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Review Article

Tracing the 'grey literature' of poster presentations: a mapping review

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Abstract

Background: Posters are a popular way of presenting information at conferences. However, little research has been conducted into their development, and the patterns and extent of their use are unclear.
Objectives: A mapping review was performed to chart the development and utilisation of the poster medium, and to highlight the main literature themes and contributions.
Methods: A search for the term 'poster presentation' was conducted simultaneously in 249 databases. Results were categorised by discipline and analysed by decade. The results were used to form an informetric-based mapping review.
Results: (i) Medicine and health care disciplines are the predominant poster users and since 1990 have accounted for 68–75% of the overall published data. (ii) Over 99% of the returns led only to abstract or title citations for conference posters. (iii) Poster presentations offer much potentially useful information, but remain difficult to access.
Conclusions: If the aim of poster presentation is to share and discuss information with others, then the limitations of poster abstracts and questions raised in the retrieved literature suggest that further efforts are required to make this more effective. Library and information specialists of all disciplines are likely to play a key role in such developments, and especially those from the medicine and health care disciplines which feature so prominently.

Keywords: information management; knowledge transfer; review, mapping

Key Messages

- There is a vast body of multi-disciplinary information presented in poster form, but it is poorly disseminated and difficult to access.
- Information presented on posters is often abbreviated to abstract form and lacks sufficient detail for academic use.
- If the objective purpose of poster presentation is to disseminate and discuss information with others, then effort is required to make the medium more effective.
- Given the presence of medicine and health care in poster literature, health library and information specialists should take an active interest in managing information presented at conferences.
- Future research needs to consider how poster presented information may be better presented, accessed and collated, so as to improve its capacity for knowledge transfer.

Introduction

Posters are a prominent form of presentation at large-scale academic and scientific conferences.[1] Used across a wide range of disciplines, posters now appear in ever-increasing numbers, and at some events over 1000 posters may be displayed during a single session.[1,2] For example, at the

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American Geophysical Union 2013 Fall Meeting[3] there were 27 subject areas, hosted over a 5-day meeting. Just looking at the first of these areas (Atmospheric Sciences), it had 176 sessions with 4419 presentations (3654 posters, 765 oral, nine virtual & 25 virtual on-demand only). If a conference delegate was interested in this particular area (not to mention the 26 remaining subject areas), it is difficult to see how they could effectively manage this mass of potentially useful information either in the time and space confines of the conference setting, or perhaps later as an accessible information resource.

Poster presentation is beyond doubt a popular medium, and this can be reflected not only in our own personal conference experiences, but also in the vast amount of abstract citations that are published in professional, scientific and academic journals. However, no empirical studies have been conducted to confirm this observation. Quantifying poster presentations is problematic, as conferences differ greatly in their reporting of poster presentations. Posters presented at small- to medium-sized conferences may not be publicly reported; however, the citations for larger events may be so numerous and published so diversely, that they deter any attempts to reliably collate and quantify them. With such a wide and undocumented spread of events, the perception of conference size is subjective. However, the Convention Industry Council[4 p3 §1] estimates that 273 700 conventions/conferences/congresses were held in the United States in 2012, with an estimated 60 960 000 participants, and an average of 223 participants per event. Based on this figure, it is practical to imagine smaller events as involving around 10–150 delegates, medium events 150–300 delegates and larger events 300+ delegates.

The presence of poster sessions at most large-scale conferences indicates that posters are a prevalent means by which delegates get to display their work to others. However, little attention has been given to the widespread usage of posters. In our own conference experiences, we are probably familiar with poster presentations, but there is little concrete data that show how they are used across disciplines. As such, it is difficult to comprehend the significance of posters in our formative and continuing educational practices, as a form of scientific communication, or as a source of potentially useful information. However, conference industry literature[5 p10] acknowledges medical meetings as filling the largest segment of the conference market, followed by scientific, other academic and professional bodies. Medicine and health care have also featured prominently in previous poster-related literature[1,6], and as a consideration for library and information science (LIS) professionals in terms of information management and access.[7] As more research is conducted in this area, conferences are likely to emerge as a rich source of information.

Both health and trans-disciplinary LIS professionals (particularly those contributing to systematic reviews) may be required to search for this type of 'grey literature', so information on its accessibility is likely to be useful. LIS professionals also use the poster medium routinely in their own professional practice (see later section on library and information science perspectives on poster presentation) and will therefore be able to use the guidance found in this mapping review to develop their own use of the poster medium.

In his 2007 literature review, Brownlie[8 p1246] was unable to provide a comprehensive coverage of the published materials on poster presentation, so an alternative approach was needed to illustrate the growth of the medium, to determine the contributions made by various disciplines and to give an insight into the themes that are prevalent in poster and conference literature.

This informetric-based mapping review was designed to answer the following research questions:

1 What are the main fields which use the poster medium?
2 To what extent is it used (in terms of numbers)?
3 How has it been developed since its inception and to what purpose?

A summarised account of the key issues that are raised in poster literature is given. However, any discussion or analysis of these issues lies outside the scope of this article, and any attempt at providing an annotated or in-depth bibliography has been purposefully avoided.

Methodology

For this study, a UK university library search facility was used to conduct a simultaneous search of 249 databases spread over 37 specialties. The major databases commonly employed in international literature searches were included. Amongst these were: *BioMed Central, British National Corpus (BNC), CINAHL, Cochrane Library, DOAJ, EBSCO, EMBASE, ERIC, JSTOR, MEDLINE, Psycinfo, PubMed, Science Citation Index, ScienceDirect, Web of Knowledge* and *Zetoc*. The results were presented as an overall return, and not by individual database. For reasons of practicality, the entire index of databases covered by the search facility is provided as supporting information to this article.

There was no attempt to focus on a specific discipline, and all returns were treated as being potentially equal in value. The returns were reviewed using an informetrics approach, which is the study of the quantitative aspects of information.[9] This includes the production, dissemination and use of information, regardless of its form or where it comes from. Of special interest were the total number of returns, the number of returns classified by discipline and the general themes discussed in poster literature. The search term 'poster presentation' was used to investigate the broad phenomena of posters and has been successfully used in two previous literature searches on the topic.[8,10] By selecting scholarly and peer-reviewed literature, it was anticipated that the available research on 'poster presentation' would be captured, rather than posters themselves, and previous research conducted using this term[4,6] makes no mention of returns other than the articles they cite.

The search facility automatically quantified the returned data in terms of source type, specialty and subject. It also offered filters such as full text only, scholarly and peer-reviewed, content type, discipline, subject terms, publication date and language. The 'scholarly and peer-reviewed' returns were accessed and are used here to provide an indication of the main contributions made to the corpus of poster literature. No limiters other than time frame were set. The search periods were structured as: <1970; 1970–1979; 1980–1989; 1990–1999; 2000–2009; 2010 – September 2015. Duplicate returns (where one paper may have been found in a number of databases) were automatically removed from the reported data by the search facility, although when a single return (e.g. a conference report or special issue citation of 'poster presentations') listed poster presentation abstracts, these were sometimes also reported individually and so lead to a duplicated title. To obtain a comparison, the academic search engine *Google Scholar* was also used to investigate the same search term, and to give an indication of any additional material that might lie outside the database searches. Google Scholar indexes the full text or metadata of scholarly literature across a range of disciplines and has been estimated to capture 87% of the documents that are available on the Web.[11] Returns can also be grouped by time frame. As such, the combined approach of multiple databases and an academic search engine was deemed to provide an acceptable level of accuracy in regard to data capture.

Results

The output of this informetric mapping review highlights the prominent use of posters by medicine and health care disciplines, as categorised by database returns and classification. A standard Google Scholar search is equivalent to an 'All of the words' search. Therefore, it is likely to detect small differences in the names of the authors, the article's title or its sources and may cause the same article to appear more than once.[12] This may explain the higher, but uniform, return rate from Google Scholar compared to the database search which also featured a small but noticeable degree of duplication. Nevertheless, the overall trends since 1980 (Fig. 1) are similar.

All of the retrieved returns were read to determine their type (e.g. article, citation, abstract, conference proceedings). The search facility automatically classified the returns in terms of contributory discipline and quantity. Any returns which yielded a text related to 'poster presentation' were accessed and read fully to determine their topic and content. For the purposes of this article, only a synopsis of the content of the retrieved articles is offered, without any formal

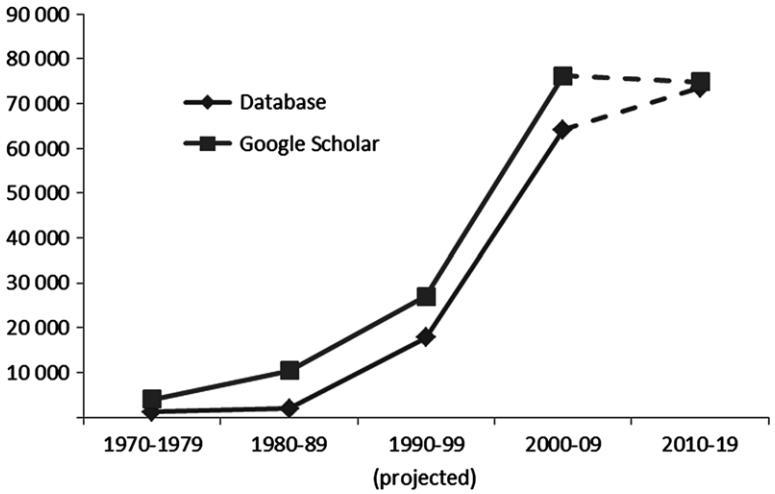


Figure 1 A comparison of database and Google Scholar returns by decade. [A consistent increase is shown in both database and Google Scholar returns 1970–2009. In the present decade, 2010–2015 showed returns of 46 940/47,80, respectively. If projected through December 2019, the database figure predicts a continued rise of 14.5%, whilst Google Scholar rates were predicted to fall by 1.8%. Although we can speculate about refined detection algorithms in the Google Scholar facility, there is no evidence to explain this finding. It may also be that the two approaches are simply coming into alignment, as there is only a 1.8% difference between their respective values. As such, it is not seen as a significant observation.]

content analysis (e.g. the quantification or analysis of specific words or concepts). Despite the search filter being set to include only peer-reviewed literature, more than 99% of the total returns were either abstract or title citations to poster presentations made in the conference setting. This is interesting from two perspectives. Firstly, it may be reasonable to expect that a search for such literature would return actual literature sources, and not just titles or short abstracts. The purposeful selection of peer-reviewed literature was aimed to promote this. By definition, an abstract is a summary of a larger work, but in the case of posters, this larger work (e.g. the actual poster or the further information which comes from the presenter) is usually not available outside the conference itself. Abstracts are not generally deemed reliable enough to act as stand-alone sources of academic information, and in a number of studies the data they provide have been found to be either inconsistent with or absent from that provided in the main text articles of large circulation medical journals,[13] pharmacy journals[14] and clinical chemistry journals.[15] Therefore, considering short abstracts and titles as peer-reviewed literature (in a scholarly search context) raises issues of the academic quality and worth of this type of return. Secondly (and covered in more detail later in this article), from a conference organiser's perspective, Rothstein[16] notes that abstracts alone cannot be examined for their reliability or validity because of their inherent content limitations. There are also proven difficulties in managing large volumes of poster abstracts because of the amount of text that any individual or conference planning committee can process in a given time. This is especially pertinent for large-scale events which can host thousands of posters and require considerable amounts of time and effort to process to a reliable standard (see later analysis of the American Geophysical Union 2013 meeting for a clear illustration). So, although it is surprising that stand-alone conference abstracts and titles are returned (at least in concept) as peer-reviewed literature, no other category currently exists in which to classify this 'grey literature' resource in its present published form. At the centre of this issue appears to be the difference between the depth and quality of the information originally presented in the conference setting (which is likely to be of a suitable depth and quality), and the information made available in published form which would seem deficient.

A similar result was seen in the Google Scholar search, with poster abstracts being prominent in

the returns. A single return might detail the full content of a conference poster session, and these can involve thousands of individual poster citations,[1] so it was not practical to quantify poster presentation abstracts in terms of their numbers or discipline. Therefore, research question (2) concerning the extent to which poster presentations are used (in terms of numbers) could not be answered other than by noting overall trends.

Early poster research (1937–1969)

There is early research that highlights interest in the poster medium from two perspectives. Elliot[17] studied the effects of presenting advertising information by visual (poster), auditory (recorded message) and combined approaches. He observed that: '... *without attention there can not* [sic] *be memory, and without memory, there is little likelihood of the learning or buying response'*. In his psychology study of >25 000 subjects, it was found that displaying posters alone attracted the least attention, auditory presentation gave increased attention, but a combined poster and auditory approach gave the highest buyer response. In a following study,[18] he observed that that radio messages held the advantage in eight of nine cross-comparisons with visually displayed information, although there was a negligible difference between the two media. These early observations may provide an indication that in regard to attracting attention and gaining a meaningful response to displayed information, it is important not only to display data, but also to describe it to viewers. A 1939 article by Riley[19] described posters being used in classroom education and provides the earliest mention of posters being used as an educational tool. She indicated that posters can represent '... *either a good idea crudely or inartistically presented, or a shallow idea beautifully executed*'. Although these contexts are different, again, the affective quality of the presented information is highlighted. There is also a book from this period which focuses on posters from a design perspective.[20]

From the conference setting, there are no published poster presentations from this period, although graphic illustrations were included in conference proceeding papers of the time. A good example of this is a computer engineering paper[21] that contains four figures and four photographs which illustrate the covered topic. Although there is evidence that posters were used educationally and as a means of displaying information to an audience, the earliest mention of them being used in the international conference setting is in the 6th annual meeting of the Federation of European Biochemical Societies (FEBS) in Madrid, Spain in 1969.[22] Prior to this time, medicine had used the poster medium to disseminate health care messages to the public, for example in posters concerning public health issues. Also, in the Wellcome Library[23] there is a tri-fold display from 1946 which offers evidence that mounted material was being used to display information for use in a medical education context.

1970–1979

This period represents the era when poster sessions were becoming established as a common practice in science and academia (Table 1). Already, there were reports of the growing popularity of poster sessions, and guidelines to preparing material for display were emerging.[24,25] Maugh[26] viewed that '*It is beginning to look as though the poster session is an idea whose time has definitely come*', and although the immediate

Table 1 Database and Google Scholar returns for January 1970–December 1979

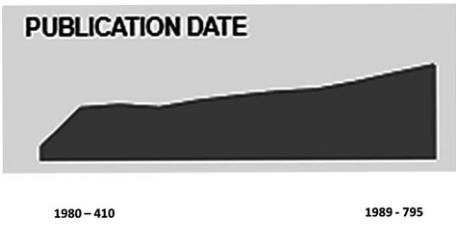
Database returns: 1139
Top 5 contributory disciplines: history & archaeology 218; sociology & social history 181; economics 179; languages & literatures 161; philosophy 132
Healthcare contributions: psychology 72; medicine 43; nursing 6
Google Scholar returns: 3970
Retrieved articles: 11

benefits of a more personal two-way conference interaction were appreciated, it was also noted that poster presentations reached fewer people than oral presentations.[27] A question of the time limits of poster sessions was raised in a survey by Eisenschitz *et al.*[28] who recommended that '*... prior to 'opening time', demonstrators should be able to examine each other's posters*', and in their study there was complete agreement that poster displays carried less prestige than either a conference paper or a journal article. During this period, educative aspects of displaying information were being linked with ideas of networking and interaction, and the medium of posters was also featured as a tool in graduate education.[29]

1980–1989

This period reiterates poster sessions as being an established conference feature, and the library-based review of poster presentations by Schmidmaier[7] is the last work to place it as a 'new' practice (Table 2). There are articles which give advice on how to prepare posters[30], but literature also features discussions on the place of posters as a continuing educational activity.[31] Liegel and Thompson[32] give an in-depth description of poster preparation, but point out that '*key points are merely highlighted to spur questions from viewers to the presenter*'. Recognising the physical limitations of posters, Ernster and Whelan[33] suggested that posters be accompanied by a short report in conference proceedings that provides more detail for the viewer. In their view, this provides more meaningful information to users than a mere abstract and also provides a more permanent record. However, Whimster[34] gives an opposing view that '*The test of a good poster is whether the material can be absorbed within two minutes*'. He views that using what is now known as the 'IMRAD' approach of structuring posters (introduction, methods, results and discussion) gives too much information for delegates to absorb in the time available (and he also suggests that prizes should be given for the worst, as well as the best poster). Ernster and Whelan[33] observed that '*With the proliferation of research results, indications are that the majority of presentations at professional annual meetings will soon be in poster rather than oral format*', and indeed, this took place over the following decades.

Table 2 Database and Google Scholar returns for January 1980–December 1989



Database returns: 1965
Top 5 contributory disciplines: sociology & social history 275; languages & literatures 273; history & archaeology 269; engineering 201; economics 172
Healthcare contributions: psychology 72; medicine 85; nursing 38; anatomy & physiology 66; public health 6; diet & clinical nutrition 3
Google Scholar returns: 10 400
Retrieved articles: 15

1990–1999

During the 1990s, medicine and the health care disciplines attained prominence as the main users of the poster medium (see Fig. 2), and this has gone on to increase through time (Table 3). Medicine has more than three times the number of returns in published literature than the next closest discipline, and health care disciplines accounted for 68% of the database returns. As well as being used to present information at conferences, posters were being used to evaluate nursing students,[35–38] as an educational learning experience,[39] and as an educational strategy.[40,41] Many articles discuss poster compilation and presentation.[42–44] A book on the subject was produced by Gosling[45] and the topic is included in various future texts on scientific writing and presentation. Additionally, there is work that looks at evaluating research posters,[46] the quality of conference presented research,[16] and the first mentions of electronic posters.[47,48] Posters also feature in non-English language literature and discuss similar themes in terms of compilation, value and presentation.[49,50]

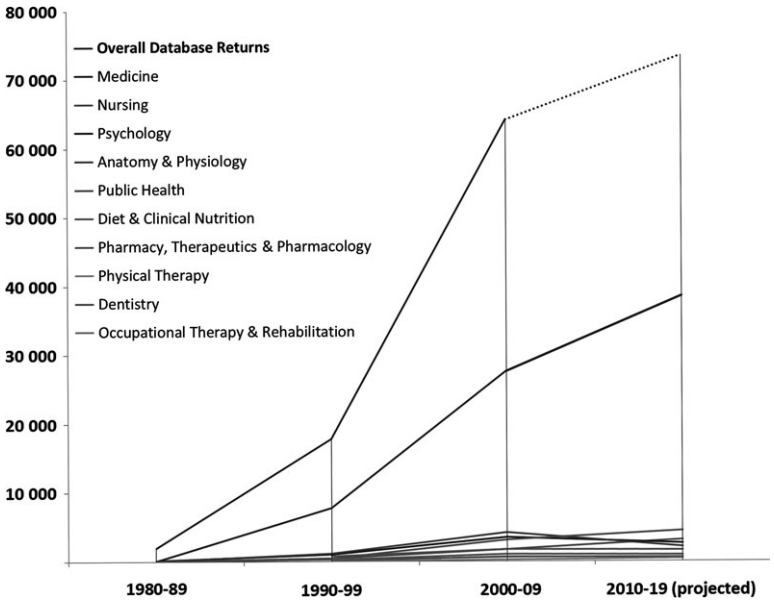
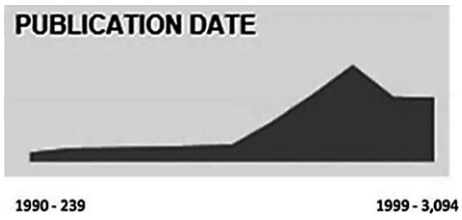


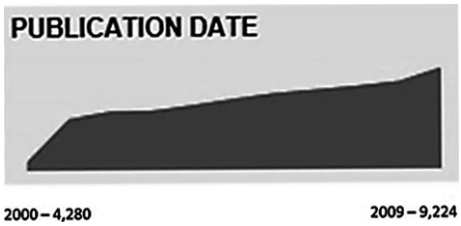
Figure 2 The overall returns of the formal database search for 'poster presentation' highlighting the contribution of medicine and health care disciplines

Table 3 Database and Google Scholar returns for January 1990–December 1999



Database Returns: 17 787
Top 5 contributory disciplines: medicine 7,730; biology 2,155; engineering 1,497; psychology 988; pharmacy, therapeutics, & pharmacology 769
Healthcare contributions: medicine 7730; anatomy & physiology 1112; psychology 988; pharmacy, therapeutics, & pharmacology 769; public health 454; nursing 449; diet & clinical nutrition 244; physical therapy 220; dentistry 123; occupational therapy & rehabilitation 29 (68% of total)
Google Scholar returns: 27 000
Retrieved articles: 31

Table 4 Database and Google Scholar returns for January 2000–December 2009



Database Returns: 64 140
Top 5 contributory disciplines: medicine 27 614; engineering 5181; education 4924; anatomy & physiology 4138; psychology 3477
Healthcare contributions: medicine 27 614; anatomy & physiology 4138; psychology 3477; public health 3073; nursing 1717; pharmacy, therapeutics, & pharmacology 1676; diet & clinical nutrition 992; physical therapy 541; dentistry 613; occupational therapy & rehabilitation 169 (68.6% of total)
Google Scholar returns: 76 200
Retrieved articles: 104

2000–2009

The returns for this period show a 360% increase on the previous decade (Table 4). This indicates a rise in poster presentation usage, but may also reflect improvements in the abilities of search engines to find and report a wider range of published material made available on the Web. The ranking factors and algorithms that each database and search facility employs differ widely, and this gives a slight variation to the results returned at any given time. However, given the variety of databases and search engines used in

this study, the collated returns are likely to give a good representation of what is available.

Poster compilation and 'tips' are again prominent.[51–58] Using posters in education is covered,[59–61] and there is continuing discussion on electronic posters,[62–65] including the view that the electronic poster will most probably replace traditional formats.[66] There are studies that begin to consider the medium as a 'marginalised genre',[10] the legal status of posters as a publication is questioned,[67] and there are a number of studies that explore the rate of development from conference presentations and abstracts to full-published papers.[68–71] Questions are also asked as to the value and efficacy of poster presentation in terms of disseminating knowledge.[6,66] Brownlie[8] produced an annotated literature review which considers poster presentation from a marketing perspective, and a wide range of non-English literature can also be seen[66,72–76] which discusses similar issues to those raised in English language literature.

Table 5 Database and Google Scholar returns for January 2010–September 2015

Database Returns: 46 940 (73 471 if projected through December 2019)
Top 5 contributory disciplines: medicine 24 593; *education 3297;* public health 2802; engineering 2512*;* nursing 1986
Healthcare contributions: medicine 24 593; public health 2802; nursing 1986; psychology 1666; anatomy & physiology 1316; pharmacy, therapeutics, & pharmacology 1000; diet & clinical nutrition 564; physical therapy 357; dentistry 328; occupational therapy & rehabilitation 227 (75.2% of total)
Google Scholar returns: 47 800 (74 827 if projected through December 2019)
Retrieved articles: 85 (<15 September 2015)

2010–2015 (September)

In the current decade, poster presentations still appear to be increasing (14.5% on the previous decade if the period is extended through December 2019 based on current rates; see Fig. 2; Table 5). Most conferences (regardless of discipline) now have similar guidelines and requirements for posters, in terms of their 'IMRAD' type format and basic design features. This can be seen from the web page instructions that cover poster design provided by many university institutions, and also in the guidelines that accompany the calls for abstracts of most larger scale events. However, articles offering advice on these issues are still prominent.[77–84] Other literature discusses the integration of information technology to broaden poster efficacy,[85,86] including the use of smart phones[86] and multimedia.[87,88] There are literary and genre considerations,[89–93] and also continuing coverage of the rates of publication trends for conference presentations.[94,95]

Of note, however, is the literature that takes a more critical view of poster presentation. There is support regarding the quality of information presented in posters in the conference[96] and educational settings,[97] yet the increased volume of posters which are presented at conferences is now seen as being difficult for both organisers and delegates to manage.[1,98] Goodhand[99] therefore questions their ability to disseminate research effectively. There is also dissatisfaction with overly textual posters,[100] the availability and 'dark-data' status of poster information,[101,102] and the limitations of posters in regard to their educational benefit.[103]

Overall, the informetric trends suggest that poster presentation will continue as a popular medium, but the questions raised in contemporary poster literature show that developments are needed to address the concerns of its users.

Discussion

This review has achieved relative success in answering the three research questions posed at the outset of the investigation.

Firstly, poster presentation is clearly a multi-disciplinary practice. Examples of poster use were returned from humanities, social sciences, natural sciences, formal sciences, computer sciences and the professions. These were spread over a total of

58 subdisciplines and reflected a worldwide authorship. Since the 1990s, medicine has been the main poster user, averaging a 20% lead over its nearest rival over the following years. However, even the least visible fields are seen to contribute large numbers of posters to conferences each year, so the practice merits consideration by all disciplines.

Because of the volume of material and inconsistencies in reporting, it was not possible to determine the exact number of posters produced in any given year. However, conservative estimates have so far been offered of 1.1 million per year.[104] This identifies posters as by far the most prevalent means of presenting at conferences, and perhaps more importantly, the second most prevalent means of communicating information across science and academia behind journal articles (2.5 million 2014[105]). More broadly, if the same measures are applied to published conference attendance figures (av. 223 delegates[4]) at a 50% presentation rate, conference presentations in fact rise to 4.4 million p.a.

Poster presentation still follows a similar process to that which was seen in its early years. Presenters show the key points of their work on a poster and make themselves available to discuss the work with passing delegates. There have been developments such as electronic poster use and limited conference material archives, but the mainstream practice of poster sessions remains relatively unchanged. However, the review shows that posters are now utilised on a greatly increased scale, and this has created difficulties for their effective management. Originally, the purpose of poster presentation was to share work with other conference delegates, and to facilitate dialogue and networking amongst researchers. These aims are still feasible at smaller events, but at larger events, despite these goals becoming increasingly difficult to achieve, poster use still continues to rise. It would therefore seem that our motivation to undertake poster presentations is also affected by other needs, but what these are has not yet been established.

What is clear is that poster presentations (and conference material in general) offer a valid source of potentially useful information. How this information can be used more effectively goes beyond the scope of this article, but this section aims to highlight the key points achieved by the review, the practical complications of accessing poster presented information, and also how library and information professionals are placed in the discussion.

What the mapping review has achieved

The informetric approach used in this literature review has charted the spread and development of the poster medium. The output maps the existing literature by decade and contributory profession (see preceding tables and Fig. 2), and as such follows the lines of a mapping review.[106] According to the typology of reviews forwarded by Grant and Booth,[106] a mapping review not only maps out and categorises existing literature, but also characterises its quantity and quality. Given the dearth of previous research on poster presentation, this review additionally sought to summarise the key points raised in the literature. Whilst the review makes no formal assessment of the quality of posters and poster presented information, it revealed peer-reviewed studies and opinion on the quality of poster abstracts[16,33,71,96] and the quality of posters themselves[67,94,99,103]. However, when addressing such a large body of information over such a broad time frame, a qualitative summary was required to contextualise issues across the data and highlight areas for further research. So, from a methodological perspective, this mapping review also shares some of the characteristics of mixed methods and scoping reviews.[106] Adopting this type of approach may therefore prove useful to researchers examining similarly broad fields.

Posters as 'grey literature'

Conference presentations (oral & poster) are 'grey literature' in the sense that they are quality intellectual works produced and disseminated by academics, despite not being controlled by commercial publishers, and where publishing is not the primary activity of the producing body.[107,108] In terms of establishing patent, posters have been deemed as a legally valid form of publication.[67] Also, in terms of intellectual

property; whilst no commercial agreements are generally entered into, the popularity and pedigree of poster abstract publications (i.e. their authors expertise, the professional and academic level of their intended audience, and their mainstream secondary publication outlets[109,110]) would indicate that library and information professionals could consider posters as a valid and potentially valuable source of information. However, Roth[108] notes that grey literature is not commonly available in archive collections, and as posters lie outside the mainstream fare of public and academic libraries, the information they contain is seldom readily available as a research resource. But even as far back as 1981, it was recognised that librarians found it difficult to deal with conference material, especially in regard to its location and acquisition,[7] p121–122 so it seems that this issue continues to go unaddressed.

Difficulties in managing poster presented information: pre-, per- and post-event

The review highlighted that more than 99% of the returns led to conference abstracts that had been published in mainly traditional journals, or in the formal proceedings of conference events. The issues of managing large quantities of abstracts have been conceptually addressed,[16] but the literature returns and increasing mass of reported presentations show that poster presentations have grown far beyond the capacity offered by the physical conference session[1,99,101,104]. Many sessions run on the assumptions that people will pre-select abstracts and directly engage with the presenter during the session or that they will browse the posters on display and interact on a less formal basis. It is also assumed that this results in an effective dissemination of information, but this may easily be refuted. Not only can we observe the low levels of interaction at larger events for ourselves, it is also described in the literature.[1,2,99,102] Moreover, if tested average reading rates for average and good readers are applied,[111,112] then the physical limitations of mass poster sessions can be seen even more clearly. With reference to the American Geophysical Union 2013 Fall Meeting session[3] described in the introduction of this article:

1 If delegates dedicated 1 hour (h) concentrated reading to studying the abstracts published for the session, then only 1.36–2.72% of the available work could have been read by any one individual.
2 The abstracts of just this one subject area alone would have taken 73.65 h to read efficiently @ 250 efficient words per minute (ewpm) ewpm/ 36.83 h @ 500 ewpm. There were 27 subject areas of similar size.
3 The AGU Atmospheric Sciences session had 3654 posters. If a poster contained 1000 words,[84] it would have taken a minimum of 122 h to 'read' all of the posters on display. Again, this does not account for any discussion with the presenter, time spent between posters, personal time or refreshments, or time spent on other aspects of the conference such as exhibitor displays or networking.
4 If only 15 words of a title were read to determine interest, it would have needed a minimum of 1.83 h of non-stop reading to simply be aware of the posters on offer (1000–2000 titles per hour). Despite the presentation abstracts being housed online by the conference organiser,[3] they occur only as short abstracts and are listed by title, and there is no recourse to the presented poster, imagery or supplementary data.

Understandably, due to variations in submission deadlines and human and technological resources, conferences may differ in how readily available abstracts and conference material is made to delegates pre-/post-conference. Rowe and Ilic[1] state that:

> Options before, during and after the conference should be considered to enhance current [conference] practices. Diverse web pages host materials that have been presented at previous conferences, but these are scattered and of varying quality. As well as repository-type sites that host materials, thought may perhaps be given to developing a central service that helps to host and collate materials, and improves access and interaction across specialities and disciplines.

In their article[1] p3666, they also find that poster presenters want to give more detail, attract

attention and increase their exposure post-conference. Developing online resources would seem to be a logical step towards addressing these needs, and also help others access and utilise this information. In tests,[112] good readers will read at 400 words per minute with an 80% comprehension rate, and excellent readers will read at 1000 words per minute with an 85% comprehension rate. However, reading in a second or other language is likely to be more difficult, and reading from a screen is 25–30% slower,[112] so any developments must take this into account.

Search term returns

It is in no way argued that too much information is available or that it lacks potential quality, but rather that it needs more efficient management to be effective and useful. The overall returned data stemmed from 58 specialities and offered >119 000 returns from the databases [all reviewed] and >370 000 from Google Scholar [0.95% reviewed]. When restricted to a title-only search (poster AND presentation), only 2403 returns were offered, 2217 of which were classed as scholarly and peer-reviewed. However, when the first 200 returns were reviewed (all listed as journal articles), they all led to abstract citations. Of these, only six (three animal science and three biochemical science) were not related to medical or health care fields. Furthermore, it was not possible to discern specific content topics without directly accessing the source (most of which again reported multiple poster presentations). Because they are often housed under 'articles' titled as '*Poster Presentations*', it is unlikely that poster abstracts will feature prominently in key word or title searches, even if they exist and are directly related to the search topic. It is also clear that even if poster findings are published in mainstream journals, it is not currently practical to search for them without considerable effort.

The current situation

Around 1.1 million poster presentations are estimated to be undertaken each year, based on the global number of registered higher education institutions (23 123), scientific associations and learned societies (17 500) and the posters they may conceivably host or support.[104] This and the large volume of returned data in the review indicates that not only is poster presentation the most prevalent form of information dissemination at conferences, but in terms of the numbers produced, it comes second only to journal articles (estimated at 2.5 million p.a.[105, p6]) as a preferred medium of information dissemination across science and academia. Despite poster presentations being seen as 'grey literature' in library terms, as a large source of potentially useful information, they should be of interest to information specialists of all disciplines, and of special interest to those linked to medicine and health care. The utilisation of posters dramatically increased in the period 1990–2009, so this may be seen as the period in which the poster medium became an established part of the conference orthodoxy. Medicine and health care disciplines display similar usage trends to the overall population, although the volume of their returns in the data is consistently larger than other fields (Fig. 2). Medicine features in the early forms of poster presentation[23] and from 1990 are clearly seen as the major poster user. Why this should be, however, has not yet been established.

Library and information science perspectives on poster presentation

Repeating the search from a library and information science perspective (using the same search facility and included within the previously reported data), 6749 scholarly and peer-reviewed returns were available (Fig. 3). When restricted to a title-only search (poster AND presentation AND library), only nine returns were offered, eight of which concerned books on academic development skills. Although the library and information science numbers are proportionally smaller than the overall data totals, Fig. 3 shows a similar pattern of returns by decade. Despite limiting the search to results for scholarly peer-reviewed articles from Library and Information Science, again, over 99% of the returns led to abstract citations, most of which in fact stemmed from the field of medicine. The ranking, collation and classification algorithms that each database and search facility employs differ widely, and the

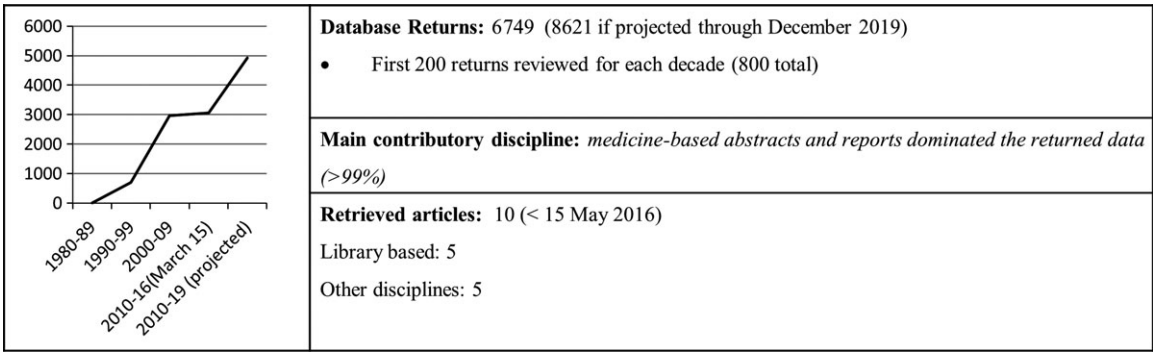


Figure 3 Discipline-specific returns of the formal database search for 'poster presentation' highlighting the contribution of Library and Information Science

difference in returns shows that although refining a search to title-only may appear to give more relevant search results, this is not necessarily the case. In this instance, although 'poster presentation (s)' was a highly popular return in an open search, it did not feature at all in a title-only search. Thus, when searching for information, open search approaches should at least be examined to verify if an advanced database search represents a true picture of the sources potentially available.

In the library speciality search, the first 200 returns for each decade were reviewed. Some duplication was seen, but there was also some useful information that provides an insight as to how library and information specialists may view the topic of poster presentation. Within library and information science, conferences and association meetings are highly valued, and Virgo (1991 cited Frank 1997[113]) views that '*A primary mark of a profession is the development of a scholarly body of knowledge which continues to grow and be furthered*'. Conferences and meetings help to disseminate this knowledge, *ibid* and Gravois[114] reports posters as having been used at American Library Association conferences since 1982. Poster sessions have been used as a direct source of ideas for librarians,[115] although they are reported as being appreciated more by librarians from academic library backgrounds.[116] Poster sessions are seen as a valid form of publishing within the field,[114] and this coincides with the legal decision which has previously been cited.[67]

In line with returns from the overall review, poster compilation has also been written about by the library community,[117,118] and various library conferences are seen which feature poster presentations. There is further coverage of poster publication rates, with one study analysing 3205 abstracts and finding no significant differences between the rates of posters and oral papers.[119] Looking from a medical and health library perspective, Harvey & Wandersee[109] noted that the conversion rates (abstract to published paper) for Medical Library Association meetings in 2002–2003 was only 26.5–27.6% for the 442 abstracts studied, but this is within the ranges reported in similar studies conducted in other disciplines.[1,68,70,71,95] Once again, however, due to the issues of reporting, collation and rates of conversion, this body of potentially useful knowledge will remain difficult to find until poster presented information is made more freely accessible.

Smaller meetings

The difficulties of finding information presented at conferences are not just restricted to the mass of abstracts that are generated by large international meetings, but also to the dissemination of work presented at smaller meetings. To gain a library perspective of this issue, a smaller US conference featured in the library review data from 2010 was examined (details deliberately withheld).

The presentation titles of this meeting were all searched for on the Internet. As seen in Table 6, there is a large degree of additional dissemination, despite copyright being asserted by both the conference organiser (in their proceedings), and also by the mainstream journal publisher which

Table 6 Availability of presentations from a small-scale library conference

		Abstracts available on professional social media	Full text on institutional repository	Slides/Text available online	Duplicate publications	Proceedings shown on Google search front page
Papers	41	31 (68% of papers)	6 (14% of papers)	21 (39% of papers)	Nil	41 (100% of papers)
Posters	18	Nil	1 (5% of posters)	1 (5% of posters)	3 (16% of posters)	1 (5% of posters)

reproduced the proceedings material verbatim. The presentation of the same poster at multiple conferences is also seen, and this phenomenon is also apparent in other disciplines.[120] Using a basic Internet search, oral presented papers were significantly easier to locate than poster presentations. However, given that all of the titles were published in the same mainstream journal, it is uncertain as to why this might be. Additionally, smaller meetings may not disseminate their presentations in mainstream media, so the author-instigated dissemination practices shown in Table 6 indicate that both oral and poster presenters are looking for additional exposure of their work.

Poster abstracts

When looking at the returns from this review, perhaps most striking are the returns which did not yield an article or text on the topic of poster presentation. Relating to the retrieved literature: of the database returns yielded since 1970, over 99% were abstract or title citations to poster presentations that had been made in the conference setting. As previously mentioned, these could be either single citations or more commonly encompass a whole body of poster presentations that had been presented at an event, so the informetric approach of this study does not reveal precisely how many posters may be produced by any one discipline. If these returns are reviewed individually however, it is easy to see that they run to very large numbers, and that individual poster sessions can host anywhere from just a few posters, to over 1000.[1] Thus, even disciplines with a comparatively low rate of data return may still produce vast numbers of posters each year.

Delegates invest large amounts of time, effort and money into presenting a poster, and the annual expenditure on international conference posters can be conservatively estimated to exceed 2.2 billion USD.[104] But, if we consider all of those who might benefit from their information, they seldom reach any significant audience (in terms of numbers) who can meaningfully engage with them. An abstract may be published in proceedings or journals, but as Rothstein[16] notes, abstracts cannot be examined for their validity or depth of content, because of their inherent limitations. Actual poster presentations contain not only the displayed information, but also the spoken information that is provided by the presenter. After a poster session has concluded, this depth of data is certainly not made available in an abstract or citation, and as previously mentioned, literature suggests that only around 30% of poster research is converted to a full paper.[1,68,70,71,95,109]

Access and dissemination

So, how can those of us who do not attend a specific conference or visit a specific poster later access the information that was once deemed important enough to fund and present to our peer communities? It is specifically this question which indicates a need to further develop the poster medium, but although this point has been discussed as long ago as the 1970s,[27,33] little has been done to address the problem. The review highlighted that in a scholarly search for 'poster presentation', more than 99% of the returns were abstracts or titles. Some organisations have online repositories that house poster format information, but as previously mentioned, this is normally only a short abstract or title listing, and rarely offers a poster image or supplementary data.

Other platforms exist which will host poster and conference materials, but despite their intentions to

capture and disseminate research work, they show limited success. For example, *F1000 Research* (see https://f1000research.com/ for details) publishes articles, posters and slides. The main articles are published as open access (with an author fee), and 'posters and slides are published under a CC-BY 4.0 license, which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited, and leaves the copyright with the current copyright holder (usually the author or their institution)'. In 2015, the F1000 Poster platform was merged with F1000 Research. At this point, the platform hosted 7086 posters drawn from 1376 conferences.[121] However, this only reflects a capture average of 5.1 posters per conference, and a large amount of potentially interesting or useful data will have been missed. As of 30.11.2016, *F1000 Research* hosted 9615 posters. These were able to be searched, and although a search for 'poster presentation' yielded 119 results, only two of these (1.7%) directly related to the subject of poster presentation. The remainder were simply posters from life science and medical disciplines, and on various subjects. All of the posters had a downloadable pdf image and a short (250–500 word) description of the work, but no extended or additional information was available.

An alternative hosting platform is *LinkedIn SlideShare* (see http://www.slideshare.net). Operating since 2006 and again reliant on author upload, the platform hosts slides in different formats, including videos, webinars and zipcasts which allow video/audio live broadcasting. Classified as presentations, documents, videos and infographics, the hosted material is also searchable, and a search for 'poster presentation' offered 1 474 555 returns. Posters were seen under presentation, document and infographic categories, but no advanced search facility was available to help isolate information, beyond specifying an upload period (7/30/365 days), the file type and language. Thus, in both the academically pointed *F1000 Research,* and the more generally pointed *LinkedIn SlideShare* services, retrieving information is still problematic.

As collators and managers of information, contemporary library and information professionals are likely to play a key role in the future development of poster presented information. In line with Roth's[108] academic perspective on grey literature, the results of this review also argue that with '... *more rigorous quality control, increased access* [...]*, and more scholarly cooperation* ...', posters as a current form of grey literature may not only have the potential to become a more recognised form of academic publication, but also be more effective in disseminating their subject knowledge to a wider audience. As experts in the collation, organisation, retrieval and dissemination of information, LIS professionals are well placed to help guide and manage such developments. Although independent efforts have been made to host and disseminate conference materials, they still do not offer a practical way of managing the mass of information involved. At present, the published output of poster presentations is commonly just a short abstract or a title mention. Poster presentation is a global phenomenon and involves massive expenditure in its production. As demonstrated by its wide use in science and academia, the information presented in posters is likely to be both useful and interesting to the global community. However, the review also showed that the outputs of our poster efforts are limited in detail and difficult to access outside of conference events. Library information professionals therefore need to engage with all conference users (i.e. presenters, organisers, funders and institutions), and search for ways that their skills in information management can help poster material (and conference material in general) be of more effective use. This is likely to involve issues of information collation, management and access and will require forward-thinking consideration of matters such as digital scholarship, open access, technology integration, and how information could and should be shared in a globally connected community.

Study limitations

The informetric approach used in this study focuses on the quantitative aspects of information. The broad search term of 'poster presentation' has been used successfully in previous studies and is the commonly used term in science and academia

for both a physical poster and the act of presenting a poster at conferences. This is reflected throughout the returned literature. It is acknowledged that the use of derivative search terms such as 'poster', 'posters', 'poster sessions' may have yielded differing results, but it is not envisaged that any meaningfully different data would have been retrieved to contradict the general findings of this review. It can be seen that these terms all featured in titles in the returned literature, and if anything, the inclusion of derivative search terms would be likely to yield an even greater number of poster abstracts and titles, and further demonstrate the mass of data that is presented at conferences. As mentioned below however, as it was not possible to determine to what extent posters are used in terms of individual numbers (research question 2), so these potential data would probably add little of significance to the findings of this particular paper.

The approach serves well in identifying the main fields which use the poster medium (research question 1), and showing how it has been developed in the decades since its inception (research question 3). Additional details of those fields outside the top five contributory disciplines may have been included, but although this is interesting, the full range of disciplines and returns is so diverse that it would make for perhaps an overly complex article. Because the ranking factors, collation and classification algorithms that each database and search facility employs differ widely, there is a slight variation in the results returned at any given time. So, although the collated database and search engine returns are likely to give a good representation of the available data, the attribution of discipline, subject category is likely to differ not only between databases, but also in any secondary collation facilities that are used. Thus, as demonstrated by the comparison with Google Scholar, replicating this study will produce similar, but not identical results.

Lastly, an informetrics-based mapping review does not usually offer content analysis. Poster presentations have been little explored as source of information, so for the purposes of this article, the main issues involved in poster presentation literature have been highlighted and used to enrich the quantitative data. Reflecting the broad timescale of this review and the large numbers of returns involved, whilst each return was viewed to establish its type (i.e. poster citation or information source), for the purposes of this article it was impractical to analyse and report the data beyond a general description of its content. However, all of the available full-text articles were traced and retained, and the main issues raised in the returned literature are presented and referenced in this paper. A formal thematic content analysis has not been undertaken, and this is perhaps best reserved for articles which explore more specific themes of poster presentation, and not its overall usage, history and trends. The approach may, however, be replicated to give discipline-specific information, such as that featuring library and information science perspectives given earlier in this discussion.

It is also acknowledged that due to the diverse and numerically unmanageable representations of posters given in abstract and citation returns, it was not possible to determine to what extent posters are used in terms of individual numbers (research question 2). However, the overall returns give a good idea of the general volume of poster sessions which are reported in published literature.

Conclusions

Medicine and health care have been clearly shown to be the predominant users of the poster medium, and this finding is therefore likely to be of considerable interest to health library and information specialists. The consistently increasing levels of returns for poster abstracts indicate that poster presentation is an individually rewarding activity and practiced worldwide. But, if its objective purpose is to disseminate and discuss information with others, then issues raised in the literature of this review suggest that further effort is required to make the medium more effective; especially, it seems that poster presentation practices have undergone relatively little development since their inception in 1969, despite the vast numbers of posters that are often seen at larger events. As far back as 1981, however, it was recognised that librarians found it difficult to deal with conference material, especially in regard

to its location and acquisition. Even at this stage, posters were specifically highlighted as being an integral part of conference outputs, of potential use, and a medium that demanded bibliographic registration. This early article highlighted many issues that still go unaddressed, and the massive increases in usage and expenditure that have since taken place suggest that a centralised approach to managing this information is still required. Research is therefore needed to differentiate between the personal and objective needs of poster users (e.g. poster presenters, viewers, conference organisers, funders, researchers and information specialists) and to ensure that our systems and practices are geared towards meeting them. Given their prominent usage of the poster medium, the medicine and health care disciplines are likely to have an important role in such work, as are library and information specialists of all disciplines.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Database index.