Weighing the scientific weight factor

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Recently (May 16, 2013), the San Francisco Declaration on Research Assessment (DORA) proposed to stop publication of the 'impact factor' of scientific journals to urgently improve the evaluation of scientific output. The day before along the same lines, the Royal Netherlands Academy of Arts and Sciences (KNAW) urged to reduce stress on researchers. If indeed stress reduction is necessary, perhaps changing the H-index, nowadays the primary weighing factor of individual scientists, is more relevant. The unfairness of this index is also causing stress.

The H-index was developed by J.E. Hirsch (*PNAS* 102 (46): 16569-16572, 2005). It is based on a list of publications ranked in descending order by their citations count. It is simple and elegantly combines the number of publications with the appreciation by the scientific community. However, it disfavours too many. Numerous disadvantages have already been published: It is well-known that this 'personal' measure of scientific productivity favours senior above junior scientists because recent publications have less chance of being cited than old ones. It is profitable to co-authors of multiple-author publications compared to single-author publications, whereas most of the work generally is done by the first author, except perhaps when alphabetic author-ordering is used. The H-index advances large above small scientific fields, it does not consider quality of journals let alone quality of scientific work, etcetera.

Scientific quality is difficult to quantify. Nonetheless, science funding agencies and institutions prefer a measure to support their choices of research and hiring or promoting researchers. This measure should be as objectively weighing quality as possible, yet be as simple as possible and cover an area as diverse as the entire community of all scientific disciplines. Here we sketch the arbitrariness of the H-index in a case-study of ourselves, two senior scientists at a middle-large oceanographic research institute, and we propose an alternative citation-value.

Our characteristics

Case 1: physical oceanographer, 121 refereed publications; last 10 years: 94 refereed publications of which 52 as first-author of which 32 as single-author. H-index = 18 (Thomson Reuters Web of Sciences 'TRWS', May 2013). For publications during the last 10 years: H_{10} = 15.

Case 2: chemical oceanographer, 45 refereed publications; last 10 years: 22 refereed publications of which 5 as first-author of which 0 as single-author. Half-time (20 hours/week) affiliation during the past 17 years. H-index = 20 (TRWS, May 2013), H_{10} = 12.

We wonder why the larger productivity of case 1 is not showing in the difference between H-indices, especially not in the overall one? Can the cause of the rather low H-index of case 1 be due to the relatively small scientific field of physical oceanography ? Is it because the high productivity of case 1 is relatively recent, although, if 10 years is recent for the H-index it really must be replaced by a better alternative. Or is the advantage of multiple-author publications increasing the H-index for case 2?

Towards a better balanced academic weighing index

In the graph of rank-ordered publications versus their citations, the size of a square just fitting below this graph is called the H-index. For example, an H-index of 20 means there are 20 publications that have 20 citations or more. This metric is allegedly useful because it discounts the disproportionate weight of highly cited papers or papers that have not yet been cited.

We propose a slightly more objective weighing factor which better balances citations of few- and many-author papers. This aspect is relatively easy to solve. It weighs citations per author and each citation results in a total value summing the contributions of all authors between 1 and 2, regardless the number of authors. (In the H-index each citation is counted totalling the numbers of authors.) If we define j as the number of citations and n the number of authors, we get for citation-value K as a sum Σ over publications p and divided by the number of publication-years y (not necessarily since publication),

For first authors: $$K = \sum_{p} j/y \, .$$

For all other authors: $$K = \sum_{p} (j/n)/y \, .$$

This gives for case 1: K = 29, for case 2: K = 20. For publications during the last 10 years the citation-value amounts for case 1: K_{10} = 37, for case 2: K_{10} = 14.

The above citation-value shows some of the high productivity of case 1, although not all. It is rather good showing in the last 10 years value. Apparently, in this K_{10}-value the size of the scientific field is less dominant, besides the obvious reduction of the influence of multi-author publications. Publication of citation-value over a limited amount of time is also more encouraging for junior scientists. After all, who has the youth, has the future.