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Developing and applying a protocol for a systematic review in the social sciences

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Abstract

The paper reports on a systematic method of undertaking a literature search on the educational impact of being a young carer (16-24 years old). The search methodology applied and described here in detail will be of value to academic librarians and to other education researchers who undertake systematic literature searches. Seven bibliographic databases and Google Scholar were searched between November 2015 and January 2016. Two and three concept search structures were compared, involving 28 search terms plus truncation variants. One hundred and eighty one relevant articles were retrieved. Sensitivity, precision and 'unique articles retrieved' were used as metrics. Social Care Online and Google Scholar had the greatest sensitivity. As well as meticulous use of AND, OR and bracket operators, the use of NEAR and NOT operators to increase precision were tested and are recommended as useful tools for conducting systematic searches.

Keywords

Academic librarians, literature search, bibliographic database, Google Scholar, education, young carer

Introduction

Systematically searching databases in the social sciences has not been given extensive examination in the literature (Best et al., 2014, p.348). It has been suggested that its multi-disciplinary nature, the lack of agreed terminology and the range of research methods used, makes database searching in the social sciences intricate (McFadden et al., 2012; Taylor et al., 2003). While the use of systematic reviews in education research is certainly not commonplace, Evans and Benefield (2001, p.39), in their examination of whether the 'medical model' of systematic reviews could be applied to education research, concluded that the success and value of systematic reviews for education research would depend on the question that was being addressed and that "Firstly … such reviews should be given the status and time allocation of a significant research project… Secondly, the review should

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focus on a specific question, and have clearly defined criteria for including and excluding studies. The advice of an expert panel is useful for helping to clarify the scope of a review. Thirdly, it is important to have clear criteria for assessing the methodological quality of the studies in order to evaluate their 'soundness' and the weight which can be given to their findings." Systematic reviews in education research include McGrath and Van Bergen (2015); Mager and Nowak (2012); O'Brien (2009); Rix et al. (2009); and Nind and Wearmouth (2006). Furthermore, staff in the EPPI-Centre[1], based at the University College London Institute of Education, UK have carried out systematic reviews on a range of education topics and questions.

The purpose of this paper is to document how a systematic literature search can be adopted in educational research. It also highlights how such a method of searching is of transferrable value to other social science disciplines. It is intended to be of use by academic librarians who contribute to the literature search process. Increasingly academic librarians have an 'embedded' role within the research process (Delaney and Bates, 2015).

The search topic for this study is: the educational impact of being a young carer aged 16-24. A young carer is a child or young person under the age of 24, whose life is affected by providing significant care, assistance or support to sick or disabled relative at home, with the term young adult carer specifically used for those aged 18-24[2]. Research carried out by Becker and Becker (2008) and Sempik and Becker (2014; 2013) on young carers in the United Kingdom (UK) has reported that having a caring role can impact on a young person's education and subsequently on their career options and future economic potential. Findings have suggested that young people may not be in work due to their level of educational qualifications which could also be potentially coupled with the assumption that they will continue with their caring role (Sempik and Becker, 2014). Sempik and Becker reported that the highest GCSE grades held by the young adult carers they surveyed were most commonly at grade D-G (Sempik and Becker, 2014). Such information reinforced the views of young carers in earlier research, who felt they had left school with qualifications not of the standard that they were capable of achieving due to their caring role (Becker and Becker, 2008, p.33). These findings highlight the need for further research into the educational impact of being a young carer.

In order to carry out a systematic review of the literature on the educational consequences of being a young carer, a systemic literature search was first undertaken and it is the methodology of this search that is being reported here. In accordance with PRISMA-P guidelines (Preferred reporting items for systematic review and meta-analysis protocols), the systematic review protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO)[3] on 1 May 2016 (registration number

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[1] http://eppi.ioe.ac.uk/cms/
[2] For definitions of young carers and young adult carers see: Sempik and Becker (2014); Sempik and Becker (2013); Becker and Becker (2008); Northern Ireland Department of Health, Social Services and Public Safety (2006); and Dearden and Becker (2000).
[3] http://www.crd.york.ac.uk/prospero/prospero.asp

CRD42016037990).

Selection of databases

For this literature search, seven bibliographic databases were used as well as the web search engine Google Scholar. Similar studies have compared the effectiveness of using different databases for systematic searches in other disciplines for example, health care (e.g. Brettle and Long, 2001; McNally and Alborz, 2004). However as they pre-date Google Scholar there is no discussion of the effectiveness of this or other search engines for academic searching in these papers. Details of the databases are provided in Table 1 below. These databases were chosen based on systematic review guidelines from The Social Care Institute for Excellence (SCIE) (Rutter et al., 2010); the experiences of other researchers (McGinn et al., 2016; Best et al., 2014; McFadden et al., 2012; Papaioannou et al., 2010; Taylor et al., 2007; Taylor et al., 2003), consultation with subject librarians; scoping exercises for relevant literature and on accessibility within Ulster University where the work was undertaken. Due to the nature of the topic, it was advisable to include databases from both education and from social care (social services), as well as a multidisciplinary database, which was SCOPUS. PsycINFO was included because of its focus on behavioural and social science research.

Table 1: List of databases

Database	Background
ASSIA *(Platform: ProQuest)*	ASSIA (Applied Social Services Index and Abstracts) is an international database, containing around 400,000 records from 500 peer-reviewed journals covering social services, health and psychology.
BEI *(Platform: EBSCO Host)*	BEI (British Education Index) has more than 230,000 articles indexed covering all areas of education in the UK.
ERIC *(Platform: ProQuest)*	ERIC (Education Resource Information Centre) is an international database containing over 1.5 million education related publications and resources.
PsycINFO *(Platform: OVID)*	PsycINFO is an international database containing over 3 million records from 2,500 peer reviewed journals.
SCO	SCO (Social Care Online) is a UK database containing over 155,000 records formed by the Social Care Institute for Excellence covering all areas of social work and social care.
Scopus *(Platform: Elsevier)*	Scopus is an international, multidisciplinary database consisting of over 49 million records from over 20,000 peer reviewed journals.
SSA *(Platform: ProQuest)*	SSA (Social Services Abstracts) indexes articles from over 1,300 peer reviewed journals concerning social work, human services, social welfare, social policy and community development.
Google Scholar	Google Scholar is a web search engine focused specifically on scholarly content. It crosses academic fields and covers an estimated 100 million English language documents (Khasba and Giles, 2014).

In addition to identifying the databases, it is important to also specify the platform, or database provider, as has been done in Table 1 above. In Campbell[4] Systematic Reviews,

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[4] "The Campbell Collaboration (C2) helps people make well-informed decisions by preparing, maintaining and disseminating systematic reviews in education, crime and justice, and social

Hammerstrøm et al. (2010, p33) explain: "The same database is supplied by different organizations, called database suppliers … Each database supplier produces their own search software and packages the data within the database differently (e.g. some fields may be included, others may not)."

Inclusion and exclusion criteria

For results to be included in the systematic review, articles returned by database searches needed to cover 'young carers aged 16-24' and 'education'. Literature on 'foster care', 'children in care' and 'looked after children' were excluded. All searches were limited to English language documents only, due to translation costs.

Sensitivity and precision

Database sensitivity (also referred to as recall) is defined as a measure of how many relevant articles are returned by a search divided by the number of known relevant studies on the topic (Best et al., 2014; McFadden et al., 2012; Taylor et al., 2007; Taylor et al., 2003). For the purposes of this study the number of 'known relevant studies' was the total number of relevant articles retrieved across all seven databases and the web search engine Google Scholar (Best et al., 2014). Precision is defined as the number of relevant articles returned by the search of an individual database divided by the total number of results retrieved for that specific database (McFadden et al., 2012, p.628).

Sensitivity %   =   no. of relevant results in one database   x 100
total no. of relevant results across all databases

Precision %   =   no. of relevant results in one database   x 100
total no. of results for that database

Sensitivity and precision have been described as having "an inverse relationship whereby, when sensitivity increases, precision decreases" (Best et al., 2014, p.351) Cochrane and Campbell Reviews seek maximum sensitivity and ignore precision to ensure that all relevant documents are retrieved for analysis, for example, in the cases of Langford et al. (2014), and Farrington and Ttofi (2009).

Retrieving irrelevant hits in the quest to locate relevant items is to be expected; however, to make results more manageable sensitivity needs to be counteracted by measures to ensure precision (Taylor et al., 2015). Adding more terms to a search may increase sensitivity but can also lead to more irrelevant results being returned (Taylor et al., 2003). It has been suggested that the key to developing a search formula is achieving a balance between sensitivity and precision – retrieving all relevant results and minimising any unwanted items (Lefebvre et al., 2011; Taylor et al., 2007). In order to increase the precision of a search and

welfare." (http://www.campbellcollaboration.org/c2_systematic_reviews/) They also provide resources and guidance on preparing systematic reviews.

make results more manageable, Taylor et al., (2003) suggest techniques can be used such as:

1. excluding studies (where able) for example in relation to this study articles covering 'children in care/looked after children' and 'foster care' were excluded.
2. using a proximity operator – in relation to this study this could mean including advanced text searching such as 'young NEAR/3 carer*' which retrieves articles where the word 'carer*' appears within three words of the word 'young'.
3. "qualifying or excluding words with many varied applications" for example the word 'care*' on its own due to the potential of returning many irrelevant results if used "without qualifiers" (Taylor et al., 2003, p.5).

Attention should also be given to the use of the Boolean NOT operator during the development of search formulas as a means of testing the addition of concept terms (Taylor et al., 2015; Best et al., 2014).

All of these techniques were considered throughout the formulation of a final search strategy and are discussed below.

Establishing concept groups and the selection of search terms

Overview

Sensitivity and precision were considered throughout the identification of concept groups while the task of converting the research topic into key search concepts was developed using the work of Best et al., (2014) and Taylor et al., (2003) for guidance.

Two concept groups

Originally two concept groups were identified – 'young carers' and 'educational impact'. The terms selected to express these two concepts were:

- "young carer*" OR "young adult carer*" OR "child carer*" OR "child care-giver*" OR "young care-giver*" OR "child caregiver*" OR "young caregiver*" OR "juvenile carer*" OR "children with dependant*" OR "young adults with dependent*" OR "young informal care giver"

AND

- Education OR school OR university OR exams OR employment OR NEET* OR "not in education" OR transition OR "educational impact" OR "academic achievement" OR "caregiver burden" OR unemployment OR achievement OR "educational inequality" OR "educational opportunities" OR training OR learning

Scoping exercises of journal articles and books found a variety of terms that expressed the concept 'young carer' and these were included in the terms outlined above. The range of terms "reflects the inconsistency of the way these terms are used in the literature" (Sprung

and Laing, 2015, p.4). It was acknowledged at this early stage that the inclusion of the terms, 'children with dependents' and 'young adults with dependents', had potential to affect the precision of search results as these terms are also used to describe young people who are parents. (Other research has also found this to be an issue, see for example: Fives et al., (2010). The group of terms selected to express the primary concept 'educational impact' sought to include general words relating to education and stages of transition in a young person's life during the ages of 16-24.

Testing of initial concept groups

Initially, these concepts were tested using text-term searching during scoping exercises on SSA (Social Services Abstracts) ASSIA (Applied Social Services Index and Abstracts) BEI (British Education Index) and ERIC (Education Resource Information Centre).

Quotation marks were used to focus the search on particular phrases, for example, "young carer" and truncation (*) was used to search for variants of words – mainly plural terms. (The search plan devised and used can be found in Appendix A).

Boolean operators, in the form of AND, OR, and NOT were used to "specify how the search terms are to be treated" (Taylor et al., 2015). For example, the Boolean operator AND was used to link the primary concepts and terms used to express each concept were linked by OR within brackets, in order to treat them as one "meaningful entity" (Taylor et al., 2015, p.55). The Boolean operator NOT was used to check the impact of new terms being added to the search formula. Taylor et al., (2015) explain the use of this operator in the following algebraic formula:

> "(A OR B OR C) NOT (A OR B) …to test for the impact of adding term 'C' to an existing search involving 'A OR B'"

Should the results of this formula not retrieve any results then the addition of 'C' to the equation can be deemed unnecessary and term 'C' does not need to be included in the search formula. This check was applied to each of the terms added to the search formulas in each of the four databases included in this scoping exercise. (An example of how the NOT operator was applied during these initial exercises can be found in Appendix B).

Table 2: Details of scoping exercise results

Database	Date of Search	Final Tested Formula	Total Hits Retrieved	Number of Relevant Hits	Precision (%)
ASSIA	09/11/2015	("young carer*" OR "young caregiver*" OR "child carer*") AND (education OR school OR university OR employment OR training OR learning)	42	30	71.4

SSA	06/11/2015	("young carer*") AND (education OR school OR university OR "caregiver burden")	32	15	46.9
BEI	11/11/2015	("young carer*" OR "young adult carer*") AND (education OR school OR university)	10	9	90.0
ERIC	12/11/2015	("young carer*" OR "child carer*" OR "young caregiver*") AND education	36	19	47.2

Table 2 outlines the results of this initial scoping exercise. All results (minus two in the ERIC search which were on child care) contained information about young carers. However, all articles retrieved did not have a reference to both young carers and education. Frequently, subject identifiers and keywords were not explicit in regards to the literature covering the two concepts, in many cases although the concept "young carer*" was highlighted, references to education were vague.

This was a useful exercise as it helped identify key terms and database index terms relevant to the research topic and it also presented the opportunity to test search terms as they were added to the formula in a systematic way. As a result of this exercise, the list of terms to express the concept groups of 'young carer' and 'educational impact' were refined to the following:

- "young carer*" OR "young care giver*" OR "child carer*" OR "young adult carer*" OR "young caregiver"

AND

- Education OR school OR university OR employment OR training OR learning

This amended list reflects the terms tested as producing relevant hits during the course of the scoping exercise.

The searches carried out using two concepts were very focused and specific and as a result they produced small numbers of 'total hits'. However there was a concern that although using two concepts may give a high level of precision, there was not a high enough level of sensitivity to the search in order to ensure that it was comprehensive and that no relevant material was missed (McFadden et al., 2012).

Three concept groups

Using the revised terms for the two original concept groups of 'young carers' and 'educational impact' as a springboard, three concept groups were formed. The three concept groups formed were:

1. Care* OR Carer* OR caregiver* OR care-giver* OR care giver AND
2. Education* OR college* OR school* OR universit* OR training OR learning OR academic achievement OR academic attainment OR academic failure OR academic underachiev* OR academic aptitude AND
3. Child* OR children OR Adolescen* OR juvenile* OR young adult* OR young people OR teenager*

Systematic reviews published by The Cochrane Library and subject librarians were consulted to explore search terms for inclusion in the three concept groups (Eccleston et al., 2015; Blaxi et al., 2014; Lins et al., 2014; Legg et al., 2011; Vernooij-Dassen et al., 2011). At this stage it was decided that the term 'employment' would no longer be included in search terms as it was not an educational term. 'Exams' or 'grades' were not included as specific search terms as these were covered by the terms 'academic achievement' and 'academic attainment'. The three concepts were then mapped out and text searched for on the PsycINFO database (See Table 3). The reason for selecting PsycINFO at this stage was that it has been described as being "one of the highest quality databases from a user perspective" and it allows for terms to be extensively mapped to subject headings which is useful both for identifying other possible concept terms for inclusion as well as assessing what the potential could be for irrelevant hits when selecting a term (Taylor et al., 2015, p.47).

Table 3: Mapping index terms and text terms as operationalized on PscyINFO database
_____

1. caregivers/
2. caregiver*.mp.
3. care giver*.mp.
4. carer*.mp.
5. care*.mp.
6. 1 or 2 or 3 or 4 or 5
7. (young adj3 carer*).mp.
8. (young adj3 care giver*).mp.
9. (young adj3 caregiver).mp.
10. (young adj3 care*).mp.
11. (youth adj3 care*).mp.
12. (youth adj3 carer*).mp.
13. (youth adj3 caregiver*).mp.
14. (child* adj3 carer*).mp.
15. (child* adj3 caregiver*).mp.
16. 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15
17. 7 or 8 or 9 or 12 or 13 or 14 or 15
18. education/ or high school education/ or higher education/ or middle school education/ or secondary education/
19. education*.mp.
20. exp Colleges/
21. college*.mp.

22. schools/ or charter schools/ or graduate schools/ or high schools/ or middle schools/ or nongraded schools/ or technical schools/
23. school*.mp.
24. universit*.mp.
25. Training/
26. exp adult education/
27. learning/
28. learning.mp.
29. exp academic achievement/
30. (academic* adj3 achiev*).mp. -
31. educational attainment.mp.
32. academic failure/
33. academic failure.mp.
34. (academic* adj3 underachiev*).mp.
35. exp Academic Aptitude/
36. academic aptitude.mp.
37. 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 36
38. young person.mp.
39. child*.mp.
40. adolescen*.mp.
41. juvenile*.mp.
42. young adult*.mp.]
43. young people.mp.
44. teenager*.mp.
45. 38 or 39 or 40 or 41 or 42 or 43 or 44
46. young carer*.mp.
47. young care giver*.mp.
48. young caregiver*.mp.
49. child carer*.mp.
50. child caregiver*.mp. #
51. 46 or 47 or 48 or 49 or 50
52. 51 and 37
53. 37 and 16
54. 37 and 17
55. limit 54 to english language
57. 37 and 5 and 45
58. child.mp.
59. children.mp.
60. 38 or 40 or 41 or 42 or 43 or 44 or 58 or 59
61. 37 and 5 and 60

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This exercise allowed terms to be scoped for relevance and other terms to be identified; based on this and further consultation with examples of systematic reviews from The Cochrane Library, concept terms where amended to:

1. Caregiver* OR carer* OR care giver*
2. Education* OR college* OR school* OR universit* OR training OR learning OR academic*adj3 (achiev* OR attain* OR failure* OR underachiev* OR aptitude)
3. Child OR youth OR young

The term 'care*' was not included in these refined concept terms based on the example of Lins et al., (2014), Legg et al., (2011), and Vernooij-Dassen et al., (2011); including the term 'care*' on its own whilst including terms such as 'education' and 'young' has the potential to retrieve high levels of irrelevant information, for example on careers, and it was believed

through using the terms 'carer*' and 'caregiver*' results would be more specific (Lins et al., 2014; Legg et al., 2011; Vernooij-Dassen et al., 2011). Similarly, including the search term 'child' as 'child*' can retrieve unwanted results for example on 'childcare' so the decision was made to use the term 'child' without truncation, to focus the search and further reduce irrelevant results. Based on the example of Eccleston et al., (2015) it was also decided that 'youth' would be adopted as an inclusive group term for adolescen*, juvenile and teenager.

Using the NEAR operator

When this three concept term search was applied to ASSIA it led to over three thousand results being returned so as a means to add more precision to the search, the NEAR proximity operator was included (Tompson and Belur, 2015; Taylor et al., 2003). The operator NEAR can be used "to search for terms that are within a given number of terms of each other, but not necessarily as a defined phrase" (Taylor, 2007, p.174). This was tested during the mapping of index terms and text terms in PsycINFO and deemed to be a compromise between searching using two concept groups which produced small numbers of results and searching using three concepts which greatly increased the sensitivity of the search but yielded a high volume of results not relevant to the topic. The rationale for using ASSIA for the exercise below was based on several factors. Following initial scoping exercises (see Table 2), ASSIA returned the highest number of relevant articles of the four databases tested. This database indexes approximately 500 journals. This is more than BEI but less than SSA and ERIC and automatically makes results numbers more manageable without any operators in place to balance sensitivity and precision. ASSIA also uses the ProQuest search platform which is user friendly and as this is the same search platform used in three of the databases included in this study (ASSIA, ERIC and SSA) there would be ease of replication.

To test the use of the NEAR operator the following search formula was constructed and applied to the ASSIA database (date of search 20 November 2015):

> (young NEAR/3 carer* OR young NEAR/3 care giver* OR young NEAR/3 caregiver* OR child NEAR/3 carer* OR child NEAR/3 caregiver* OR youth NEAR/3* carer* OR youth NEAR/3 caregiver*) AND (education* OR college* OR school* OR universit* OR training OR learning OR "academic NEAR/3 (achiev* OR attain* OR failure OR underachiev* OR aptitude)") AND la.exact ("ENG")

It should be noted that the term 'care giver' is only present in this formula alongside the term 'young' because it was identified as a particular phrase referring to young carers as 'young care givers'. To apply this alongside the terms 'child' and 'young' increases the return of irrelevant results focusing on the topic of childcare.

When this formula was applied to ASSIA, one thousand four hundred and sixty one articles were retrieved, thirty of which were deemed relevant. To test scientifically the effectiveness of using this style of search, relevant results were cross-referenced with the relevant articles retrieved during the initial scoping exercise in the ASSIA database (Table 2). Cross-referencing highlighted that only twenty five of the thirty relevant articles were retrieved

from the original search using two concepts with four unique relevant results also present. To ascertain why five relevant articles were missing in this search, abstracts for these articles were consulted and it was found that in each of the articles 'young carer' and 'education' or 'school' or 'university' was highlighted as an identifying term raising concerns over the formula structure where all of these terms were already present.

Upon closer examination, to give the search more precision, brackets were added around each young /child /youth and carer*/caregiver*/caregiver*combination making each into individual entities grouped within brackets to join the terms together as one concept. The search terms regarding academic achievement /underachievement /attainment were made into individual search terms in brackets within the education concept aspect of the formula. The amended formula was applied as follows (date of search 27 November 2015):

> ((young NEAR/3 carer*) OR (young NEAR/3 care giver*) OR (young NEAR/3 caregiver*) OR (child NEAR/3 carer*) OR (child NEAR/3 caregiver*) OR (youth NEAR/3 carer*) OR (youth NEAR 3/caregiver*)) AND (education* OR college* OR school* OR universit* OR training OR learning OR (academic NEAR/3 achiev*) OR (academic NEAR/3 attain*) OR "academic failure" OR (academic NEAR/3 underachiev*) OR "academic aptitude") AND la.exact ("English")

The same cross-referencing exercise was then repeated and all thirty relevant articles were retrieved from the original search using two concepts plus the same four unique relevant results from the search utilising the NEAR operator.

It must be concluded that due to the inclusion of the terms 'carer' and 'caregiver' in concept search terms, it is somewhat unavoidable that results will be returned using the definition of 'carer' or 'caregiver' as being in reference to next of kin, parent/guardian, or teacher alongside articles focusing for example on children in care or children with disabilities. This ambiguity was displayed in the following way during this search:

- 'parent/carers', 'parents/caregivers', 'caregiver-child', 'caregivers of children'
- 'children in care', 'looked after children', 'in primary care', 'foster care', 'foster carers', 'foster children'

An additional way of reducing the number of irrelevant results and consequently limiting the ambiguity of terms is to exclude certain studies from the search (Taylor et al., 2003). In the case of this topic, the studies that were sought to be eliminated from the search results were those relating to 'foster care*', 'looked after children' and 'children in care'. These studies were excluded from results using the NOT operator. Each study was removed from search results as an individual set so as to not complicate the search formula (See Appendix C). As the use of NOT in this manner has been described as needing a "note of caution", as each study was removed it was checked that all relevant articles were still present and after the removal of all three studies it was found that all relevant studies were still present (Taylor et al., 2015).

Returning to a two concept search strategy

Testing using three concept groups in ASSIA, with the NEAR operator employed to improve the precision of the search, did increase by four the number of relevant hits being returned compared to the original two concept search on the same database. Retrieving irrelevant results through applying a three concept group search with the NEAR operator was to be expected, however the extent to which this occurred resulted in search precision becoming greatly reduced at 2.2%.

Table 4: Comparing two concept and three concept NEAR searches on ASSIA

Database & Date of Search	Number of Concepts Used	Formula	Total Hits Retrieved	Number of Relevant Hits	Precision (%)
ASSIA 09/11/2015	2 concepts	("young carer*" OR "young caregiver*" OR "child carer*") AND (education OR school OR university OR employment OR training OR learning)	42	30	71.4
ASSIA 27/11/2015	3 concepts using 'NEAR' Operator	((young NEAR/3 carer*) OR (young NEAR/3 care giver*) OR (young NEAR/3 caregiver*) OR (child NEAR/3 carer*) OR (child NEAR/3 caregiver*) OR (youth NEAR/3 carer*) OR (youth NEAR 3/caregiver*)) AND (education* OR college* OR school* OR universit* OR training OR learning OR (academic NEAR/3 achiev*) OR (academic NEAR/3 attain*) OR "academic failure" OR (academic NEAR/3 underachiev*) OR "academic aptitude") AND la.exact ("English")	1561	34	2.2

This comparison exercise outlined in Table 4 illustrates the contrast between the precision of the two concept search strategy and the three concept search strategy using the NEAR operator. To summarise, there was a 69.2% reduction in precision for an additional 11.8%

(four) relevant hits when moving from a two concept search strategy to a three concept strategy. As the focus of this study is on balancing sensitivity and precision, seeking to minimise irrelevant results and retrieving all relevant results, and that this is a time bound study[5], continuing with a three concept search strategy using the NEAR operator was not a viable option. Such a small return on relevant articles could be identified through the citations of articles classified as relevant and a search of grey material without search precision being so significantly impacted.

Following the decision to return to searching using two concepts, the following search structure was used after finalising during the scoping exercise outlined in Table 2.

1. "young carer*" OR "young care giv*" OR "young caregiv*" OR "child carer*" OR "young adult carer*"
2. Education OR education* OR school OR school* OR university OR universit* OR employment OR training OR learning

Truncation was added to the terms 'education', 'school' and 'university' to increase sensitivity. After further reading of Cochrane reviews on carers, the terms 'young care giver*' and 'young caregiver*' were amended to "young care giv*"and 'young caregiv*" (Candy et al., 2011). Following the review of articles returned previously, the decision was also made to re-admit the term 'employment' into the search structure as a link was noted between the future aspirations, employment and qualifications of young carers (Aylward, 2009; Warren, 2005).

Before these concept terms were applied to the remaining databases and the web search engine Google Scholar, for consistency and thoroughness, the formulas already finalised for ASSIA, SSA, BEI and ERIC were tested with the addition of the new truncation operators. This exercise did not yield any relevant additional articles on any of the four databases so their final formulas remain unchanged to those described in Table 2.

Table 5 outlines the final search formulas which were formulated by applying and testing the above concept terms on each individual database, which explains the variance in formulas across the different databases. As before, the NOT operator was used to assess the impact of including a term in the final search formula (Taylor et al., 2015; Best et al., 2014).

Table 5: Details of the final search formulas

ASSIA	09/11/2015	("young carer*" OR "young caregiver*" OR "child carer*") AND (education OR school OR university OR employment OR training OR learning)

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[5]The amount of time needed to review and assess abstracts for relevance to the inclusion criteria was three and a half days for one thousand five hundred and twenty five articles.

BEI	11/11/2015	("young carer*" OR "young adult carer*") AND (education OR school OR university)
ERIC	12/11/2015	("young carer*" OR "child carer*" OR "young caregiver*") AND education
PsycINFO	13/01/2016	("young carer*" OR "young caregiv*" OR "child carer*" OR "young adult carer*") AND (education* OR school* OR learning)
SSA	06/11/2015	("young carer*") AND (education OR school OR university OR "caregiver burden")
Scopus	18/01/2016	("young carer*" OR "young care giv*" OR "young caregiv*" OR "child carer*" OR "young adult carer*") AND (education* OR school* OR employment OR training)
Social Care Online	11/01/2016	("young carer") AND (education OR school OR university OR employment)

Applying a two concept search to Google Scholar

Rather than relying on the Boolean Operators AND and OR utilised in previous database searches, advanced searching on the web search engine Google Scholar is structured as illustrated in Figure 1.

Figure 1: Google Scholar Advanced Search Options displaying final search strategy

Initially, individual young carer concept terms were tested in the 'with the exact phrase' field using quote marks to focus the search and the first four hundred hits checked for relevance to the topic under study. Due to lack of precision displayed in this scoping exercise of the 'exact phrase' "child carer" (seventeen out of four hundred or 0.04% of results were relevant to the topic of a young person providing care for a sick or disabled relative), it was decided not to include this term in the final search strategy. Each young carer term was then tested in the 'with the exact phrase' field alongside the 'with at least

one of the words' section containing all education concept terms and the relevance of results to the topic was assessed.

The final search strategy adopted for Google Scholar was to use the Advanced Search Options and insert in 'with the exact phrase' the terms '"young carer" OR "young care giver" OR "young adult carer" OR "young caregiver" alongside the terms 'education school university employment training learning' in the search section titled 'with at least one of the words'. The Boolean operator OR can only be applied in the 'with the exact phrase' field of this search (as shown in Figure 1 above). It should be noted that due to this being a time-bound study, the sequence order that concepts were added into Google Scholar were not applied in any other order to the way they are outlined above; doing so may return different results due to Google Scholar being a web search engine and this should be noted by other researchers / librarians undertaking systematic searches in Google Scholar.

Results included 'citations', which Google Scholar authors describe as "articles which other scholarly articles have referred to, but which we haven't found online" (Google Scholar, No date). Such references can be excluded from search results via Google Scholar settings. However, as no filters were placed on other databases aside from sort by relevance and in the English language only, this was not applied to the Google Scholar search. Citations where there was no link or further details, even if the title looked promising, were not included as a relevant hit, but details were noted for follow up hand searches.

Relevant hits were sought in the first one hundred, two hundred, and three hundred search results following the example of McFadden et al., (2012) with precision and sensitivity calculated at each stage as a means to assess the rationale for continuing to analyse search results for relevant and unique hits (McFadden et al., 2012). This led to the decision to continue analysing up to the level of four hundred search results, following search results between two hundred and three hundred showing a growth in sensitivity. By search result four hundred sensitivity levels had stabilised and only one unique hit was identified. The results of these calculations appear in the results tables as GS100, GS200, GS300, GS400, when calculating overall sensitivity of results only GS400 figures are included.

Results

Number of relevant items and unique hits retrieved

After cross-referencing to ensure articles had been consistently classified adhering to the inclusion criteria throughout all seven database search results and those of Google Scholar, and once duplicate articles or "overlap between databases" (McFadden et al., 2012, p.630) were removed, one hundred and eighty one relevant articles had been retrieved overall. This number was then used to calculate the sensitivity of each database search and the results of these calculations alongside the number of unique hits present, and the precision of each database, is outlined in Table 6.

Table 6: Results of database searches

Database	Date of Search	Total Hits Retrieved	Number of Relevant Hits	Unique Relevant Hits	Sensitivity %	Precision %
ASSIA	09 Nov 2015	42*	30*	8	16.6	71.4
BEI	11 Nov 2015	10*	9*	5	5.0	90.0
ERIC	12 Nov 2015	36*	19*	6	10.5	47.2
GS100	30 Jan 2016	100*	41*	24	22.7	41.0
GS200	30 Jan 2016	200*	57*	30	31.5	28.5
GS300	30 Jan 2016	300*	71*	35	39.2	23.7
GS400***	30 Jan 2016	400*	73*	36	40.3	18.3
PsycINFO	13 Jan 2016	41*	22*	5	12.2	53.7
SCO	11 Jan 2015	148*	81*	64	44.8	54.7
Scopus	18 Jan 2015	107*	38*	12	21.0	35.5
SSA	06 Nov 2015	32*	15*	0	8.3	46.9
Total		816*	181**			

Note: * is used to identify that number includes duplicates between databases; total number of relevant hits with duplicates removed can be identified by ** (Best et al., 2014, p.352). ***Only GS400 was used to calculate total hits retrieved, sensitivity and for comparison with results from other databases (McFadden et al., 2012, p.631)

Table 7: Ranking of databases based on unique hits

Database	Unique Hits Ranking	Unique Relevant Hits
SCO	1	64
GS400	2	36
Scopus	3	12
ASSIA	4	8
ERIC	5	6
BEI	6	5
PsycINFO	6	5
SSA	7	0

Table 7 shows that Social Care Online produced the highest number of unique relevant hits with 64. This was 28 unique hits more than Google Scholar with 36, followed by Scopus with 12, ASSIA with eight, ERIC with six and BEI and PsycINFO both with five. SSA had no unique relevant hits identified. Of the fifteen relevant hits contained in SSA, nine were returned by ASSIA and GS400, six by PsycINFO and Scopus, four by SCO, three by ERIC and one by BEI.

Sensitivity and precision

Social Care Online had the highest level of sensitivity at 44.8%, closely followed by GS400 with 40.3%. Much lower, in third place with 21.0% was Scopus, then ASSIA with 16.6%, PsycINFO with 12.2%, ERIC with 10.5% and SSA with 8.3%. BEI had the lowest level of sensitivity with 5.0%. The average level of sensitivity overall was 19.8% (See Table 8 below).

Table 8: Ranking of databases based on sensitivity

Database	Sensitivity Ranking	Sensitivity %
SCO	1	44.8
GS400	2	40.3
Scopus	3	21.0
ASSIA	4	16.6
PsycINFO	5	12.2
ERIC	6	10.5
SSA	7	8.3
BEI	8	5.0

BEI had the highest level of precision at 90.0%, followed by ASSIA at 71.4%. Social Care Online and PsycINFO performed similarly with 54.7% and 53.7% respectively. Likewise the precision levels of ERIC (47.2%) and SSA (46.9%) had only a 0.3% difference. Scopus was next at 35.5% and GS400 had the lowest level of precision with 18.3%. The mean level of precision overall was 52.2% (See Table 9).

Table 9: Ranking of databases based on precision

Database	Precision Ranking	Precision %
BEI	1	90.0
ASSIA	2	71.4
SCO	3	54.7
PsycINFO	4	53.7
ERIC	5	47.2
SSA	6	46.9
Scopus	7	35.5
GS400	8	18.3

Types of relevant articles

Of the one hundred and eighty one relevant articles identified, one hundred and fifteen were empirical studies (63.5%), twenty-eight were literature reviews (15.5%), twenty-three were policy documents (12.7%), and fifteen (8.3%) were classified as 'other'. The classification of 'other' was assigned to articles that outlined training or guidance on how to help young carers in education where, on closer examination, they could neither be deemed policy or a literature review.

Table 10: Types of relevant articles in individual databases

Database	Total Hits Retrieved	Relevant Hits	Number of Policy Documents	Number of Literature Reviews	Number of Empirical Studies	Number of 'Other' documents
ASSIA	42*	30*	0	7*	23*	0
BEI	10*	9*	0	2*	6*	1*
ERIC	36*	19*	2*	3*	13*	1*
GS400	400*	73	2*	14*	51*	6*

PsycINFO	41*	22*	0	3*	19*	0
SCO	148*	81*	17*	10*	44*	10*
Scopus	107*	38*	0	6*	31*	1*
SSA	32*	15*	0	3*	12*	0
Total	816*	287*	21*	46*	201*	19*

Note: * is used to identify that number includes duplicates between databases

Discussion

The databases and web search engine Google Scholar selected as search tools for this study can be categorised as falling into five categories: education (ERIC, BEI), social work/social policy (ASSIA,SSA,SCO), psychology (PsycINFO) and multidisciplinary (Scopus, Google Scholar). Despite the inclusion criteria being on young carers and education, it was the databases that were social work/social policy and multidisciplinary in nature that returned the largest quantity of relevant hits, not those databases selected from the field of education. It could be argued that this highlights the multidisciplinary nature of the subject in question; potentially the lack of research explicitly on young carers and education; or the limited coverage of ERIC and BEI in relation to certain education topics. BEI had high precision demonstrating a good thesaurus of search terms, but the low sensitivity suggests limited coverage of relevant journals.

One limitation of the study is that while systematic reviews in the Cochrane Library were consulted during the process of identifying and selecting search terms, reviews of the EPPI-Centre and the Campbell Collaboration were not utilised for this purpose. This is something that academic librarians may wish to consider for undertaking systematic reviews in the future.

 Social Care Online with 64 and Google Scholar with 36 returned the highest number of unique hits. In relation to sensitivity, Social Care Online and Google Scholar were ranked first and second respectively. However, when it came to precision, Google Scholar was ranked last and Social Care Online was ranked third (this being due to the high number of total hits retrieved by Google Scholar). Social Care Online returned 45% of the one hundred and eighty one documents identified overall, closely followed by Google Scholar with 40%. Google Scholar identified more documents than Social Care Online that were returned by other databases (37) and had a similar number of unique hits (36). Social Care Online identified 17 documents present in other database results but had a much higher level of unique hits than Google Scholar. Further analysis of search results from Social Care Online and Google Scholar showed that had they been the only two databases used in this study, between them they would have returned 141 (78%) of the 182 documents identified across the seven databases.

The precision scores were high compared to similar studies cited above, attributed to the attention to detail in search construction. Each database had all concept terms tested on them, with any additional results retrieved through the addition of a term identified for examination using the NOT operator. If a term yielded a relevant result it was included in

the final search formula even if irrelevant ones were returned as well. Although in a systematic review for the Cochrane or Campbell Collaborations sensitivity is paramount at the expense of precision, for other review purposes – such as grant applications and PhD theses – this is not realistic given the number of irrelevant hits that will be retrieved. This article provides an exemplar for considering the dimension of precision as well as sensitivity in searching systematically for 'everyday' review purposes.

The value of the 'unique relevant hits' metric is that it enables a consideration of how many hits would be lost if certain databases were not used. In this case there was a large margin between the four databases with the fewest unique relevant hits. If these (ASSIA, BEI, ERIC, PsycInfo) were not used, 24 of the 181 relevant articles would not have been retrieved. Thus, the other three databases (SCO, Scopus, SSA) plus Google Scholar between them would have retrieved 87% of the hits retrieved by this search across seven databases plus Google Scholar. An accumulation of this type of knowledge will be invaluable to researchers and librarians wanting to select the most appropriate databases for searching where time and resources are not unlimited (Best et al., 2014; McFadden et al., 2012).

Social Care Online showed itself in this study to be a valuable source of information, ranking first in sensitivity and number of unique hits, however if the search platform and saving options were more like those of Scopus and PsycINFO it would more user friendly. Currently it has no recent search option, unless searches are saved, and sets of formulas cannot be easily combined.

The web search engine Google Scholar had the second highest number of unique hits overall and was ranked second for sensitivity. When analysing results in Google Scholar, the work of McFadden et al., (2012) was used as a comparator in relation to how many search results should be examined, (up to three hundred search results were included in McFadden et al., (2012). The present study required up to four hundred search results to be examined due to sensitivity increasing substantially between GS200 and GS300 (see Table 6). Further research is required to determine the optimal number of hits to appraise when using web search engines which return large numbers of hits of diminishing utility. The method used here is to calculate sensitivity and precision for one hundred search results at a time and identify the unique hits up to the point where sensitivity stabilises and perhaps up to the point where unique hits are no longer identified (McFadden et al., 2012). At present, intervals of 100 hits seems appropriate; in future this might be fine-tuned to smaller intervals for appraisal of web search engines.

For inclusion in a systematic review, it is more efficient if results can be saved and abstracts are available for all articles. This is problematic for Google Scholar, and there is no guarantee that results will be accessible again at a later date (Boeker et al., 2013). An important element to systematic reviews is that the searches can be replicated by others. The absence of abstracts makes classifying results time consuming as full articles very often had to be accessed to make a decision. Accessing full texts via Google Scholar was problematic when an article had a bad link and could not be retrieved (Bergman, 2012). The

'All Versions' option was helpful in these situations, providing a different successful link to the article; however, it was also found that when attempting to access articles via 'Springerlink' one was unable to return to the original search results. Instead it was necessary to re-enter the search, which could raise questions over the validity of sensitivity calculations for each 100 results analysed since search results vary in each search carried out. Several documents were also found during the classification process to have the same content but different titles.

When the option was given to choose between using ProQuest and EBSCO Host as the platform through which to search ERIC, ProQuest was chosen due to its layout, user-friendly saved search options, and easier navigation. Problems were however experienced with ProQuest in relation to ASSIA and duplicate articles. When a saved search was run, the figure given for the number of results returned included duplicates even when the original search that was saved excluded them. As abstracts were consulted it was observed that no more abstracts would be displayed, yet the figure of abstracts viewed and overall figure given for search results were different, with the number of abstracts viewed being less than the figure given overall for search results. After manually re-entering the same search and investigating through the 'help' section it was confirmed that the difference in numbers was due to the inclusion and subsequent removal of duplicate articles.

Throughout database searches, particularly in Scopus, ASSIA, SSA, BEI and ERIC, the concept terms 'university', 'school' and 'education' were highlighted in abstract/search details even when they were only contained in the authors details and there was no apparent link between the article to the topic of young carers and education. Due to the review topic it is unavoidable to exclude terms from concept groups, but it raises questions about how some topics are indexed on these particular databases.

The Boolean operator NOT was invaluable throughout the formulation of search formulas as a means to test the addition of terms to the final formula and was tested on all databases (Taylor et al., 2015).

Conclusion

Full-scale systematic reviews such as for the Cochrane and Campbell Collaboration libraries require a paramount focus on sensitivity to the disregard of precision. However, for almost all other purposes, cognisance needs to be paid to some optimisation between sensitivity and precision. Due to the limitations of time and resources, reviews for grant applications and PhD theses need to be based on reasonable scope. The methods and metrics illustrated here provide tools for undertaking this task in a rational manner. This paper has demonstrated some of the methods that may be developed to support academic librarians and researchers in developing robust searches, and in making informed decisions about optimal choices about database selection. This paper will assist academic librarians think through the issues involved in creating effective and efficient concept groups in their research support roles, and in determining the number and range of databases to search.

The 'unique relevant hits' metric is useful to elucidate additional dimensions of these choices. The paper has also illustrated some of the challenges involved and the knowledge and skills required to progress robust approaches to systematic literature searching. With the 'information explosion' the task and the challenges involved in retrieving relevant research efficiently will become more demanding. The skills illustrated in this paper will become ever more crucial for reviews to have credibility.

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