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The benefits of publishing systematic quantitative literature reviews for PhD candidates and other early career researchers

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The benefits of publishing systematic quantitative literature reviews for PhD candidates and other early career researchers

Abstract

Universities increasingly expect students to publish during a PhD candidature because it benefits the candidate, supervisor, institution and wider community. Here we describe a method successfully used by early career researchers including PhD candidates to undertake and publish literature reviews — a challenge for researchers new to a field. Our method allows researchers new to a field to systematically analyse existing academic literature to produce a structured quantitative summary of the field. This method is a more straightforward and systematic approach than the traditional ‘narrative method’ common to many student theses. When published, this type of review can also complement existing narrative reviews produced by experts in a field by quantitatively assessing the literature, including identifying research gaps. The method can also be used as the initial step for further analysis, including identifying suitable datasets for meta-analysis. Students report that the method is enabling and rewarding.

Keywords: PhD students; doctoral education; publication output; research student; thesis.

Introduction

‘Publish or perish’ has become the dogma in many Australian universities (Bretag, 2012). New imperatives from university management to publish research papers are linked to measures of personal and institutional performance. These ‘performance-based’ imperatives have followed Australia’s adoption of a research quality framework and mirror the metrics underpinning international institutional rankings (ARWU, 2011). These recent developments in the academy have arguably ushered in a new ‘corporatised managerialist era’ of academic publishing (Norrie, 2012). And the imperative to ‘publish or perish’ now extends to PhD student publications, which are increasingly expected during a candidature (Lee & Kamler, 2008; Robins & Kanowski, 2008; Wilson, 2002).

To boost publication output, many universities now provide practical support for early career researchers, including PhD students. This support includes: greater involvement of supervisors in the publication process; publication workshops; writing groups; and other types of practical training (Lee & Kamler, 2008). Recent research suggests that many benefits accrue from such programs, especially increasing publication rates (McGrail et al., 2006). We are actively involved in this process with our own students, but also provide advice and run publication workshops for other early career researchers. We have found that publishing during candidature has direct and tangible benefits for PhD students, including: increasing research opportunities; improving competitiveness for scholarships; improved grant success; garnering awards; and importantly, securing permanent employment.

In this paper we offer a new method for producing and publishing literature reviews, using what we call a ‘systematic quantitative assessment’ technique. This technique is easy to use and offers insights that cannot be gleaned via more traditional ‘narrative’ approaches (Petticrew, 2001; Healy & Healy, 2010). It is systematic in terms of how papers are initially assessed for inclusion. In our technique, we enumerate the number, proportion, and type of papers dedicated

to the topic(s) under investigation including highlighting research gaps. By mapping the boundaries of the existing literature it is possible to identify where generalisations occur, and also the limits of those generalisations. Our method has proven to be effective in enabling early career researchers, including PhD students, to undertake systematic quantitative reviews of the literature for their chosen field (oftentimes a daunting task). More experienced researchers are also finding our method useful for assessing emerging trends within disciplines. Our method has enabled our students to efficiently and confidently conduct their literature reviews, and then submit them for publication within international peer-reviewed journals.

In the remainder of this paper, we discuss the method and how it can be operationalised, and we identify its strengths and weaknesses. We illustrate the various stages of the method using three case studies. We begin by addressing the specific benefits and challenges PhD researchers face when publishing. We then discuss our method in detail. We conclude by offering some suggestions for improving this approach. We should mention from the outset that the method we describe here is by its nature systematic, quantitative, and analytical. While embedded in a positivist paradigm — which is not universally supported (Hammersley, 2010) — our pragmatic approach to the initial stages of research has been very helpful for our students, and we feel it will help many others. Because our method approaches the literature review as a series of steps to be followed, it will obviously be better suited to some fields of research, and students/supervisors, than others (e.g. Hammersley, 2010). Nonetheless, as an ecologist and an urban geographer — each with different scholarly training and academic proclivities, we and our students have found this method invaluable.

Benefits and challenges of publishing during candidature

Aside from satisfying the obvious ‘publish or perish’ imperative discussed above, there are many benefits of publishing early in the PhD, benefits that accrue to students, supervisors, the

home institution and the general community (Kamler, 2008; Lee & Kamler, 2008; Macauley & Green, 2007). For students this includes an increased sense of achievement during the course of their study and improved motivation in progressing to the next stage of their research. The traditional thesis style, where the thesis is submitted at the end of three or more years, becomes a series of more discrete papers/chapters produced during the PhD. This allows the various stages of the PhD — assessing existing research, implementing methods and collecting data, analysis, and writing up results — to be broken down into separate but related projects (Robins & Kanowski, 2008). Mistakes common to novice writers of academic texts are thus made on smaller components of their work, and earlier in their studies, with the obvious benefit of quicker feedback and more time for reflection and improvement. Students obtain the benefit of multiple forms of feedback about their writing style, methods, analysis of results, and discussion of their work in relation to the literature — not only from their supervisor but also from journal reviewers (Kamler, 2008; Robins & Kanowski, 2008). This helps students to benchmark the quality of their work against that expected within their discipline, and to better understand the nature of academic research (Kamler, 2008; Macauley & Green, 2007; Robins & Kanowski, 2008).

Publishing papers at any time certainly helps with employment, promotion and obtaining grants (Macauley & Green, 2007; McGrail et al., 2006), but earlier is better. Within the new institutional environment where scholarly publications matter more than ever (McGrail et al., 2006), producing papers during a PhD increases a student's chances of securing permanent employment and provides them with an existing research record and broader profile in their research community than that provided by a thesis and conference presentations (Kamler, 2008; Robins & Kanowski, 2008). It also removes some of the pressure on first completing a PhD and then attempting to publish, which can become much harder once new commitments begin

(Robins & Kanowski, 2008). And because research can date rapidly within many disciplines, timely publication of results is often essential (Robins & Kanowski, 2008).

Supervisors can benefit from publication too. Benefits potentially include: a better return for effort from students (particularly where publication contributes to student completion); co-authorship; spreading supervision workload; and faster student completion. However co-authorship of publications is not automatic, and varies among students, supervisor and disciplines (Kamler, 2008; Robins & Kanowski, 2008). One effect of publishing during a PhD candidature, which could be either beneficial or problematic, is that publishing can change the dynamic between the supervisor and student depending on the circumstances (Robins & Kanowski, 2008). This may make for better relations, or worse, depending on who is responsible for the original research ideas, who does the most work, and who gets the credit for the research.

For universities rewards include more publications sooner, and hence a greater return for institutional investment of money, time, and resources to PhD students, including scholarships, supervision, laboratory or office space, library resources, information technology, and field resources (Macauley & Green, 2007). For examiners of the final thesis, the inclusion of work that has already been published simplifies the assessment process — although in some fields it may pose some issues in terms of originality of the research (Robins & Kanowski, 2008). For the research community, it means that new research may be disseminated faster, in more detail, and more effectively than by other methods such as conference proceedings (Macauley & Green, 2007). And on those occasions when students do not complete their PhD, which is far more common than often realised, students, supervisors, universities and the research community may still benefit from publications during candidature.

There are, however, three evident disadvantages to publishing papers during a PhD. First, the road to publication is not smooth. Writing and submitting research for publication can result

in anxiety, even for experienced researchers, which is often associated with feelings of being judged (Kamler, 2008; Lee & Kamler, 2008). This can discourage some students from even attempting publication (Kamler, 2008). Supervisors need to offer practical support and realistic advice during this process, highlighting how these types of feelings are common.

Reassurance is even more critical when students do submit a paper and it comes back with critical comments from one or more reviewers. Unless well managed, this can result in strong feeling of rejection (Kamler, 2008; Lee & Kamler 2008). The popularity of the '*Third Reviewer*' YouTube video highlights the generality of the problems arising from negative feedback from a reviewer, and reflects common stages of grieving (denial, anger, bargaining, depression and finally acceptance) (McKissock & McKissock, 2012). At this point, the involvement of supervisors and other more experienced researchers is important, particularly in reminding students that the reviewers' comments should be used as constructive criticism to improve the actual research, the paper, and the resulting thesis (Lee & Kamler, 2008), and in providing practical advice about how to revise the manuscript and respond to reviewers comments. Reviewers might be treated by students as a kind of 'partner', whose feedback will ultimately improve their writing.

A second disadvantage is the potential additional work for students, supervisors, journal editors, and reviewers that is associated with publication (Kamler, 2008; Robins & Kanowski, 2008). At the simplest level, the time spent formatting articles for different journal styles, including differences in referencing, may just add to student workloads (Robins & Kanowski, 2008).

Last, the long 'lead-time' involved in review, revision, acceptance, revising proofs and eventual publication can also mean that papers submitted during the course of a PhD may not actually be published (or even accepted) prior to thesis submission. It takes many months (sometimes much longer) from initial submission to final publication (Robins & Kanowski,

2008). When a paper is rejected by one journal and hence submitted to another, this increases both workload and time — even if it does eventually result in publication.

So publication is good, but why try to publish a literature review?

The first work undertaken by most PhD students is a review of the literature within their chosen field (Green, 2009). This allows students to familiarise themselves with the current status, theory and methods in their field. It also allows them to identify gaps that their own research could address (Green, 2009). Often the literature review is undertaken using a narrative method, where the student reads as much of the relevant literature as possible, assesses its importance, and then constructs a carefully argued narrative of their analysis of the current status of research – and current issues and themes (Green, 2009).

These types of narrative reviews are common in the academic literature for a wide range of disciplines, and provide important updates for the research community on research findings, locations and subjects (Collins & Fauser, 2005). Sometimes these reviews are commissioned by journals where they contact experts in the field to provide such reviews. However, such ‘narrative reviews’ (Healy & Healy, 2010), are highly subjective and hence are open to a range of potential biases (Petticrew, 2001; Borenstein et al., 2009). Consequently these reviews are more reliant on the expertise and authority of the author(s) than more systematic review methods (Borenstein et al., 2009).

Postgraduate students are also expected to be able to understand and evaluate what can seem to be a mountain of previous work (Kearns et al., 2008). Often it can be harder for students to distinguish relevant from irrelevant literature, and to know when to stop reading (Healy & Healy, 2010). How to turn any resulting document into a form suitable for publication can be challenging for four reasons: (i) narrative reviews are often less structured; (ii) such reviews will be read by an audience potentially more familiar with the area that the student; (iii) the

‘expertise’ of the author is important in giving authority to views, opinions and perspectives (Borenstein et al., 2009), and (iv) student researchers are less likely to have established track-records limiting their authority. Moreover, it is often expected that much of the initial literature review will contribute to the first chapter(s) of the final thesis. But when students come to write the thesis, they often find they not only need to include new literature published during their PhD, but they also must re-read the original literature to remember exactly how previous research relates to their own. Undertaking a systematic quantitative literature review potentially remedies these problems.

Why use a ‘systematic quantitative approach’ to literature reviews?

We recommend using an alternative type of literature review to the ‘traditional’ narrative style, to obtain the above-mentioned benefits and ameliorate some of the above-described problems. We have termed this a ‘systematic quantitative approach’. This type of review is systematic because the methods used to survey the literature, and then select papers to include, are explicit and reproducible. In other words, similar results should be obtained if the procedure is repeated. The review is quantitative because it quantifies where there is research, but also where there are gaps. And the review is also comprehensive because it assesses which different combinations of locations, subjects, variables and responses have been examined by researchers, and what they have found. By mapping the literature it is possible to highlight the boundaries around generalisations derived from the literature. The review is also structured because the process for collecting and analysing the literature, and for the resulting publication and/or thesis chapter, follows a series of clear steps.

This method works well for natural and social sciences, and is likely to prove effective for a wide range of disciplines that use a positivist approach. It can be used to review quantitative and qualitative literature, and thus is particularly suitable for trans-disciplinary research

(Petticrew, 2001; Kamler, 2008; Lee & Kamler, 2008). Also, by identifying the gaps in the literature, including geographic, scalar and methodological differences and deficiencies, this method illuminates the most critical subjects and variables for future research, including by PhD students.

We describe our new method in the next section (see Figure 1). This approach is beneficial in initial exploratory stages of assessing literature, particularly for new fields. It can be used on its own or in conjunction with methods that weight different studies using specific criteria (Petticrew & Roberts, 2006).

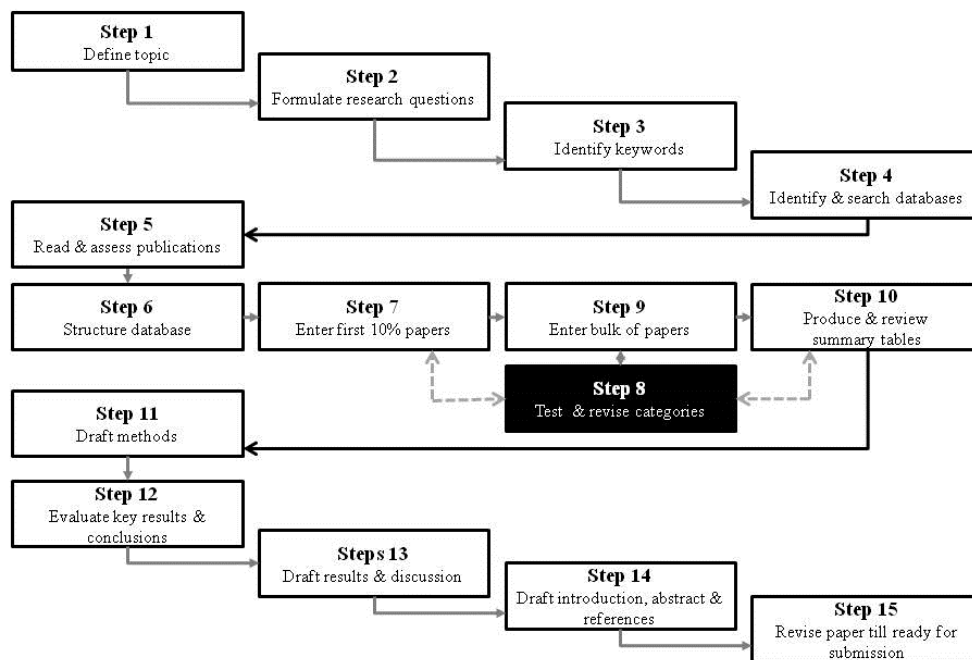


Figure 1. Fifteen stages in undertaking systematic quantitative literature reviews.

We have found that this literature review method has seven benefits:

1. The method provides a straightforward structure/process for undertaking and writing literature reviews.

2. By analysing their database, students can demonstrate important geographic, scalar, theoretical and methodological gaps in the literature, which can then help them to better design and justify their research.
3. The outcomes can be used in confirmation of candidature reports required by some universities in the early stages of the PhD candidature.
4. The quantitative literature review can also be rapidly turned into a manuscript for submission to a journal, early in the PhD.
5. The student's database of papers can easily be updated during and after the PhD, with new papers added as they are published.
6. The database can be interrogated repeatedly, to rapidly identify relevant literature for inclusion in specific research papers during and after the PhD.
7. The updated database can be used in the discussion of the final thesis to show how the student's results relate to existing work, without having to re-engage with every paper in their chosen field of research.

The process

The process involved in undertaking this type of literature review can be illustrated using case studies based on the experience of three of our students (Table 1). Examples of topics that our students have reviewed include: the impacts of nature based recreation on birds (Steven et al., 2011); urban tree benefits, costs, and evaluation methods (Roy et al., *In Press*); and urban community garden research (Guitart et al., *In Press*) (Table 1).

Table 1. Characteristics of three research projects and resulting papers that have used this systematic quantitative literature review methodology.

<i>Papers published using this method</i>		
Steven et al. 2011	Roy, et al. in press	Guitart, et al. in press
<i>Topic</i>		
Impacts of nature based recreation on birds.	Benefits, costs, and evaluation methods for urban trees.	Urban community garden research.
<i>Research questions</i>		
What methods have been used to detect effects on birds?	Where was the research undertaken?	Who has undertaken the research?
Which species/families of birds have been assessed?	What methods have been used?	Where was it published?
What were the responses of the birds?	What evaluation techniques are there for assessing tree services and disservices?	Where were the gardens located?
Where was the research conducted?	What did the research find?	What types of methods were used?
Conversely, which locations, habitats and bird taxa are missing from the literature?	What are the gaps in the literature?	What were the characteristics of the gardens assessed (what is grown, who is involved, land ownership)?
		What were the motivations, benefits and limitations associated with the gardens?
<i>Search terms used in electronic databases</i>		
'bird' in combination with; 'trail', 'track', 'walking', 'hiking', 'impact', 'disturbance', 'mountain bike', 'effect', 'dog walking', 'horse riding', 'ecotourism', 'tourism' 'recreation'.	'urban trees', 'urban tree benefits', 'urban tree ecosystem services' 'urban tree disservices.	'community garden' and a combination of terms including: 'space', 'green', 'gardening', 'school', 'urban', 'food production', 'land use', 'place', 'planning', 'agriculture' 'people'.
<i>Electronic databases searched</i>		
Web of Science, Google Scholar, Science Direct.	Scopus, Science Direct, ProQuest, Web of Knowledge, Sage, Google Scholar, Google.	Google Scholar, Geo Base, ISI Web of Knowledge, Pro Quest, Bio Med.
<i>Number of papers in personal database</i>		
69	115	87
<i>Categories and subcategories</i>		
Number categories/subcategories used (columns)		
63	216	158
<i>Categories about the paper</i>		
Full reference details, Authors names, Year, Journal title.	Full reference details, Authors names, Year, Journal title, Journal discipline.	Full reference details, Authors names, Year, Journal title, Authors affiliations, Journal research discipline, Article research discipline, Country of authors affiliation.

<i>Categories about the location of research</i>		
Country, Broad climatic regions, General habitat types, in protected area?	City, State, Country, Continent, Climatic zone.	City, Country, Continent.
<i>Categories about the methods used</i>		
Observational vs experimental?	Natural science, social science or mixed.	Natural or social science methods (observation, surveys, interviews, focus groups, case studies and archival research) or both?
Did it compare disturbed and undisturbed areas, or had controls?	Which qualitative approach(es)? (interviews, content and text analysis, case studies, observations, and focus groups),	Data qualitative, quantitative or both?
Type of recreational activity?	Which quantitative approach(es)? (questionnaire surveys, field-surveys and samples, field experiments, GIS, remote sensing and satellite imagery)	Did paper define the term 'community garden'?
Size of group undertaking activity?	Which mixed approach? (including existing data base and records searches, or other literature analysis).	
<i>Categories for response variables</i>		
Did it measure:	Did it assess ecosystem services? (carbon sequestration, air quality, storm water attenuation, energy reduction, habitat provision, noise reduction and provision of microclimate)	Information about garden(s) in paper:
Individual response? (physiological or behavioural),	Did it assess disservices? (social, economic, health, environmental, and aesthetic aspects)	Land tenure type?
Population level response ? (density/abundance),		Property values?
Reproductive response ? (number of nests, number eggs laid, number of chicks that hatched or fledged)?		Yield of garden,
		Characteristics of gardens,
		Did participants have different cultural backgrounds?
		Motivations/reasons for participating?
		Challenges for garden.
<i>Categories for the subjects of the research</i>		
Number and name of bird species assessed.	Location of tree? (natural or remnant vegetation or planted trees),	Data from: managers, gardeners, both, others?
Conservation status of the birds?	Where they street trees or green space trees?	Number of gardens assessed?
Type of foraging guild?		
<i>Categories for overall results</i>		
Positive, neutral or negative impact?	Studied and discussed, or actually demonstrated?	Discussed benefit vs proved benefit?
		Overall outcomes positive, negative, neutral, mixed or other?

The first step is to identify and carefully define a specific topic within the overall field of research (Figure 1, Table 1). We have found that the systematic quantitative review method works well for emerging areas, and for areas where methodological approaches are so diverse that there is limited potential for other types of quantitative reviews, such as meta-analysis. As with all reviews, careful reflection on the topic is required to ensure that it is original and appropriate. The method we describe here is likely to work particularly well where there are specific terms associated with the topic that can facilitate the search process.

It is important to identify what types of questions should be addressed by the literature review (Step 2). We recommend at a minimum assessing: (i) where, when and by whom research was published; (ii) the geographical spread of the research; (iii) types of methods used; (iv) types of subjects examined; (v) types of variables measured; (vi) different disciplines assessing the topic; and (viii) patterns found in research results. These questions need to be revised in each stage of the process, as the researcher's understanding of the topic, and the types of data available, increases.

Once the topic and potential research questions have been defined, key words need to be selected. These search terms will be used to search electronic databases for relevant papers (Step 3, Figure 1). They should identify as much of the relevant literature as possible, but not extend too far into less pertinent fields. Sometimes a certain amount of trial and error is required to initially identify the best keywords. In some cases this may entail using one or more search terms in combination with others (Table 1). Students should also employ a range of synonyms to identify all relevant literature. Examining the keywords of frequently cited papers is a good place to begin.

Appropriate scholarly databases will then need to be selected and searched (Step 4). We have found that a mix of databases has provided the best results for our students, and has enabled them to cross check if their searches were sufficiently comprehensive (Table 1).

Advice from university librarians may help new researchers to select appropriate keywords and databases.

The next step involves reading and assessing each publication, to ascertain if it is relevant and whether it should be included (Step 5). The inclusion criteria must be carefully considered and elucidated in the methods section to ensure that results are reproducible. In some cases, reading the title and abstract may be sufficient to exclude a potential publication, whereas for others careful reading of the entire paper may be necessary.

The first inclusion criterion our students have used is: 'the publication must be an original research paper'. This ensures that the research results have been peer-reviewed and that the paper is a primary source. In some disciplines, where other types of publications such as book chapters, conference proceedings and/or reports are more common, their inclusion may be appropriate. Existing literature reviews and 'grey' literature, such as reports, are still useful as they enable students to develop their understanding of the field. They may often be referred to in the introduction and discussion of the resulting literature review, even if they are not included in the student's personal database. Reference lists, together with those from original research papers, should be used to cross-check results from searches, and to locate older publications that may be missed by electronic searchable databases.

Before proceeding further, it is worth estimating the number of relevant original research papers. A quantitative review may not be required if there are very few papers (15 or less), or may become unwieldy if there are too many ($\sim > 300$). In either case, it might be necessary to expand or narrow the topic under review, or to undertake a different type of review (narrative if too few papers and meta-analysis if sufficient datasets are found).

The student should then develop the structure for their own personal database on the topic (Step 6). This is in addition to bibliographic datasets such as *EndNote* that the student may use. We have found that a simple spreadsheet file will suffice. Each paper is assigned to a single row in the spreadsheet, and categories/subcategories become columns. However, other types of

databases may also be suitable, and could be used for more sophisticated analysis, if desired (such as developing look-up tables).

Structuring this personal database involves selecting and defining categories and subcategories of data to be populated with information about each paper found through the electronic searches. This step may also necessitate revising the topic and questions to be addressed, so appropriate categories and subcategories are used. To facilitate developing summary tables, some information may appear in several different forms within the personal database, such as descriptive, presence/absence, or numerically. As with the selection of the topic and key search words, care must be taken in selecting, defining, and articulating the methods categories and subcategories, and in then assigning values for each paper. In some cases tight criteria may be used while in others the criteria may be broader. We recommend that students develop and revise the initial categories and criteria for assigning values in discussion with their supervisors and others.

We recommend that basic information about each paper is included, such as the author(s), year of publication, journal, and journal discipline (Table 1). For some disciplines information about where the studies were conducted is important such as the (i) geographical location of the study, (ii) spatial scale, (iii) ecosystem type, and (iv) climatic zone. Often a range of different response variables have been examined among papers and hence categories for these can be included. The subjects/objects of the research and the type of methods used can also vary, and this information needs to be coded (Table 1).

Papers can be treated equally or they can be weighted based on the type of methods used, sample size, effect size and/or other criteria (Petticrew & Roberts, 2006). A range of checklists that can be used to assess the reliability of different studies are available including in the health and social science disciplines (Petticrew & Roberts, 2006). However, the time and expertise required to use these criteria to assess each paper consistently can limit their applicability, particularly for PhD and other early career researchers (see below). For students who are new

to a research field establishing the reliability, validity and durability of research papers can be difficult. Many disciplines have examples of papers once thought to be obsolete suddenly gaining new life as a paradigm shifts or as new information alters a perspective. In terms of a broader literature, we suggest that students follow standard ‘information literacy’ guides for assessing the currency, relevance, reliability, quality (e.g. validity, accuracy), authority and purpose of the literature (Blakeslee, 2004; Seely et al., 2011; Stanger, 2009). Ultimately students will still need to be guided by their supervisor’s expert judgment and by the standards of their discipline.

Once the categories and subcategories have been identified for the personal database, we suggest that students should next enter approximately 10% of the papers they have found into their database (Step 7). This provides a test of how well the categories, subcategories and criteria for data inclusion work, and thus determine whether they need to be revised (Step 8). This type of process may alleviate the need to modify the entire personal database later, if issues arise such as the need for greater level of detail for an existing category, or use of a new category. There is a general trade-off between including so much detail that the categories become redundant, or too little – requiring categories to be subdivided. Nonetheless, it is better to err on the side of too much detail as it is easier to combine categories later, whereas splitting categories latter may require rereading each paper.

The bulk of the papers can then be entered into the database (Step 9), and checked with grey-papers and literature reviews in an iterative fashion, to ensure the personal database is comprehensive. Again, the categories, subcategories and criteria for assigning value to should be reviewed (Step 8). The database can then be used to produce summary tables which list the number and/or percentage of papers in the different categories (Step 10). Doing this can rapidly identify errors in data entry and also issues about category definition, potentially requiring the database to be updated, and the summary tables regenerated (Step 8 again!).

Structuring and writing the paper/chapter

We recommend drafting the methods section next while it is still fresh in the student's mind (Step 11). This should include: why the research topic was chosen, the methods used, key words and electronic databases searched, identification of relevant papers, selection and definition of categories and subcategories, and criteria used to assign values to categories.

The next step is to carefully assess the summary tables of the results which should document the breadth, depth, and type of published literature on the topic (Step 12). This entails determining which results are the most important and why, as these findings will form the basis of the conclusions of the review. The results need to be related back to the overall topic and the original research questions. Sometimes results can be surprising, and hence the research questions may need to be updated. This reflective process should include discussions with supervisors, to determine which are the most important points a student should highlight, and which are more subsidiary. We have found that effort spent establishing what the review has found, and its importance, dramatically reduces the time taken to write the actual text. These discussions should help students to match the aims/questions outlined in the introduction with the summary tables and written section of the literature review. They should also help students to identify issues to be included in the discussion.

Some common questions can be asked and answered using this type of literature review. These include: how large is the literature on this topic (number of papers), when was it published (age), where was the research conducted (geographic distribution), at what scale, and by whom (geographic/institutional bias)? For two of the literature reviews our students have written (community gardens and urban trees), a major result was that research had been undertaken in a wide range of disciplines and that results were published in diverse journals (Guitart et al., *In Press*; Roy et al., *In Press*). All three student reviews also found considerable diversity in the methods, variables and subjects studied, which limited: (i) direct comparisons of results using meta-analysis and (ii) generalisations about the topics that have been made in the past.

The next stage involves drafting the bulk of the paper, often starting with the results and discussion sections (Step 13) and then the conclusions, introduction, abstract and reference list (Step 14). The final step (15) entails re-reading and revising the paper in the iterative process characteristic of producing academic papers until it is ready for submission. Next we highlight potential methodological limitations of the quantitative review technique we are advocating.

What the quantitative review method can, and cannot, do

We have already discussed many of the advantages and disadvantages of our technique in comparison to more ‘traditional’ narrative reviews and meta-analyses, and hence why we recommend the new method to students. It is worth briefly recapping these points before we discuss how the technique might be improved.

Our method has several advantages. It can supplement or complement traditional ‘narrative-style’ reviews, by incorporating a more systematic and quantitative approach – thus addressing concerns about bias (Petticrew, 2001; Collins & Fauser, 2005). Because the method used to select literature is comprehensive and reproducible, it can go some way towards minimising partiality. A particular strength of the method is that it can readily highlight the diversity and spread of existing research, including identifying important research gaps. Perhaps the most important benefit of our method is that students find it comparatively easy to use, and it can give them a much faster appreciation of the literature in their chosen field of study than a ‘narrative-style’ review.

Our method does not automatically require the weighting of studies, although this can be done if feasible and appropriate. This is both a benefit and a limitation. For some disciplines there are well-recognised criteria for weighting studies, based on factors such as the types of methods used, the rigor with which they were applied, the sample size and effect size among other criteria (see Petticrew & Roberts, 2006 for details). For example, where studies have similar experimental methods, response variables and subjects, meta-analysis can be performed to deal

with differences in sample size and size effect (Borenstein et al., 2009). However, for many topics the amount of data suitable for meta-analysis is limited (Petticrew, 2001). Consequently, determining the criteria used to evaluate/weight studies often requires detailed and diverse expertise; reviews using these types of criteria are typically undertaken by teams of experts collaborating over long periods (Petticrew & Roberts, 2006). Also, despite the prevalence of such weighting methods in some disciplines, there is still considerable divergence in how they are used, including which criteria are used and how they are applied (Petticrew & Roberts, 2006). Finally, generally accepted weighting criteria are not available for many disciplines, and are often inappropriate to use when reviewing trans-disciplinary research. Therefore, we feel that where the focus of the review is to map the breadth of the literature rather than focus on evaluating its depth, the systematic quantitative review has logistical and methodological advantages, particularly for PhD students, over approaches that require studies be weighted.

An important limitation that applies all literature review methods is how to deal with potential biases in searching for relevant literature. The use of systematic methods can minimise such biases, but will not completely eliminate them. Biases that may remain include the effect of not reviewing: research published in other languages, and research studies that are not accessible by electronic databases. The underrepresentation of 'negative' or 'neutral' research compared to 'positive' results in the literature is another potential limitation, albeit one not limited to our technique (Petticrew & Roberts, 2006; Borenstein et al., 2009; Combs et al., 2011). Searches using multiple languages are obviously advantageous when feasible, although if English is used, the language bias may not be large. Some studies suggest that 70% of social science and 90% of natural science research is published in English (Hamel, 2007). The risk of missing literature that is not available via electronic search engines, including older research can be minimised by using reference lists and previous literature reviews to identify older studies.

Dealing with the 'positive' bias towards the publication 'positive' effects is more difficult (Petticrew & Roberts, 2006; Borenstein et al., 2009; Combs et al., 2011). Some disciplines such

as health have registries of randomized control trials and other types of studies. There are mathematical modelling techniques that can be used to try to estimate and deal with the 'positive' research bias, although these modelling techniques can only be applied to certain types of methods and disciplines (Petticrew & Roberts, 2006). Finally, journals specifically for 'negative' results have been established to help to deal this issue in some disciplines (Petticrew & Roberts, 2006). Despite this, for many literature review topics, this bias remains a major challenge with few easy solutions. Therefore, as with all types of literature review, students should acknowledge these limitations in their findings.

Conclusion

Universities are increasingly expecting PhD students to publish during candidature as a way to bolster institutional publication output. We have developed and demonstrated a method of rapidly assessing academic literature which is easy for students to use and which produces a quantitative overview of a field of research that journal editors and reviewers have found valuable and worthy of publication. In this paper we have described this method, and situated it within the benefits of PhD students publishing. We have identified the relative strengths of this approach and have discussed some limitations that can be minimised through care and attention to detail.

Although we are building a track record of publications using this new method, there is still much work to be done in evaluating its merits. For example, we have seen first-hand the responses of reviewers from within the environmental sciences and geography, but how might reviewers from other disciplines regard this method? Is it likely to work for anthropology, law, history, engineering or medicine? Would the humanities and creative arts also see merit in this approach? We cannot answer these important questions, and we advocate that colleagues from other disciplines try the method to see how it works.

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