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**GUEST EDITORIAL**

## Bibliometrics – problems and promises

'*Bibliometrics has a problem. In fact, the field – which tracks scholarly impact in everything from journal papers to citations, data sets and tweets – has a lot of problems. Its indicators need better interpretation, its tools are widely misused, its relevance is often questioned and its analyses lack timeliness.*'

– from the review by Jonathan Adams of the book *Beyond Bibliometrics: Harnessing Multidimensional Indicators of Scholarly Impact* (eds Cronin, B. and Cassidy, R.), MIT Press, 2014; which appeared in *Nature*, 2014, **510**, 470–471.

Long-time readers of *Current Science* will be familiar with its somewhat ambivalent attitude to the discipline that now goes by several names: bibliometrics, scientometrics, informetrics, evaluative bibliometrics, research evaluation, altmetrics, etc. This is well reflected in the dozen editorials or so that have appeared in the journal over the years from 1998 to 2013.

There is a saying that 'if you can't measure it, you can't manage it'. Bibliometrics became prominent because of the need to manage the huge investments that were going into the science and technology (S&T) sectors and into research and development activities in particular.

As early as 1939, J. D. Bernal made an attempt to measure the amount of scientific activity in a country and relate it to the economic investments made. In *The Social Function of Science* (1939), Bernal estimated the money devoted to science in the United Kingdom using existing sources of data: government budgets, industrial data (from the Association of Scientific Workers) and University Grants Committee reports. He was also the first to propose an approach that became the main indicator of S&T: gross expenditures on research and development (GERD) as a percentage of GDP. He compared the investment of UK at that time (0.1%) with that of the United States (0.6%) and USSR (0.8%), and suggested that Britain should devote 0.5–1.0% of its national income to research. Since then, research evaluation at the country and regional levels has progressed rapidly and there are now exercises carried out at regular intervals in USA, European Union, OECD, UNESCO, Japan, China, etc. It is important to note here that India's GERD to GDP ratio has never crossed 1%!

Science is a socio-cultural activity that is highly disciplined and easily quantifiable. The complete chain can be thought of as follows: input $\rightarrow$ processes $\rightarrow$ output $\rightarrow$ outcome $\rightarrow$ impact. The last two steps are the most difficult to measure and usually involve cognitive skills that go beyond bibliometrics. Bibliometrics helps one measure the output of science relatively easily in terms of articles published and citations to these, etc. Inputs are mainly those of the financial and human resources invested in S&T activity. The financial resources invested in research are used to calculate the GERD, and the human resources devoted to these activities (FTER – full time equivalent researcher) are usually computed as a fraction of the workforce or the population. The US science adviser, J. R. Steelman pointed out in 1947 that 'The ceiling on research and development activities is fixed by the availability of trained personnel, rather than by the amounts of money available. The limiting resource at the moment is manpower'.

Although the discipline has origins that go back to the early years of the last century, it became data-driven and evidence-based exactly 50 years ago – when the *Science Citation Index* was launched in 1964, a brain-child of the legendary Eugene Garfield. It came with a lot of promises but the problems arose because, in the words of Jonathan Adams, 'the non-experts – such as reviewers, hiring committees and grant panels [use] and often misuse bibliometrics to make decisions.'

Let us first start with an example that is close to us all. Without such measurements we would have no idea, except from anecdotal evidence, where we stand as a nation in the S&T space. Derek John de Solla Price, one of the pioneers of the field, showed around the mid-sixties that the size of the scientific enterprise can be measured crudely by the number of first authors who publish papers and he established a cursory relationship that this was approximately proportional to the economic size of the country as measured by the Gross National Product. So around 1967, India ranked ninth in economic size (just behind Canada) and eighth in scientific size (again just behind Canada). That is, our science stayed ahead of our economy. Today, nearly half a century later, while we are the eleventh largest economy in the world in nominal GDP terms, we rank in bibliometric terms, around the sixteenth position in a simple quantity measure (scientific output), and around the twenty-eighth position in quality terms (measured by scientific output per million dollars of GDP). That is, our science is not even as good as our economy says it should be.

Evidence of this slow and steady decline was already known to our practitioners of bibliometrics and has been recorded in the very own pages of *Current Science*. From the first half (1980–84) to the second half (1985–89) of the decade of the eighties, India's total contribution to the world's publication output (as measured by the Science Citation Index database) dropped by 17.8%, while the world output increased by 9.7% (ref. 1). A more detailed study[2] covering the two decades from 1980 to 2000, showed that while Chinese science rose by a factor of 23 (from 924 papers in 1980 to 22,061 papers in 2000), Indian science actually slowed down (from 14,983 papers in 1980 to 12,127 papers in 2000). This is bibliometrics at its best, when applied at the macro-level. It is not clear whether our science administrators and bureaucrats learned any lessons from such bibliometric investigations.

Bibliometric studies at the meso-level (institutions, agencies, disciplines, journals, etc.) can also give useful insights into how funding should be targeted and channellized. In this manner, it serves the needs of research evaluation and management well. At the micro-level, for assessing individual scientists for awards and promotions, or for project proposals for grants, it has to be used with caution. Here, citation-based measures should complement expert peer-review rather than supplant it.

It is at the level of science and understanding that bibliometrics has gone far beyond its earliest promises. Garfield's revolutionary idea that science can be tracked by an association of ideas, and the Francis Narin and Gabriel Pinski proposal to use recursive iteration and weighting to separate prestige from mere popularity led to the merging of social networking and graph theoretical tools that inform much of how the web-ranking algorithms such as the one found in Google's PageRank are now implemented and used. Such tools have now come back (recursively?) into bibliometrics to produce indicators like Eigenfactor, Article Influence and the Scopus Journal Ranking scheme.

This is not to say that the temptation to use bibliometrics carelessly and thoughtlessly can be easily checked. It will be useful to remember Albert Einstein's caveat – 'Everything that can be counted does not necessarily count; everything that counts cannot necessarily be counted.'

One of the gravest dangers to the way science is practised is the pervasive, and sometimes perverse, influence that Hirsch's *h*-index has had on the collective imagination. Bibliometrics can now be divided into a pre-Hirsch and a post-Hirsch phase. More dangerously, science is getting increasingly polarized into groups that do science for the pleasure of unravelling the hidden truths of the universe and those who pursue science simply to enhance their *h*-index. I recall the words of a famous bibliometrics expert Tibor Braun, the founder editor of the journal *Scientometrics*, when I met him a few years ago: 'Nowadays, everyone wants to know the *h*-index of his enemy'. It is not rare to find scientists who now consult almost on a daily basis databases such as the Thomson Reuters Web of Science, Elsevier's Scopus and Google Scholar to see what their *h*-index is! Nor is it unusual to find research managers and funding agencies who demand that the *h*-indices be provided as part of the curriculum vitae. Indeed, if this 'stranglehold of the *h*-index and the impact factor is loosened science might again be fun'[3].

1. Prathap, G., *Curr. Sci.*, 1995, **68**, 983–984.
2. Arunachalam, S., *Curr. Sci.*, 2002, **83**, 107–108.
3. Balaram, P., *Curr. Sci.*, 2009, **96**, 1289–1290.

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