

Scientific Interactions and Research Evaluation: From Bibliometrics to Altmetrics

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Abstract

Since its creation 350 years ago, the scientific peer-reviewed journal has become the central and most important form of scholarly communication in the natural sciences and medicine. Although the digital revolution has facilitated and accelerated the publishing process by moving from print to online, it has not changed the scientific journal and scholarly communication as such. Today publications and citations in peer-reviewed journals are considered as indicators of scientific productivity and impact and used and misused in research evaluation. As scholarly communication is becoming more open and diverse and manuscripts, data, presentations and code are shared online, the altmetrics and open science movement demand the adaption of evaluation practices. Parallels are drawn between the early days of bibliometrics and current altmetrics research highlighting possibilities and limitations of various metrics and warning against adverse effects.

Keywords: Bibliometrics; Altmetrics; Scholarly communication; Research evaluation; Social media

In: F. Pehar/C. Schlögl/C. Wolff (Eds.). *Re:inventing Information Science in the Networked Society*. Proceedings of the 14th International Symposium on Information Science (ISI 2015), Zadar, Croatia, 19th–21st May 2015. Glückstadt: Verlag Werner Hülsbusch, pp. 36–42.

1 Scholarly communication: from 1665 to today

350 years after the *Philosophical Transactions* was published as the first scholarly journal¹, changing scholarly communication from personal correspondence in letters, books and society meetings to regular structured diffusion of research results, the scientific journal remains the central and most important means of scientific communication. The journal enabled priority claims, peer-review, wide dissemination and archiving of scientific knowledge (Mierzejewska, 2008). Derek de Solla Price (1963) was the first to provide numbers for the success of the scientific journal, depicting the exponential growth of the number of periodicals since 1665. Price, who was later called the “father of scientometrics” (Merton & Garfield, 1986: vii), and others noted the information overload created by this growth that scientists were confronted with. The issue was discussed at the Royal Society’s Scientific Information Conference as early as 1948:

[M]ore acutely than ever before, there was a fear that scientists would be overwhelmed, that they would be no longer able to control the vast amounts of potentially relevant material that were pouring forth from the world’s presses, that science itself was under threat. (Bawden & Robinson, 2008: 183)

Citation indexing was initially thought to overcome this information overload and help scientists to stay on top of the literature and filter the most relevant publications based on the assumption that citing authors outperform indexers in highlighting cognitive links between documents (Garfield, 1983).

The digital revolution was expected to change the scholarly journal and provide a solution to the serials crisis. However, electronic journals mimicked their print counterparts, when the PDF became the established format (Mackenzie Owen, 2007; Mierzejewska, 2008). The digital era thus increased publication speed, improved access, intra- and inter-document searchability and navigation, but did not change the form of the scientific journal (Kling & Callahan, 2005).

As more and more publications are available open access, manuscripts, presentations, data, code and review reports are increasingly shared online, research ideas and results are discussed and criticized openly on blogs, scholarly communication is becoming more open and diverse. This allows

¹ The *Journal des Sçavans* appeared before but contained only a small original research section, which is why *Philosophical Transactions* is considered the first scientific journal.

for more transparency as well as diversification of the scientific reward system but also leads to additional information overload, demanding new filters faster and broader than citations (Priem, 2014; Priem, Taraborelli, Groth, & Neylon, 2010).

2 Bibliometrics: from world brain to counting house

In retrospective, the concept of citation indexing can be considered a pre-social web version of *crowdsourcing*, where the community of citing authors was believed to outperform indexers in identifying knowledge flows and highlighting specific ideas and concepts based on links between citing and cited paper (Garfield, 1983). The Science Citation Index (SCI) was developed to help scientists overcome information overload. Garfield (1964) envisioned it as a Wellsian ‘World Brain’ of scientific information and argued that it would be feasible for researchers to stay on top of developments in their fields, if citation indexing helped to identify relevant papers (Garfield, 1955).

Since the early days of the SCI, citation analysis has developed from a retrieval tool to manage information overload to the basis of bibliometric indicators used for evaluation purposes in order to increase efficiency and effectiveness of research funding (Moed, 2006). Its perceived objectivity, simplicity as well as the possibility to apply publication and citation analysis large-scale, have created adverse effects of bibliometric methods and led to the oversimplification of the concepts of productivity and quality in science, creating a ‘publish or perish’ culture. This includes honorary authorships and authorship for sale, citation cartels, ‘salami publishing’ and the concept of the least publishable unit, as well as misuses of indicators such as cumulative impact factors and the h-index (Binswanger, 2015; Haustein & Larivière, 2015; Weingart, 2005). The SCI has become a “counting house” (Adam, 2002).

3 **Altmetrics: more diverse types of output and impact**

The idea of *altmetrics*, short for alternative (to citation) metrics, developed out of the need for new filters in the diversified scholarly communication landscape and to steer against the oversimplification of scientific success based on the number of publications and citations (Piwowar, 2013; Priem et al., 2010). *Altmetrics* are usually based on the measurement of online activity related to scholars or scholarly content derived from social media and web 2.0 platforms. They include various scholarly ‘products’ such as datasets, blog posts and software code as well as mentions on Twitter, Facebook, in blogs, reader counts on social reference managers such as Mendeley or recommendations and ratings on F1000. Even though the term *altmetrics* was coined in 2010 by Jason Priem, the idea of collecting online traces and mentions of scholars and their publications to measure scientific output and impact had been discussed before, mainly in the context of webometrics (Almind & Ingwersen, 1997; Cronin, 2005; Cronin, Snyder, Rosenbaum, Martinson, & Callahan, 1998; Thelwall, Vaughan, & Björneborn, 2005).

Priem (2014: 266) defined the field of altmetrics quite inclusively as the “study and use of scholarly impact measures based on activity in online tools and environments” and as such as a subset of webometrics, but there is no general consensus of what constitutes this new set of metrics. This is largely due to the fact that these metrics are constantly changing and expanding, influenced by technical possibilities – in particular the availability of application programming interfaces – and business models of data aggregators and publishers. For example, Altmetric.com tracks mentions in mainstream media and news as well as policy documents (Liu, 2014) and Plum Analytics measures library holdings (Parkhill, 2013). The common denominator of altmetrics is that they *exclude* ‘traditional’ citation-based indicators. However, due to their heterogeneity and the constant changes of platforms, it has recently been argued that it is elusive to find an umbrella term that is oppositional to bibliometrics (Haustein, Bowman, & Costas, in press) and “instead think of all of them as available scholarly *metrics* – with varying validity depending on context and function” (Haustein, Sugimoto, & Larivière, 2015: 3).

Although research and the number of studies analyzing various metrics has increased in the last years and contributed to the understanding that, for

example, Mendeley reader counts show moderate correlations with citations and thus represent much better predictors of citation impact than tweets (Costas, Zahedi, & Wouters, in press; Haustein, Costas, & Larivière, 2015; Haustein, Larivière, Thelwall, Amyot, & Peters, 2014; Li, Thelwall, & Giustini, 2012; Priem, Piwowar, & Hemminger, 2012), the meaning of various altmetrics is not yet understood.

In particular the processes behind the online events used to create various metrics need to be further investigated. Drawing some parallels between altmetrics and bibliometrics, both communities have been driven by pragmatism creating metrics based on data availability. While bibliometric indicators are based on publications and citations, which are central components since the early days of modern science, the acts on social media and other online platforms used in altmetrics are, however, still shaping and constantly changing (Haustein et al., in press). It is thus of central importance to validate these new metrics and identify biases and limitations before they are being used to avoid misuse and adverse effects.

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