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Commentary on Ruscio et al.: "Measuring Scholarly Impact Using Modern Citation-Based Indices"

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There is currently a surge of interest in comparing research impact and performance at various levels, for instance ranking countries, universities, departments, programs, journals, and even individual scientists. These rankings are typically based on certain simple bibliometric measures, such as impact factors, the *h* index, and so forth. This interest is not purely academic; it is part of a more general ongoing political debate at international, national, and institutional levels since rankings have caught the attention of policy makers. The findings of these measures have caused serious concern in some countries, and new policies have been put in place to improve on their lagging performance. Even in Europe, the apparent lagging of performance compared to the United States has generated policy discussions. The lagging of Europe has been established in a number of studies for different disciplines (see, e.g., Panaretos & Malesios, 2012, for mathematics).

Among the modern citation-based indicators devised to compare research impact, the *h* index and its modifications have had major influence. Besides its basic use as a measure of quantity (and quality) of the work of a single researcher, the *h* index has been applied to assess the productivity of journals, departments, and universities, among others (see, e.g., Rousseau, 2007; Braun, Glänzel, & Schubert, 2005; Kinney, 2007).

Besides having great popularity, the *h* index has raised a lot of criticism. There is a vast literature of articles that stress the disadvantages of the index (see, e.g., Adler, Ewing, & Taylor, 2008; Vinkler, 2007), while a large number of modifications and generalizations of it have appeared in the literature intended to correct its insufficiencies. For certain fields of research, with special characteristics such as mathematics, where we usually find low citation counts, the accuracy of citation statistics based on bibliometric measures such as the *h* index has been questioned (Adler et al., 2008).

In their article Ruscio et al. (Ruscio, Seaman, D'Oriano, Stremlo, & Mahalchik, this issue) present a comparative study of some of the different variants of the *h* index. The study evaluates a total of 22 metrics, including the *h* index and *h*-type indices, as well as other conventional measures. The novelty of their work is to a large extent based on the proposed criteria presented for evaluating the bibliometric measures. Specifically, the authors evaluate the various indices using five criteria, ranging from their ease of understanding to their validity. Although there are

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many other *h*-type indices not included in the specific selection of measures, the paper includes the majority of the most important *h*-type indices that have appeared in the recent literature.

Through the evaluations that are based on the five criteria proposed by the authors, several suggestions are put forward, pointing to the use of modern *h*-type metrics, such as *h, h_t, f, t, g,* and *hg* indices.

The authors present several statistical analyses using two different sets of data in order to classify *h*-type indices. It is clear that these indices can be divided into different groups: one that exhibits stability/reliability including the aforementioned set of *h*-type indices, one that leads to robustness (such as *N*, *h,* and m_q), one that performs well on the validity criterion (including *N* and the set of *h, h_t, f, t, g,* and *hg*). In some instances, the authors confirm earlier research. They prove that the *g* index belongs to the group that loads high on the impact dimension (precisely the reason it was introduced). Many of the results and discussions are quite interesting and novel.

The authors also discuss the different *h*-type indicators, how they are related and how they can be used, making interesting statements about the inadequacy of using only one or two indicators for the assessment of scientific performance of individual researchers, a conclusion supported by other relevant studies.

In summary, the current study adds to the important discussion taking place in recent years on the issue of which measures to use for assessing scientific performance from the large pool of indices devised. It is clear by now that there are very important problems related, on the one hand, to the bibliometric analysis of individual researchers and, on the other (more specifically), to the use of *h*-type indices at this level of analysis.

We believe that the current as well as similar studies, reinforce the idea that using only one or two indicators, both traditional and more modern, is always inadequate for the research assessment of individuals. Although the *h*-type indicators are better in comparison to the number of articles or the citations received, it is still recognized that the *h* index and the *h*-type indicators have strong intrinsic problems and limitations. Distinction between the 2 basic dimensions of scientific performance, namely, quantity and quality of scientific output, is only possible for some of the proposed modern indices. However, for the majority of them, there is no clear categorization into a single dimension. Of course, some indices, the *g* index for instance, manage to describe more than one dimension in comparison to others.

Nevertheless, usually the final conclusion deduced from such analyses is that most of the (more complicated) alternatives do not really make much difference and that—if one wants to use this type of indicator—one should stick to the original *h* index (or the *g* index). Among the advantages of the *h* index is its simplicity and ease of calculation. There are a number of situations, however, in which the *h* index may provide misleading information about a scientist's output. There are also a lot of voices arguing that scientific impact is a multidimensional notion that cannot be effectively reduced to a single indicator (Bollen, Van de Sompel, Hagberg, 2009).

Measuring the research performance of a scientist by using only his or her bibliometric data is already more or less restrictive by default, let alone by measuring the citation performance with only a single one of the metrics available.

There is a huge volume of literature in recent years, presenting more and more *h*-type indicators intended to improve on the typical *h* index. These indices are shown to be highly correlated to the *h* index and to each other. This direction of research does not seem to be the one necessary for setting up standards for the assessment of research impact. Since most of the indicators involved in the current and previous studies are directly or indirectly related to each other, more

theoretical work is necessary for the analysis of their interdependence, than just relying on a hypothetic (linear) relation, based on their correlations.

Thus, future investigations toward methodologies of rating scientific performance based on combining *h*-type indices proposed in the literature with older bibliometric measures could provide a more accurate picture of a scientist's productivity.

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