in the same sentence.
Qualitative research	Research involving detailed verbal descriptions of characteristics, cases, and settings. Qualitative research typically uses observation, interviewing, and document review to collect data.
Quantitative research	Research that examines phenomena through the numerical representation of observations and statistical analysis.
Recall	In database searching, the proportion of relevant hits retrieved by in a search – a search with high recall is called 'sensitive'.
Scope	The extent or range of a subject.
Search engine	An enormous database of internet sites, usually compiled by robots.
Search filter	A search filter is a series of search commands designed to retrieve a particular type of result. Filters might be created to locate a particular type of study (e.g. controlled trials) or query specific (participants, educational aspects, outcomes) studies (e.g. undergraduate students, OSCEs, or competencies).
Search interface	The "front end" to a database – what you see when you are

searching. This phrase can also imply the tools and facilities presented by the programming behind the interface.

Search set	A single search statement – for example, in a search history like the one built up in the sample Medline search in this guide, each line in the search history is a 'set'. Building up a history of search sets as in the sample is called 'set searching'.
Search strategy	Sometimes used interchangeably with 'search history' but can also refer to a larger systematic strategy for retrieving information that also includes handsearching journals and discovering unpublished research.
Selectivity	The choice of Subject headings made by the indexer to anticipate the concepts of greatest utility to the database user; also the degree to which a search is specified or narrowed.
Sensitivity	When referring to a literature search, means inclusive, so that you get more hits, and may get some irrelevant ones. Synonymous with high 'recall' in that a sensitive search aims to retrieve the highest proportion possible of relevant database records.
Specificity	When referring to a literature search, means exclusive, so that you get fewer hits to sift through, but may miss some relevant information. Synonymous with 'precision'.
Subheading	In the context of Subject headings, represents a popular facet of study related to a Subject heading
Subject heading	A term used to describe the content of a publication – usually derived from a Controlled thesaurus.
Synonymy	Where concepts can be named using different terms – this a problem with free-text searching, which requires you to think of as many terms as possible to capture the various words or phrases that authors could use in writing about the same concept. In theory, Subject headings should mitigate this issue.
Thesaurus	See Controlled thesaurus
Truncation	Truncation (or wildcard searching) is the substitution of a character to retrieve variations in spelling and word ending. It cannot be utilised with the set terms of a controlled vocabulary, but is a powerful aid in improving the sensitivity of free-text searches. The truncation symbol varies from one search interface to another (see help or search tips to find out). Ovid uses the $: portfolio$ - finds the singular and plural (portfolio or portfolios) evaluat$ - finds multiple variations, evaluate, evaluation, evaluations, evaluative, evaluator, etc. Internal truncation is also possible. With Ovid, the # can be used to find spelling variations between versions of English: an#esthesia or "standardi#ed patient$".
URL	Uniform Resource Locator – a website's address: www.bmj.com.
Usenet	Archived electronic discussion lists on nearly any topic imaginable; first appeared on the Internet in 1981.
Web browser	A software application that lets you view web documents written in html – like Netscape or Internet Explorer
World wide web	One part of the Internet – other parts include email and discussion groups.