# WEB INDICATORS FOR RESEARCH EVALUATION. PART 3: BOOKS AND NON-STANDARD OUTPUTS

## Indicadores Web para evaluación de la investigación. Parte 3: Libros y resultados académicos no estándar

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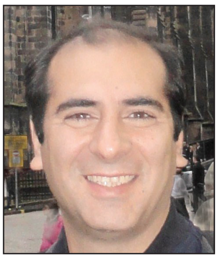

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### Abstract

This literature review describes web indicators for the impact of books, software, datasets, videos and other non-standard academic outputs. Although journal articles dominate academic research in the health and natural sciences, other types of outputs can make equally valuable contributions to scholarship and are more common in other fields. It is not always possible to get useful citation-based impact indicators for these due to their absence from, or incomplete coverage in, traditional citation indexes. In this context, the web is particularly valuable as a potential source of impact indicators for non-standard academic outputs. The main focus in this review is on books because of the much greater amount of relevant research for them and because they are regarded as particularly valuable in the arts and humanities and in some areas of the social sciences.

### Keywords

Citation analysis; Book citation analysis; Scholarly communication; Web indicators; Altmetrics; Alternative indicators.

### Resumen

Esta revisión bibliográfica describe indicadores web para evaluar el impacto de libros y otros resultados académicos no estándar, tales como software, bases de datos y videos. Aunque los artículos de revistas dominan la investigación académica en ciencias de la salud y naturales, otros tipos de resultados pueden ser también estimables contribuciones a la ciencia, y son más usuales en otras disciplinas. No siempre es posible obtener indicadores de impacto basados en citas a esas contribuciones debido a su ausencia o a la cobertura incompleta en los índices de citas tradicionales. En este contexto la Web es particularmente valiosa como fuente potencial de indicadores de impacto de los resultados académicos no estándar. El foco principal de esta revisión son los libros, debido a que se han estudiado mucho más y porque son considerados particularmente valiosos en arte y humanidades y en algunas áreas de ciencias sociales.

### Palabras clave

Análisis de citas; Análisis de citas de libros; Comunicación académica; Indicadores web; Altmétricas; Indicadores alternativos.

Manuscript received on 24-07-2015
Accepted on 05-10-2015

**Kousha, Kayvan**; **Thelwall, Mike** (2015). "Web indicators for research evaluation. Part 3: Books and non-standard outputs". *El profesional de la información*, v. 24, n. 6, pp. 724-736.

*http://dx.doi.org/10.3145/epi.2015.nov.04*

## Introduction

This article reviews research about web indicators for the impact of academic outputs other than journal articles. Even in fields for which articles are the dominant dissemination form, other types of outputs, such as books, software, datasets, videos and images, can still play an important role in some contexts. It is to develop indicators for these in order to help their authors to claim recognition for their work. Without this, it may be harder for the creators to justify the time spent on producing non-standard outputs or to gain peer recognition for their contributions. Scholarship as a whole would also suffer if this happened and important types of research output were no longer produced as extensively as before. Books are a special case because they are the primary outputs that scholars are judged on in most of the humanities and also to some extent in the arts. Thus they are not minority pursuits and there are established channels for recognition for them, such as through publisher prestige and academic book reviews. Nevertheless, they may also benefit from new indicators to complement existing evaluations and reduce the current reliance on a few peer judgements.

Research evaluation in book-oriented fields is more challenging than for article-based subject areas because counts of citations *from* articles, which dominate traditional citation indexes, seem insufficient to assess the impact of books. The *Book Citation Index* within the *Web of Science* is a response to this issue (previously noted in **Garfield**, 1996) since journal citations on their own might miss about half of the citations to books (**Hicks**, 1999). Some academic books are primarily written for teaching (e.g., textbooks) or cultural purposes (e.g., novels and poetry) and citation counts of any kind may be wholly inappropriate for these, however.

Books were more frequent in the humanities (48%) and social sciences (17%) than in science and medicine (0.5%) in the 2014 UK *Research Excellence Framework* (*REF*), and many of these books (history, art, music and literary works) may have merits that are not reflected by conventional bibliometric methods. Moreover, the main sources of citations to humanities books are other books (**Thompson**, 2002; **Kousha**; **Thelwall**, 2014). Even today, the *Thomson Reuters Book Citation Index* and *Scopus* index a relatively small number of books (60,000[1] and probably 70,000[2] as of July 2015, respectively) and this may cause problems for bibliometric analyses of books (e.g., **Gorraiz; Purnell**; **Glänzel**, 2013; **Torres-Salinas** *et al.*, 2012, 2013). Expert peer judgment of books seems to be by far the best method but it is even more time-consuming and expensive than article peer assessment because books tend to be longer and some aspects of book impact (e.g., teaching or cultural) could be particularly subjective (see **Weller**, 2001). In response, different alternative sources have been investigated for book impact assessment, including syllabus mentions, library holding counts, book reviews and publisher prestige.

Many of the indicators discussed in parts 1 and 2 of this review (see: **Thelwall**; **Kousha**, 2015ab) can also be used for books but have not yet been evaluated for this purpose. Since books seem to be usually read offline, download indicators are probably not relevant. As in the previous parts, correlations between citation counts and new indicators are the primary source of evidence of the value of the new indicator to show that is at least related to academic communication in some way (**Sud**; **Thelwall**, 2014a). These correlations are more problematic in the humanities and social science because citation counts are less reliable as scholarly impact indicators (e.g., *Hefce*, 2015). In addition, the breadth of the humanities, coupled with their frequent merging into a single group for correlation calculations, is likely to artificially reduce the correlation coefficients (**Thelwall**; **Fairclough**, 2015).

Scholars nowadays may also produce and use non-standard academic outputs, such as multimedia products, datasets and software. It is important to estimate the impact of these non-standard outputs too, if possible, and new usage-based indicators are needed for this. This literature review finishes by discussing the use of indicators for assessing the impact science videos, datasets and software. Appendixes A and B also summarise sources of data and impact types for the alternative impact indicators of books and other non-standard academic outputs respectively.

## *Google Books*

*http://book.google.com*

*Google Books* (*GB*) contains a large number of academic and non-academic books from digitising the collections of selected major libraries as well as partnerships with publishers:
*http://books.google.com/intl/en/googlebooks/about*

*GB* seems to cover at least 30 million volumes (**Darnton**, 2013), although the exact figure has not been disclosed. Several studies have shown that the coverage of *GB* is quite comprehensive, however. For instance, it contained 84% of 401 randomly selected books from *WorldCat* (a global catalogue of library collections) in different languages (**Chen**, 2012) and 80% of 1,500 Hawaiian and Pacific books from a university library (**Weiss**; **James**, 2013b). A study of 400 English and 400 Spanish language books from a university library also found that almost all English (92%) and Spanish (89%) titles were in *GB*, suggesting small language differences in comprehensiveness (**Weiss**; **James**, 2013a). A study of 2,500 pages from 50 randomly selected books found that less than 1% had legibility errors (**James**, 2010) and so *GB* seems to be a fairly comprehensive and good quality source of digital books. Nevertheless, due to copyright considerations, *GB* does not always reveal to users the full text of the books that it has indexed.

## *GB* citations for impact assessment

Although *GB* is not a citation index and provides no citation statistics of any kind, it is possible to manually search it for academic publications and hence identify citations to these publications from digitised books (**Kousha**; **Thelwall**, 2009; **Kousha**; **Thelwall**; **Rezaie**, 2011). This could be useful because citations from books have been largely been invisible in traditional citation indexes and the current book citation search facilities in *Scopus* and *WoS* cover relatively few books that are predominantly in English and from a small number of publishers, which is problematic for citation impact assessment in book-based disciplines (**Gorraiz**; **Purnell**; **Glänzel**, 2013; **Torres-Salinas** *et al.*, 2012, 2013).

Several studies have explored the potential use of *GB* citations for research assessment. A comparison of citations from *GB* searches with *WoS* citations to 3,573 *journal articles* in ten science, social science and humanities fields found *GB* citations to be 31%-212% as numerous as *WoS* citations in the social sciences and humanities, but only 3%-5% as numerous in the sciences, except for computing (46%) (**Kousha**; **Thelwall**, 2009). There were significant positive correlations between *GB* and *WoS* citation counts for all fields, although they were higher in computer science (.709), philosophy (.654) and linguistics (.612) and lower in chemistry (.345) and physics (.152). Despite *GB* not being a citation index, its citation search capability clearly has promise as an additional source for the citation impact of research. A follow up study manually searched and compared citations from *GB* with citations from *Scopus* (cited references search in articles) to 1,000 books submitted to the 2008 UK *RAE* in seven book-based fields (**Kousha**; **Thelwall**; **Rezaie**, 2011). Overall, *GB* citations were 1.4 times more numerous than were *Scopus* citations. In history, the median number of *GB* citations (11.5) was higher than for both *Google Scholar* (7) and *Scopus* (4) citations. Moreover, in communication studies and law the median number of *GB* citations (11.5 and 6, respectively) was roughly three times as large as the *Scopus* citations (4 and 2, respectively). There were also high, significant and positive correlations between *GB* and *Scopus* citation counts in all fields (ranging from 0.616 in law to 0.833 in sociology). Thus, in many humanities subject areas citations from books to books may be more substantial than citations from journal or conference papers to books and hence *GB* seems to be valuable, and perhaps in some cases the most valuable source, for the impact assessment of books. This was confirmed with a study of citations to 14,500 monographs in the *Thomson Reuters Book Citation Index* (*BKCI*) (see also: **Chi**; **Jeuris**; **Thijs**; **Glänzel**, 2015) against *GB* automatic searches in 24 subject areas because *GB* citations were 103% to 137% higher than *BKCI* citations (including journals) in the humanities, except for tourism (72%) and linguistics (91%), 46% to 85% in the social sciences, but only 8% to 53% in the sciences. There were also moderate correlations between the *GB* and *BKCI* citation counts in social sciences and humanities, suggesting that citations from *GB* and *BKCI* could reflect different aspects of impact with most *BKCI* citations coming from *WoS*-indexed journals rather than books (**Kousha**; **Thelwall**, 2014). Good results have also been obtained from *GB* for counts of citations to books in a non-English nation, Malaysia (**Abrizah**; **Thelwall**, 2014), and it seems that both *GB* and *GS* could be very helpful for non-Western countries seeking to assess the impact of their locally-published books, especially in the social sciences and humanities.

Although *GB* citation searches can be automated through the *Google Books* API with searches constructed from the bibliometric information of books and articles, the raw data needs to be filtered because not all matches are genuine citations. Nevertheless, a highly accurate (over 90%) filtering process has been developed to deal with this issue and so automatic *GB* searching is practical (**Kousha**; **Thelwall**, 2014). However, for the individual assessment of academics extra manual checking might be necessary, and citations to documents with titles or authors containing non-ASCII characters may be less reliable.

> *GB* citation searches seem useful for assessing academic research impact of publications

In summary, *GB* citation searches seem useful for assessing academic research impact of publications, especially in book-oriented fields, but only for subjects for which experts agree that *GB* citations (or citations in general) tend to reflect a desired property of research. *GB* citations provide unique and more numerous citations from books in comparison to conventional citation databases in many arts and humanities fields and some social sciences, but not in the sciences. *GB* citation counts may tend to reflect the teaching or cultural impact of books (e.g., textbooks or novels), when they are cited in other contexts than research, such as for educational or literary reasons. In contrast to *GS*, which indexes web publications, *GB* indexes published books and hence seems less likely to be spammed, although it is possible to publish fake or artificial books through cheap publishers and this could be used to generate self-citations. Moreover, although it is possible to use automatic *GB* citation searching with a high level of accuracy in terms of the results (90%), this level of accuracy is probably lower than for the major current citation indexes.

## Libcitations

Librarians use statistics, such as the demand for photocopies of publications, to assess the usage or impact of their library collections (e.g., **Cooper**; **McGregor**, 1994). Moreover, library journal use (counting journal reshelving) has been found to correlate with the citation counts and impact factors of 835 medical journals in one general hospital library (**Tsay**, 1998). Hence, library usage statistics may also be useful for research evaluation, particularly for books for which electronic download statistics are not available. A recent study compared library loan statistics for the most borrowed monographs from two European university libraries (Granada and Vienna) with citation counts (*WoS* and *GS*). Loans and citations did not significantly correlate, however, except for *GS* citations for textbooks or manuals from the Vienna sample (**Cabezas-Clavijo** *et al.*, 2013). There does not seem to be an initiative to systematically collate any such usage data from libraries, however, and so it is not currently a practical option.

Another straightforward way to assess the impact of a book is to assess its sales or to count how many libraries have bought it. **White**; **Boell**; **Yu** *et al.* (2009) coined the term "libcitation" for the number of libraries holding a book, as calculated from national or international union catalogues, and suggested that this may give an indication of the cultural benefit of books from the social sciences and humanities. A comparison of the libcitations of books from several Australian academic departments in history, philosophy, and political science, concluded that libcitation statistics can potentially "allow the departments to be compared for cultural impact" (**White**; **Boell**; **Yu** *et al.* 2009, p. 1083).

> Library holdings statistics seem to reflect a different type of impact to that of citations

Significant correlations have been found between library holdings and *WoS* citation counts for books produced by the *Faculty of Humanities* at *Leiden University* (Pearson's r= 0.29). The correlation was higher for books in English (r=0.39), but insignificant for books in Dutch, perhaps because libraries outside of The Netherlands and Flanders may be reluctant to stock Dutch books and scholars internationally may be reluctant to read and cite them, and so there may be less data for such books (**Linmans**, 2010). A much larger-scale study compared *Scopus* citations to 59,000 history books and 42,000 literature books referenced in *Scopus*-indexed journals with library holding counts from the *Association of Research Libraries* (*ARL*), non-*ARL* libraries and all libraries. Low Spearman correlations were found, ranging from 0.288 for citations and *ACRL* library holdings to 0.244 for citations and non-*ARL* libraries. The low but significant relationships confirm that "citations and 'libcitations' [...] measure (partially) different dimensions" (**Zuccala**; **Guns**, 2013, p. 359). A follow-up comparison between libcitations and *Scopus*-indexed citations for books in two areas of the humanities found weak positive correlations for history (0.24) and literature (0.20) and slightly higher correlations within more specific subsets (e.g., 0.28 for the Dewey decimal class History and Geography for history books) (**Zuccala**; **White**, 2015). Finally, a comparison of *WorldCat* library holdings with citations from *Thomson Reuters BKCI* and *GB* to 2,739 academic monographs from 2008 also found significant but low positive correlations in the social sciences (r=0.145 for *BKCI* and 0.234 for *GB*, n=759), arts and humanities (r=0.141 for *BKCI* and 0.268 for *GB*, n=1,262). However, in science the correlation was only significant between library holdings and *GB* citations (0.112, n=718) (**Kousha**; **Thelwall**, in press). It is also possible to gather and collate library holding information from a defined set of libraries, if universal coverage is not wanted (**Torres-Salinas**; **Moed**, 2009).

Overall, it is clear that library holdings statistics can indicate library interest in books and seem to reflect a different type of impact to that of citations, perhaps including educational and cultural impacts. These statistics are relatively simple to collect automatically from the *OCLC WorldCat* library holding catalogue with more than 2.2 billion items from over 72,000 libraries in 170 countries:
*http://www.worldcat.org*
*http://oclc.org/worldcat/catalog.en.html*

This data, which is based upon book holdings and hence would be costly to spam, seems promising for assessing the wider influence of books in the social sciences and humanities based on the information needs of users, teaching staff and researchers. Whilst more detailed borrowing statistics might be even more useful, this does not seem to be currently available.

## Book reviews

Scholarly book reviews are important in some fields and are an academic genre in their own right (**Hartley**, 2006). An early investigation reported a high association (r=0.620) between the number of reviews in the *Book Review Index* and the number of library holdings in the *OCLC* database for 200 novels (**Shaw**, 1991), suggesting that book reviews could be a usage or popularity indicator that may reflect wider cultural impacts. Moreover, there is evidence that sociology monographs (n=420) with positive reviews attract considerably more citations (from *Social SciSearch*) than do monographs with negative reviews (**Nicolaisen**, 2002), and so the content of a review may be important in an academic context. Nonetheless, the relationship between the number of book reviews and citations could differ between subject areas (**Gorraiz**; **Gumpenberger**; **Purnell**, 2014). Another study compared book review ratings in the publication *Choice: Current reviews for academic libraries* with citation and non-citation metrics for 451 book reviews from 2011 across the humanities, social sciences and science. Low but significant positive Spearman correlations were found between *Choice* ratings with *Google Books* citations, academic syllabus mentions, *WorldCat Library Holdings* and the number of *Amazon* book reviews. However, the correlations were higher between *Choice* ratings and *Google Books* citations (.350) in science and with *WorldCat* library holdings counts in the humanities (.304). Books recommended for undergraduates and researchers tended to be more mentioned in academic course syllabi and more cited in other books respectively (**Kousha**; **Thelwall**, 2015).

> Online book reviews could theoretically be used to generate indicators for the wider impacts of books

## Online book reviews

Online book reviews, such as those at *Amazon.com* and *Goodreads*, could theoretically be used to generate indicators for the wider impacts of books based upon feedback from readers inside and outside of academia. One study found low but significant Spearman correlations between the numbers of *Amazon* reviews and citation metrics for 2,739 academic monographs published in 2008 (**Kousha**; **Thelwall**, in press). The correlations were higher in the social sciences (0.223 for *BKCI* and 0.182 for *GB*, n=759) and arts and humanities (0.189 and 0.188, n=1,262) than in science fields (0.121 and 0.158, n=718), indicating that *Amazon* book review counts may partially reflect scholarly impact and may reflect wider impacts such as teaching, cultural or social influence. The relatively low correlations are not surprising given the low correlation previously found for library holdings (see above). An investigation of 180 Chinese books with at least 10 user reviews, 40 in economics, 44 in management and 98 in literature, found positive correlations with a hybrid combination of review ratings, numbers of positive and negative reviews, and helpfulness scores (**Zhou**; **Zhang**, 2015). Another study also found a low but significant Spearman correlation between *Goodreads* reader ratings and *Scopus* citations (0.212, p<.01) to 8,538 history books. Further analysis showed that books with *WorldCat* library holdings tended to receive more *Goodreads* reader ratings, suggesting that *Goodreads* metrics may reflect the broader impact of books based on public readers' recommendations (**Zuccala**; **Verleysen**; **Cornacchia**; **Engels**, 2015).

## Book review sentiments

Sentiment analyses of social web postings are routinely used commercially to assess public opinion about products, services or popular events and automatic methods are reasonably effective at identifying sentiment in social web texts (e.g., **Pang**; **Lee**, 2008). The *SentiStrength* software, for instance, reports sentiment based on a dual scale of 1 (no positive sentiment) to 5 (strong positive sentiment), and -1 (no negative sentiment) to -5 (strong negative sentiment) and is optimised for tweets and other short social web texts (**Thelwall**; **Buckley**; **Paltoglou**; **Cai**; **Kappas**, 2010); see:
*http://sentistrength.wlv.ac.uk*

Could you change it to: The *SentiStrength* software has been used for sentiment-based indicators, as discussed below.

Despite the commercial success of sentiment analysis, it has been only rarely assessed for scholarly-related social texts such as comments on research articles. One study, however, estimated sentiments in *Amazon.com* book reviews about academic monographs and compared them with citation indicators and found significant but low correlations between *BKCI* and *GB* citation counts and book review sentiments, indicating that monographs with more citations tend to have more positive *Amazon.com* reviews (**Kousha**; **Thelwall**, in press). The Spearman correlations between the positive and negative sentiment strengths of book reviews with *BKCI* citations were higher in the social sciences (0.216 and -0.218, respectively) and in arts and humanities (0.174 and -0.181) than in science (0.108 and -0.100). The number of reader ratings from the *Goodreads* site can also be used as evidence of the value of an academic book since these numbers correlate weakly with citation counts, at least in history (**Zuccala**; **Verleysen**; **Cornacchia**; **Engels**, 2015).

In conclusion, counts of reviews and sentiments of reviews of academic books seem to both be useful indicators of the reception or wider uptake of scholarly books. Academic book review databases such as *Choice: Current reviews for academic libraries*, with many book reviews and recommendations (e.g., 7,000 reviews per year) by editors, experts and librarians in the field could be a useful altmetric source for research evaluation of books, especially in the arts and humanities.
*http://www.ala.org/acrl/choice/about*

*Amazon* reviews can be automatically extracted, making them a possible choice, but are easily spammed and so should not be used for formal evaluations. Research into review indicators is still at an early stage, however.

## Publisher prestige

In the absence of effective citation counts for the impact assessment of books, publisher prestige is an alternative simple way to identify more important books, and online initiatives may support this. For example, book impact assessment experts in economics in one study believed that "books should have the same weight as any other publication and should be restricted to those published by major academic presses or a few prestigious commercial publishers" (**Donovan**; **Butler**, 2007, p. 237).

There have been attempts to evaluate the prestige of publishers with surveys for library collection management and research assessment purposes. **Metz** and **Stemmer** (1996), for example, surveyed collection development officers in academic libraries about the prestige of different publishers, with university presses being found to be highly regarded. They believed that subject differences, the existence of specialised publishers and the necessarily subjective nature of judgements were all problems for assessing publishers.

A survey of 603 American political scientists generated rankings of scholarly publishers based upon their publication and reading preferences, with university presses forming the top 10, followed by a mix of university and commercial presses in the top 20 (**Garand**; **Giles**, 2011). A much larger survey of Spanish researchers and faculty members with over 3,000 responses has been used to create ranked lists of publishers in the social sciences and humanities, with *Oxford University Press*, *Cambridge University Press* and *Routledge* being the top most prestigious publishers across all of the studied fields, whereas there were large differences in the rankings of the other publishers (**Giménez-Toledo**; **Tejada-Artigas**; **Mañana-Rodríguez**, 2013). This confirms the existence of disciplinary differences in publisher prestige. See also the *Scholarly Publishers Indicators* project:
*http://ilia.cchs.csic.es/SPI*

In contrast to reputational surveys, bibliometric indicators from *BKCI* have been used to create '*Book Publishers Citation Reports*' by analogy with the '*Journal Citation Reports*' (**Torres-Salinas** *et al.*, 2012; see also: **Torres-Salinas**; **Robinson-García**; **Jiménez-Contreras**; **Fuente-Gutiérrez**, in press). This study ranked publishers across 19 social sciences and humanities fields in terms of the production (e.g., number of books/book chapters indexed) and impact (e.g., total/average citations per book and percentage of non-cited items) of the publishers. The over-representation of English-language books, unbalanced coverage of publishers and partial coverage of *BKCI* were all identified as problems, however. Citations from *Scopus* and matching data from *WorldCat.org* have also been used to rank 50 academic book publishers in history. *Oxford University Press*, *Cambridge University Press* and *Routledge* were again the top three publishers based on total citations and citations per book. Nevertheless, the process of matching, cleaning and standardising bibliographic data of books was difficult, which is a practical limitation (**Zuccala**; **Guns**; **Cornacchia**; **Bod**, 2014).

> Reputational surveys, libcitation and citation indicators can help to identify prestigious scholarly publishers

Overall, it is clear that reputational surveys, libcitation and citation indicators can help to identify prestigious scholarly publishers. A combination of all of the above may be more useful for rating (rather than ranking) academic publishers of books or monographs as long as other factors, such as geographical, language and disciplinary differences taken into consideration when they are used. Nevertheless, the construction of publisher prestige indicators may be time consuming and it may be acceptable to allow evaluators to use their own field judgements about the relative prestige of publishers if they do not have to assess books out of their area of expertise. Publisher prestige assessment, and more generally, academic book impact assessment is likely to become easier in the future due to national efforts in Europe to systematically collect relevant academic book information (**Giménez-Toledo**; **Mañana-Rodríguez**; **Engels** *et al.*, 2015).

## *Mendeley* bookmarks

*Mendeley* bookmark counts may be useful as indicators of the readership of books, although current evidence suggests that they are not frequent enough to aid the impact assessment of scientific books. For example, out of 2,739 scientific monographs indexed by *BKCI* in 2008, only 7% had at least one *Mendeley* bookmark and in science and medicine there were very low correlations between *Mendeley* bookmarks and *BKCI* and *GB* citations (Spearman r=0.106 and 0.139 respectively, n=718) (**Kousha**; **Thelwall**, in press). Similarly, only 7% of 54 English books published by Swedish universities were in *Mendeley* (**Hammarfelt**, 2014).

## Syllabus mentions

As with academic articles, it is possible to automatically extract online syllabus mentions of academic books. A large-scale study of about 14,000 monographs found that over a third had one or more academic syllabus mentions, with more in the arts and humanities (56%) and social sciences (52%). Low but significant correlations between syllabus mentions and citations across most fields were found (**Kousha**; **Thelwall**, 2015a). The results also suggested that some books can have more educational influence than research impact and online academic course reading lists may help to identify these, especially in teaching-based fields (**Kousha**; **Thelwall**, 2015a).

## Indicators for the impact of non-standard outputs

Although scholars seem to be evaluated mainly based upon their articles or books, especially in research assessment exercises, they also produce other outputs that may have substantial value, such as scientific websites, videos, images, datasets and software. Moreover, in some subject areas, non-standard outputs, such as artworks, exhibitions, performances and compositions, may dominate. For instance, about a third of scholarly submissions to the 2014 UK *REF* in art and design (35%) and, music, drama, dance and performing arts (28%) were non-standard outputs, including performance, composition, design, artefacts, exhibition and digital or visual media:
*http://results.ref.ac.uk*

For some of these there may be plausible indicators, such as audience size, art gallery prestige, composition commissioner prestige, art sales or sales prices. In most cases, however, it is likely that the contributions of individual works are so varied that any data presented to support an impact case would not be directly comparable with other available data, although it could be presented as evidence to support a specific argument about its contribution (**Thelwall**; **Delgado**, 2015). This section covers the small minority of potential indicators for non-standard outputs that have been investigated so far, all of which are online. The lack of research into offline indicators reflects the difficulty of gathering them but perhaps also the absence of a drive to create indicators for non-refereed arts and humanities outputs.

> In some subject areas, non-standard outputs, such as artworks, exhibitions, performances and compositions, may dominate

This section does not cover grey literature publications that do not receive traditional citations. Although there has been a proposal for their impact evaluation (**Wilkinson**; **Sud**; **Thelwall**, 2014), it uses an ad-hoc set of indicators rather than a specific type. This section also does not cover research evaluation for websites, although large websites can be compared through link counts from web crawlers (**Thelwall**, 2004) or equivalent search engine searches (**Sud**; **Thelwall**, 2014b), data sources such as *Alexa* popularity or site inlink counts (**Vaughan**, 2012; **Vaughan**; **Yang**, 2012) or *Google Trends* search volume (**Holmberg**, 2015; **Vaughan**; **Yang**, 2013), perhaps in conjunction with user interviews and other methods (**Eccles**; **Thelwall**; **Meyer**, 2012).

## Scientific data

In some fields, such as genetics, data sharing is vital and datasets are significant research outputs (**Borgman**, 2012), to the extent to which they may be subject to peer review in their own right (**Mayernik**; **Callaghan**; **Leigh**; **Tedds**; **Worley**, 2015). Most of the datasets reported in research articles in forensic (86%), evolutionary (79%) and medical (64%) genetics are shared (**Anagnostou**; **Capocasa**; **Milia**; **Bisol**, 2013) and a survey of 1,329 scientific members of the *National Science Foundation* funded *DataONE* project indicated that the majority (85%) were interested in using datasets by other researchers, if they were easily accessible (**Tenopir** *et al.*, 2011). An international survey of about 370 researchers in the field of biodiversity science showed that 84% agreed that sharing article-related data was a basic responsibility, and only 11% disagreed. Nonetheless, over 60% were unwilling to share primary data before the final publication of their articles (**Huang** *et al.*, 2012).

Due to the significant role of research datasets in some subject areas, there has been a call for a "Data Usage Index (DUI)" by analogy with conventional citation indexes, such as *WoS* and *Scopus*, so that data usage indicators could be developed to recognise the work of the dataset creators (**Chavan**; **Ingwersen**, 2009; **Ingwersen**; **Chavan**, 2011) as well as to help scientists to discover relevant data (**Mooney**; **Newton**, 2012; **Poldrack**; **Poline**, 2015). Alternative indicators, such views, saves, discussions, and recommendations, are also relevant for dataset impact assessment (**Konkiel**, 2013). All of these could indirectly help to encourage data sharing by recognising popular datasets and creators. This recognition already occurs indirectly to some extent because a study of 85 cancer microarray clinical trial publications with shared datasets showed that just under half of the trials with publicly available data received about 85% of the aggregate citations and clinical trials with publicly shared data were cited around 70% more frequently than those without (**Piwowar**; **Day**; **Fridsma**, 2007). *Thomson Reuters* launched its *Data Citation Index* in 2012 to index "a significant number of the world's leading data repositories of critical interest to the scientific community, including over two million data studies and datasets" and so dataset citation analysis is likely to become routine and simple when this matures.
*http://wokinfo.com/products_tools/multidisciplinary/dci*

An early analysis of this resource suggests that datasets are cited most frequently in science, engineering and technology, but that less than 20% of the datasets indexed had received any citations (**Robinson-García**; **Jiménez-Contreras**; **Torres-Salinas**, in press).

## Software

In fields such as software engineering and bioinformatics, software can be an important scholarly output. Programmers may develop useful software and tools for the research community or the public, and free scientific software may be heavily downloaded by researchers or other end users. Some computer programs may also have a significant social, health or educational impacts. For instance, over 400,000 copies of *AIDA*, a free educational computer program about diabetes, have been downloaded and 580,000 simulations have been run on *AIDA* websites:
*http://www.2aida.net*
*http://www.2aida.net/aida/logstats.htm*

A range of alternative indicators has been suggested to monitor the success of software projects, such as the number of downloads (e.g., **Crowston**; **Annabi**; **Howison**; **Masango**, 2004; **Rossi**; **Russo**; **Succi**, 2010), reuse of programming code, the number of users, and user ratings and satisfaction (**Crowston**; **Annabi**; **Howison**, 2003). Alternatively, the online popularity of software could be assessed based on search engine results (**Weiss**, 2005). It would be useful to have a software citation index to help to reflect the impact of scholarly software in the future. Without this, creators could perhaps choose their own indicator to help demonstrate the value of their work. One study has gone further and proposed a full-text analysis approach that will allow the context in which software is used to be extracted so that its contribution to a paper may be estimated (**Yan**; **Pan**, 2015).

## Science videos

Online scholarly videos are produced and used by academics for real-time scientific demonstrations, live conferences, presentations, and course lectures. The *Journal of Number Theory* and the *Journal of Visualized Experiments* even have dedicated *YouTube* channels for their articles. Over 1,800 *Scopus* publications have cited at least one *YouTube* video in their reference lists (as of December 2011) and there has been a constant growth in the citing of online videos from three citations in 2006 to 719 citations in 2011. A content analysis of 551 *YouTube* videos cited by articles showed that in the natural and medical sciences over three quarters of the cited videos had scientific content (e.g., laboratory experiments or academic talks), whereas in the arts and humanities about 80% of the *YouTube* videos had art, culture or history themes (**Kousha**; **Thelwall**; **Abdoli**, 2012). Hence, online videos are a tiny but growing proportion of academic outputs and can have value for research. Nevertheless, it is hard to quantify the impact of videos even if they are obviously successful (e.g., **Haran**; **Poliakoff**, 2012).

> The *TED Talks* video series have a much greater impact on society than on the scientific community

A prominent venue through which science and technology information can be communicated to the public is the *TED Talks* video series. These videos contain curated lectures by academics, artists and others and reach a wide audience. An investigation into *TED* videos found that few were formally cited in academic publications but a range of metrics including views, comments and comment sentiments were better impact assessment indicators because even academic talks that are highly viewed may not be cited in research (**Sugimoto**; **Thelwall**, 2013). For instance, a *TED* talk video by a social psychology professor, 'Your body language shapes who you are', from June 2012 had been viewed online 20.8 million times but had received only two *Scopus* citations, suggesting a much greater impact on society than on the scientific community. The metrics in *YouTube* can be easily spammed but the numbers may be large enough to make effective spamming difficult for this initiative.

## Academic images

There are now many scientific or artistic images produced by scholars that are on the web and in some cases these are the main products of scholarly activities. For instance, specialised photographs of deep astronomical objects are major research outputs in astrophotography (**Schröder**; **Lüthen**, 2009). Scientific images also have applications in the biological sciences (**Glasbey**; **Horgan**, 1995) and for medical diagnoses (**Lim**; **Feng**; **Cai**, 2000). In art and documentary photography the main scholarly outputs are photographs of people, places, or nature. These pictures may appear in publications or be shared online. For instance, the *National Geographic* magazine has a worldwide reputation not only for its articles but also for its high quality photographs of wildlife, world culture and scientific advances. It also provides some social media statistics for *Facebook* likes, *Tweets* and *Google+* for some pictures. More generally, interesting scientific pictures may also be useful for educational and science communication purposes.

There have been attempts to develop metrics as indicators of the type of image impact. For example, tag usage within university image groups in *Flickr* can be a helpful indicator of social influence (**Angus**; **Thelwall**; **Stuart**, 2008). The number of copies of a science picture on the web may also be an indicator of the level of interest in it, particularly if it is copyright-free. This is possible to count using an image search engine, as shown by an investigation into academic images from *NASA*'s astronomy picture gallery with *TinEye* (**Kousha**; **Thelwall**; **Rezaie**, 2010). Only 1.4% of these pictures seem to have been used in academic publications, but 37% had been used for educational or other scholarly-related reasons, indicating their wider impact.

## Conclusions

There are now, perhaps for the first time, several useful sources of quantitative information with which to help evaluate the impact of books. Publisher prestige seems to be a credible indicator for books in some areas of research and there are now some web initiatives to make prestige information online, more transparent and better understood.

At the level of individual books, libcitations seem to be difficult to manipulate and could help to give impact indicators to aid arts and humanities researchers. More research is needed to check peer review evaluations against library holdings, however, so that it is clear how to interpret the results. This is especially true because some types of books aim at a popular audience and others at a specialist one, so the two types should not be compared with raw libcitation scores. Effective field normalisation strategies also need to be investigated for arts and humanities books as well as comparisons with peer-review evaluations. In addition, it may be necessary to exempt certain areas, without prejudice, when they are valued for contributions, such as uniqueness of expertise, complexity of problem solved, or value for applications, that would not be reflected at all by library holdings.

Also for evaluations of individual books, *Google Book Search* citations can provide useful impact indicators although it is not yet clear that systematic manipulation is possible and so formal evaluations with *GB* are not recommended. Research into *GB* citations is also needed because in the future, the coverage of book-to-book citations in the major citation indexes may be expanded to the extent that they are useful and any findings about *Google Book Search* citations may give early evidence about how to interpret them. As for libcitations, effective field normalisation strategies need to be investigated for arts and humanities books as well as comparisons with peer-review evaluations. In addition, it may be necessary to exempt certain areas, without prejudice, when they are valued for contributions that would not be reflected at all by citations.

Assessing the impact of academic datasets is also important in some fields. This could become possible in the future with the *Thomson Reuters Data Citation Index* or other alternatives, if they are effective. Whilst most researchers probably do not create datasets, this would allow those that do to claim credit for it and would also encourage data sharing.

Software seems to be usually overlooked in research evaluations. It would be useful to have a software citation index to help to reflect the impact of scholarly software in the future. Until then, creators could choose their own indicator to help demonstrate the value of their work, although it could be easily spammed.

Although videos are probably ignored in almost all current research evaluation exercises and videos are awkward to systematically assess because few researchers produce them and they can have very different audiences (from field specialists to the general public) and can be hosted in different ways, it would be valuable to at least allow academics to make the case for the impact of their videos. In this context, usage indicators such as views, comments and comment sentiments would be most appropriate (see **Thelwall**; **Sud**; **Vis**, 2012), although they are easily spammed.

Assessing the impact of academic images is important for academics that produce them and is difficult because images may be used in different ways and for different reasons. However, a combination of text searches (e.g., photographer name, title of image or its URL citations) image searches (e.g., *TinEye*) and social statistics such as comments, views or tags in *Flickr* may be useful for their creators as sources of evidence for their uptake, providing that steps are taken to avoid spamming.

In conclusion, there is some promise for generating indicators for all of the types of outputs discussed here. A general problem, however, is that there are different audience sizes and levels of engagement, even for outputs of the same type and so it is intrinsically problematic to systematically compare indicators for many non-standard outputs. A way around this is to allow the academic to present their own quantitative data in conjunction with contextual evidence about the type of impact claimed (**Thelwall**; **Delgado**, 2015). This approach requires peer review, however, and so may not be suitable for large scale evaluations.

## Notes

1. *http://wokinfo.com/products_tools/multidisciplinary/bookcitationindex*

2. *http://blog.scopus.com/posts/scopus-content-book-expansion-project-update*

## Acknowledgement

This document is an updated version of part of a review:
*http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2015/The,Metric,Tide/2015_metrictideS1.pdf*
commissioned by the *Higher Education Funding Council for*

*England* (*Hefce*) as part of the independent review of the role of metrics in research assessment that began in 2014.
*http://www.hefce.ac.uk/rsrch/metrics*

Thank you to members of this group for comments on earlier drafts.

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## Appendix A: Sources of data for the alternative impact assessment of books

| Alternative source | Impact type | Advantages | Disadvantages |
|---|---|---|---|
| *Google Books* citations | Scientific; Scholarly; Educational; Cultural | Automatic citation counting via the *Google Books* API from a large number of digitised academic and non-academic books that may not be indexed in other citation databases. | Although the method has high accuracy overall (over 90%), it may need extra manual checking to identify missing/false results for some books. |
| *OCLC WorldCat* library holdings count (libcitations) | Cultural; Educational | Library holdings reflect demand for books by students, lecturers, researchers or librarians, providing wider usage impact for book assessment. | Automatic data collection via the *WorldCat* API requires explicit permission from *WorldCat* and manual data collection could be very time consuming for large scale projects. |
| Online reviews (e.g., *Amazon, Goodreads* and *Choice Online*) | Societal; Educational; Cultural | It is possible to semi-automatically capture customer-related statistics such as reviews and ratings (e.g., *Amazon*, *Goodreads*) as well as ratings by academics and librarians for books (*Choice Online*). Sentiment analysis can also be used to assess the strength of positive and negative sentiment in reviews. | Data collection is not fully automatic and depends on the accuracy of the bibliographic data. Online book review indicators could be easily manipulated except for *Choice academic book reviews*. |
| Online academic course syllabi | Educational; Cultural | Syllabus mentions can be located automatically via the *Bing* API and results can be refined and limited to world university websites, reflecting teaching or educational benefits of books. | Many academic syllabi are not available in the public web and many are not indexed by *Bing*. The coverage and accuracy of academic syllabus mentions are largely dependent on the queries used. |
| Publisher prestige | Scholarly; Educational; Cultural | Publisher prestige is a simple way to identify more books that are likely to be important. | Publisher prestige reflects the reputations of publishers rather than of individual books. Publisher prestige varies across fields, languages and countries and probably needs reputational surveys to identify. |
| *Mendeley* bookmarks | Scholarly; Educational | Readership counts can be systematically collected via the *Mendeley* API to assess the readership of books. | In contrast to articles, *Mendeley* bookmarks are not numerous enough to assist the impact assessment of typical books. |

## Appendix B: Sources of data for the alternative impact assessment of non-standard academic outputs

| Alternative source | Impact type | Advantage | Limitation |
|---|---|---|---|
| Scientific data | Scholarly | Views, downloads, shares, recommendations, and tweets may be extracted from data sharing websites (e.g., *figshare.com*) for the impact assessment of scientific data. Citations to scientific data can also be extracted from academic publications. | Scientific data might not be publicly shared or available and most seems not to report systematic usage metrics. |
| Software | Scholarly; Educational; Commercial | Downloads or citations to software may reflect demands for software by students, researchers, software developers or other potential users, as an indication of their benefit. | Most software does not provide alternative metrics and download rates can easily be spammed and manipulated. |
| Science videos | Scholarly; Educational; Cultural; Societal | The number of views, comments, likes, dislikes, and shares can be automatically extracted via the *YouTube* API, although not for most other sites. | Online video metrics can easily be manipulated or spammed. |
| Scientific images | Scholarly; Educational; Cultural; Societal | Social media statistics form social image sharing websites (e.g., *Flickr*) or scholarly-related online sources (e.g., the *National Geographic*) can be extracted to assess aspects of interest in images (e.g., educational or other scholarly usage) | Online image metrics can easily be manipulated or spammed. |