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Twelve tips for undertaking a systematic review

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SUMMARY *The need to underpin health and education with a firm evidence base is of increasing significance. Systematic review offers an effective approach to critically assessing research in order to understand its overall impact on practice. Based on 5 years' experience undertaking systematic reviews of interprofessional education, this paper offers guidance for researchers and practitioners about to embark upon systematic review work.*

Introduction

The need for research evidence to inform health and education policy and practice is now well established (e.g. Department of Health, 1997, 1998; Harden *et al.* 1999; Davies *et al.*, 2000). Robust, well-conducted research can provide important information for practitioners, policy makers and service users. However, locating all the evidence within a certain field and understanding its significance for practice is a complicated process. Systematic reviews can help in this area.

Systematic reviews provide a critical synthesis of research evidence relating to the effects of specific 'interventions'. This type of enquiry involves searching and analysing *all* available evidence in a *systematic* and *transparent* fashion. For Evans & Benefield (2001) a systematic review requires:

... an explicit research question to be addressed, transparency of methods used for searching for studies, exhaustive searches which look for unpublished and published studies, clear criteria for assessing the quality of studies (both qualitative and quantitative), clear criteria for including and excluding studies based on the scope of the review and quality assessments, joint reviewing to reduce bias [and] a clear statement of the findings of the review (p. 529).

A number of review bodies now promote and disseminate systematic review work. These include: the Cochrane Collaboration; the Campbell Collaboration; the Centre for Reviews and Dissemination; Best Evidence Medical Education and the National Institute for Clinical Excellence [1]. The shared aim of these bodies is to build a substantial evidence base for practitioners, policy makers and service users.

Members of our group have been working on systematic reviews for over 5 years as a way of contributing to the development of an evidence base for interprofessional education. To date, we have produced two reviews: one completed; the other ongoing [2]. The first review was registered with the Cochrane Collaboration. It focused on

establishing the effects of interprofessional education in relation to three research designs (randomized controlled trials, controlled before-and-after studies and interrupted time-series studies) and two outcome criteria (changes in organizational and/or patient outcomes). See Zwarenstein *et al.* (1999, 2001) for further details on this review.

During our work on the first review we found a number of studies that, despite falling short of our initial inclusion criteria, offered potentially useful insights into the wider range of effects produced by interprofessional education. Interested in pursuing this work in more depth, our group embarked on a second review. The aim of this work was to be less constrained by methodological and outcome criteria. Details of our ongoing review can be found in Barr *et al.* (1999a, 1999b); Koppel *et al.* (2001); Hammick *et al.* (2002) and Freeth *et al.* (forthcoming).

This paper offers a series of reflections on our collective experience of systematic review work. Its aim is to provide practical guidance to researchers and practitioners about to begin a systematic review.

Tip 1

Pay attention to group-forming processes. Be careful not to underestimate the effort required to form your review group. These processes are crucial in providing firm foundations for your review.

Systematic reviews are a group activity. There are a number of reasons for this. Primarily, review work involves a considerable amount of effort searching and analysing a large volume of research literature. Sharing these tasks means that your review can be managed more effectively. Teamwork is also important as it allows members of your group to debate, clarify their ideas and obtain peer support during the lengthy process of completing a review.

The significance of teamwork in conducting a review means that you need to consider a number of issues in forming your group. First, there is a need to consider group size. Although there is no ideal number, do be aware of certain trade-offs. For example, larger groups can share the workload more widely. However, larger groups may encounter logistical problems when working together (e.g. finding a suitable time for *all* members to meet). It is likely that the ideal number lies between four and eight. In our experience, a group of five has effectively achieved a

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balance between sharing the workload and overcoming the logistics associated with working in a larger group.

Second, in recruiting potential members to your group it is helpful to initially invite a number of interested colleagues to discuss the possibility of undertaking a review. We found this process allowed time to explore and share our assumptions and ideas about the work. As a result of these early discussions some of your members may decide to opt out (usually because of competing commitments or lack of enthusiasm for the review process). This process is helpful as it allows a 'core' of like-minded and similarly interested reviewers to emerge.

Finally, it is helpful, if possible, to form your review group from a mix of different professions. The diversity of perspectives and experiences that come from an inter-professional group can be beneficial in meeting the different demands required from a systematic review. We have found that the interprofessional nature of our group (we have representation from medicine, radiography, social work, sociology and education) has been particularly useful in fusing together our different knowledge bases and skills to enrich our work.

Tip 2

A number of initial tasks need to be undertaken in the early stages of your review. Take time to complete this early work as decisions you make at this stage will influence the subsequent direction of your review.

Following the formation of your group, there are a number of initial tasks you need to undertake. First, discussion on and clarification of the following areas is required: the question(s) your review is trying to answer; definitions of terminology; your inclusion/exclusion criteria. Explicit agreement in these three areas is crucial. They provide the parameters that will shape your review. Our group took considerable time discussing and debating each of these issues. This time was important in allowing us to develop a shared understanding of our work. A word of caution: it may be difficult to invite new members into your review group after this stage as any new members are likely to find it hard to 'catch up' and understand the norms and meanings jointly held by the group. Nevertheless, if you do encounter this situation, you will need to dedicate additional time to allow a new member to get 'up to speed' with all the decisions, debates and agreements that have occurred.

The next task is to agree on the range of sources that you will search to locate any research evidence. There are two main sources to consider: electronic bibliographic databases (e.g. Medline, CINAHL) and the 'grey' literature (e.g. unpublished theses, conference proceedings). Strategic thinking in this aspect of your review is essential. It is more effective to target the searches to a few directly relevant databases, rather than attempt to search a large number of databases. More on this later.

In this initial phase of your review, agreement around the group's division of labour is also necessary. Time is needed to discuss the various roles and responsibilities each group member will adopt to complete the review. In our group, two members lead the searching and

abstracting, while other members are more involved in appraising the quality of studies, analysis and writing-up. So far, this approach has been beneficial. It exploits the range of skills, abilities and interests that lie within our group. Clearly, if problems do arise around an agreed working arrangement, you will need to negotiate a new division of labour (with an extended time frame) within your group.

At an early stage in your review, it may be useful to consider submitting the work to one of the review bodies that promote and disseminate systematic reviews (see above). This can be advantageous. You will be able to obtain support when undertaking your review and help in disseminating the completed work. Association with these bodies can also increase the profile of your review. However, it should be remembered that once a review body has accepted your work, it must then be developed, undertaken and written up within its particular parameters.

Tip 3

Expert input is advantageous in progressing your systematic review. This input is especially invaluable for inexperienced review groups.

In some groups, there may be a lack of expertise about how to undertake a review. Expert input is invaluable and should be sought. Three sources of expertise should be obtained.

Input from an experienced systematic reviewer can provide a valuable resource. This was the case for our group when we started in 1997. By contacting the Cochrane Collaboration, we were put in touch with a person who had experience in systematic review work. Initial guidance and training was extremely useful in developing the skills required for our subsequent review work. We found it necessary to devote 5 days to our initial training. Some groups might find that they need less time. Nevertheless, this time is useful for the 'storming' and 'norming' processes (Tuckman & Jensen, 1977) that are crucial for successful group work.

In the early stages of your review, the expertise and experience of a statistician is recommended. Their input is invaluable in both planning your data analyses and offering advice when you reach this part of your review.

Finally, a professional librarian/information scientist is another vital source of help. This person can provide assistance in developing your search strategy and also offer help in identifying the most relevant range of electronic bibliographic databases you should search (see below).

Tip 4

Hold regular meetings. Coming together in the same space enables in-depth discussion and debate to occur. This not only maximizes opportunities for making good progress with your review; it also helps produce high-quality work.

The work of any group benefits from regular interaction. Therefore, when undertaking your review, it is helpful to identify regular team time to come together to discuss progress, consider any problems and plan future work.

Being based in different universities (City, Birmingham and Westminster) in different geographic locations (London and Birmingham), we commonly rely on information technology (email, Internet) to support and progress our work. However, we find these forms of communication are no substitute for coming together to meet and discuss our review. This time is important as it allows regular debate and clarification with our work.

In our experience, a half-day meeting every 3–4 months is helpful in sustaining the momentum of our review. For equity between group members, the location of these meetings alternates between London and Oxford.

Tip 5

Developing a protocol for your review is vital. It provides an explicit plan of your proposed work. Such transparency ensures you produce a rigorous review.

Development of a protocol is the next stage in the review process. A protocol has three purposes. First, it provides a detailed description of your review. In doing so, your protocol should incorporate the following sections:

- background information outlining the rationale for your review;
- the aims of your review;
- inclusion and exclusion criteria;
- your search strategy;
- the methods you intend to use for extracting data from eligible studies;
- details of your approach to abstracting key information from each study;
- information on how you intend to assess the quality of included studies.

Second, the production of a protocol is helpful in setting out all the initial decisions you have taken with your review. Thus it provides a ‘mission statement’ for the group. However, it is important to remember that a review protocol is a living document. It is likely to evolve in the light of group discussions around the various issues and problems you may encounter as your review proceeds.

Third, a protocol is useful in allowing peers to scrutinize your intended approach. Such transparency is crucial. Peer feedback can identify any potential weaknesses or oversights in your proposed review. This will strengthen your work and contribute to a more rigorous review.

Tip 6

The development of an effective database search strategy is crucial. Spend time testing your strategy and be sure to amend it when using different databases. Also, think carefully about the range of sources you will search.

The best mechanism for locating research material is electronic bibliographic databases such as Medline or CINAHL. These software applications allow you quickly and easily to locate a range of published research material. To enable you to use an electronic database for your review an effective search strategy needs to be developed. We took around 3 months developing and testing a strategy that we could confidently use in our work. This process involved

an initial group brainstorm to generate potential ‘subject headings’ [3]. To accommodate the large number of phrases that are employed to describe interprofessional education (some of which may not be used as subject headings) we incorporated a number of additional search terms (e.g. ‘multi-institutional training’) during our brainstorming session. Both subject headings and additional search terms were then constructed into a more formal strategy with the help of a professional librarian/information scientist. This preliminary strategy was then tested and modifications made. For example, one of our modifications was to include both hyphenated and non-hyphenated versions of our additional search terms (e.g. ‘interagency’, ‘inter-agency’). This resulted in an increased yield of potential studies for our review.

Having spent time discussing and agreeing your search strategy, you need to consider the range of sources you will search. Again, input from a professional librarian/information scientist can be helpful at this point. In our review, so far, we have searched Medline and CINAHL. We began searching these two databases as between them they abstract the largest number of healthcare journals in the world. We have plans to expand our search to other relevant health and education databases (e.g. British Educational Index, EMBASE, ERIC) to ensure that we have located all relevant published material for our review.

Care is required when searching different databases. A search strategy developed for one database needs to be modified for other databases as they often use different subject headings to abstract studies. For example, whereas Medline uses ‘interprofessional’ as a subject heading CINAHL does not. Similarly, Medline uses ‘health care outcomes’ as a subject heading, whereas CINAHL uses ‘outcomes (health care)’. Failure to alter subject headings when using different databases can considerably reduce the yield produced from your search.

You should also consider other possible sources in your search for relevant studies. Hand searches of specialized journals, searches of the grey (unpublished) literature and contacting recognized experts working in the same field as your review can all be helpful in locating a variety of potential studies. It is important to employ a combination of different methods when searching for literature. As McManus *et al.* (1998) found, combining electronic database searches with hand searches of journals and grey literature searches doubled the yield of material produced in their review.

Tip 7

Be flexible. Where you encounter problems, consider refocusing the review to make it more manageable within the restrictions of time, cost and the available literature.

It is sometimes necessary to refocus the aims of a review. After an initial search, it may be discovered that the aim of your review is too broad. This can occur when, for example, a literature search produces an unmanageable number of studies. Given limitations of time and resources, you may need to refocus your work to produce a ‘narrower’ review aim and thus a more manageable amount of material.

In refocusing, you may decide to split the work into a number of different but related reviews. This was necessary in our work. As noted above, our initial review was organized around meeting strict methodological and outcome criteria. During this work we came across a number of potentially interesting studies that we felt could contribute to the knowledge base if systematically reviewed. In refocusing our review we expanded the methodological and outcome criteria to include all studies that produced educational, organizational and/or health-related outcomes. In addition, our initial review question changed from 'does interprofessional education work?' to asking, 'what kind of interprofessional education, under what circumstances, produces what kind of outcomes?'

We also refocused our work in another area. While we were originally interested in studies that had 'explicit' educational input, we found that a number of quality assurance studies that followed a well defined audit or guideline development process offered useful insights into 'implicit' approaches to interprofessional education. Consequently, our original definition was revised to incorporate both formal and informal evaluations of interprofessional education.

Tip 8

An ongoing system of quality assurance is vital within any systematic review. It ensures that potential biases introduced by your group are minimized.

During any review it is essential that you are vigilant about bias you may introduce into your review. A number of quality mechanisms should be developed to minimize this problem.

Searches of the literature are likely to produce a large quantity of material that all needs to be assessed before a decision is made on its eligibility for your review. When undertaking this process, it is vital that at least two members of your group read (independently of each other) all the potential material. A discussion should then take place between these individuals to agree which material to include. Where there is any continuing disagreement between reviewers, a third member of your group should mediate.

Like any review, you need to employ a two-stage quality process in your work. The first stage focuses on an assessment of each abstract generated from your literature searches. If it is felt that an abstract meets your inclusion criteria, the full paper should then be obtained. The second stage involves an assessment of each paper to finally decide whether it should qualify for your review. During both these stages, at least two members of our group independently assess the material. They should then come together to discuss and agree their decisions.

We have added a further quality check into our work. For consistency, one member of our group undertakes data abstraction of all the full papers. To ensure that quality of abstraction is maintained, around 10% of studies are abstracted separately by different members of our group. Where a discrepancy is encountered, further discussion is undertaken to ensure that the work remains focused.

Tip 9

Dedicate time to developing an abstraction sheet that can reliably record the key information you need from included studies. Be prepared to produce and test a number of drafts before your group is satisfied.

Once your literature searches have been completed and agreements made over the eligibility of studies, the next stage in your review is to extract data from all your included studies. The purpose of this process is to record, in summary form, key information from each study. This information is ultimately used for the analytical basis for your work. Three types of information are normally abstracted:

- Contextual information (e.g. details on the location where the research took place) is needed to examine the possible effect of this factor on outcomes.
- Methodological information (e.g. research design, sampling, data-collection method, data-analysis method, consideration of bias) is needed to judge the overall quality of studies.
- Outcome information (e.g. main results from each study) is needed to establish commonalities and discrepancies between studies.

In our work, the creation of an abstraction sheet involved identifying specific aspects of information we needed to record from each paper. For example, in relation to the contextual information we felt the duration of an interprofessional course might have an influence on shaping the outcomes from this activity. We therefore ensured that our abstraction sheet contained a section where this information could be recorded. Through brainstorming and discussion we produced a first draft of our abstraction sheet. This sheet was then tested by each member of the group abstracting information from a small number of papers followed by discussion of the process and comparison of data each member recorded. Whilst developing our sheet, we kept asking ourselves: What are the questions in our research? Are the categories in the sheet appropriate? Are they likely to produce adequate information for our analysis? Group discussion and debate played a large part in this developmental process. Overall, it has taken six drafts to design an abstraction sheet that we felt could adequately extract all the information we wanted for our analysis.

Tip 10

Ensure that your group develops a reliable data-handling system to manage the vast amounts of material generated from your review. Nominating one member to take charge of this work can be effective. Also, consider the use of specialized computer software.

As undertaking a review involves handling large quantities of material (e.g. abstracts, full papers) it is vital that data are handled efficiently and effectively. Lost information causes unnecessary delay, repetition and frustration. In our group, one member leads this work. In having an 'information coordinator', it is ensured that all information is passed through a central point.

Our information coordinator keeps a ‘master record’ of the information we generate from our review (e.g. records of all material produced from our searches). This system permits us to keep track of all the abstracts and papers that were allocated to members of the group when undertaking the quality check processes outlined above.

In terms of the material produced from our searches of the electronic databases, our work is helped by the use of *Reference Manager* (a software package for handling bibliographical information). This software allows us to download all abstracts produced from a database search and allocate each a unique identification number. Another advantage of the software is that we can easily identify any duplicate abstracts produced from different database searches.

Tip 11

The analysis stage of your review can be a slow and complex process. Ensure you dedicate sufficient time to develop, discuss and explore all emerging analyses.

Once you have agreed which studies qualify for inclusion in your review, the next process is to begin analysing this material. The analysis draws together all the findings from the included studies in order to offer synthesized information on the content, methods and outcomes. It is usually presented in the form of a structured narrative detailing the aggregated findings from a review. Importantly, the analysis also offers an overall assessment of the quality of evidence presented in the studies to provide conclusions on the current state of the evidence base in a particular area.

Our analysis adopted the following process. Initially, we agreed how we would code our abstracted data on to SPSS (a software package for statistical analysis). These data were then fed into the software and time was spent ‘cleaning’ the data (i.e. searching it for data-entry errors). A simple frequency count of all the categories was then generated to stimulate discussion. As a result, a number of questions began to emerge around potential associations between some of the categories. Based on this work, we then began testing a number of provisional hypotheses. For example, one hypothesis stated that there would be an association between the ‘stage’ of an interprofessional education course (e.g. pre-qualification, post-qualification) and the reported outcomes. By undertaking this process we have begun to identify a number of emerging associations between our categories. Further details of our analysis can be found in Koppel *et al.* (2001) and Freeth *et al.* (forthcoming).

Assessing the overall quality of evidence contained in the eligible studies is a complicated but essential process during the analysis of a review. Like our work in previous stages of our review, we spent a number of months discussing and developing a system that we felt could provide a robust indication of the quality of evidence we were finding. We produced a system of two five-point scales (5 represents the highest score in both scales). The first scale assessed the ‘methodological quality’ of eligible studies. This scale took into account factors such as the appropriateness of an evaluation design in relation to its research question(s), whether selection of participants

rested on clear criteria and whether issues of validity/reliability or authenticity/trustworthiness had been addressed. The second scale assessed the ‘clarity of information’ contained in studies. This scale took into account factors such as whether there had been a clear rationale for the evaluation, whether there was sufficient information on sampling, ethics and possible bias and whether the analysis had been described in sufficient detail.

Using this approach, for example, where the research questions were appropriate to a quantitative research design, a well-conducted controlled before-and-after study would score highly, provided sampling, data collection/analysis and consideration of ethics and bias were appropriate and were all adequately described. Similarly, where the research questions were process orientated, a well-conducted ethnographic study would score highly, provided the issues of reflexivity, relevance, authenticity, trustworthiness and ethics had been appropriately considered and well described. For a more detailed explanation of this part of our work, see Freeth *et al.* (forthcoming).

Tip 12

If possible, incorporate ‘workshop time’ during your review. This type of time can nurture a deeper level of thinking and collaboration within your group.

As indicated, undertaking a systematic review involves considerable effort. This task is generally made more difficult by normal workplace interruptions. Therefore, whenever possible, it is helpful if your group can take time away from these environments to work together on your review. Spending this type of focused time together will allow you to make good progress. Intermittent, partial funding for our work has allowed us to buy time together in the form of a two-day workshop once per year. Each period of concentrated workshop time has resulted in significant progress, new insights and renewed motivation for our review.

These workshops have also been useful in providing informal time to bond more closely as a team. As a result, a good level of trust has developed within our group. This has been advantageous in dealing with the inevitable differences of opinion that emerge in any group. For us, such tensions have helped create a constructive and open atmosphere that allows a free exchange of views. Progress cannot be guaranteed without this degree of openness.

Concluding comments

The amount of effort needed to produce a rigorous systematic review should not be underestimated. As indicated, systematic review work is slow and complicated. In offering these 12 tips, it is hoped that newly formed review groups will be better equipped to undertake and produce high-quality systematic reviews.

Notes

[1] Further information on these review bodies can be found by going to the following websites: the Cochrane Collaboration (www.cochrane.org); the Campbell Collaboration (www.campbell.gse.upenn.edu); the Centre for Reviews and Dissemination (www.york.ac.uk/inst/crd/welcome.htm); Best Evidence Medical

Education (www.bemecollaboration.org) and the National Institute for Clinical Excellence (www.nice.org.uk/nice-web).

[2] This first review was undertaken by Jo Atkins, Hugh Barr, Marilyn Hammick, Ivan Koppel, Scott Reeves and Merrick Zwarenstein. The group re-formed for work on the second review: Jo Atkins and Merrick Zwarenstein withdrew and Della Freeth joined.

[3] Subject headings are words, terms and phrases used to abstract research studies contained on electronic bibliographic databases.

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