Understanding author scientometrics – How tall is tall?

"Science offers intellectual pleasure during its work and promises practical gain at the end" - Sigmund Freud

Publication in academic journals is one of the essential fuels for zealous scientific research and is critical for the career progression of a researcher. The number of publications may indicate productivity but is not a true measure of the quality or impact of research. Scientometrics is the fundamental bibliographical tool that quantitatively measures the academic standing and professional repute of the researcher in terms of productivity, quality, and impact.[1,2] Objective quantification of individual research quality and impact is essential not just to stratify the academic standing of the researcher, but also to support decisions on employment, remuneration and career progression, quantify the return on research investment and strengthen research grant applications and awards.[2]

Quality Versus Quantity

Traditional publication metrics based on productivity include the quantity and type of peer-reviewed publications in indexed journals as the first or as the corresponding author, reputation and impact of the journal, academic standing and institutional affiliations of co-authors, and the number and types of citations.[3] Citation analysis is a method of assessing research impact by counting the number of citations for an author, or to a specific publication.[4] Since there is no imposed temporal limit, older publications yield higher citation counts than recent ones, leading to a possible bias. Also, novel early reports are often not cited for several years (Mendel effect or "Sleeping Beauties"), while some works are highly cited soon after their publication.[3-6] Citations can also be manipulated by self-citation or reciprocal citations.[3] While the quantitative indicators continue to be used for a gross estimation of academic standing, the stress, currently, is on more accurate and specific bibliometric indices that help realistically fathom the quality of research.

Author Impact Metrics

Author-level metrics are the bibliometric measures of the impact of individual researchers. These consider a variety of factors other than the total number of citations (such as the distribution of citations across publications over a period) using robust statistical principles.[7] Some of the currently used author impact metrics are as follows:

h-Index

Proposed by physicist Jorge Hirsch in 2005 to quantify the cumulative impact of an individual's scientific articles tracked by a citation database, h-index (also called the Hirsch Index) has been widely used as a simple, intuitive, and universally applicable metric, automatically calculated and displayed on author profiles at Scopus, Web of Science, and Google Scholar.[8,9] The h-index reflects the overall number of publications attributed to an author, and how many times those publications have been cited. h-index = number of papers (h) with a citation number $\geq$ h. This can be manually calculated by listing citation counts in decreasing order.[8,9] For example, if an author has published 100 articles, of which 60 have been cited at least 60 times, the h-index is 60. The advantages of the h-index are that it looks at the cumulative impact of an author's scholarly output and performance, and measures quantity with quality by meshing publications to citations, and is freely available on Google Scholar.[10] It does not, however, account for the number of authors per article, nor does it account for the sequence of authorship or self-citations. It seems to be biased against early-career authors with fewer publications.[10] The implications of h-Index are shown in Table 1.[11]

g-Index

Leo Egghe has proposed the g-index, focusing on a set of highly cited articles.[12] It can be calculated on the Harzing's Publish or Perish website, using data from Google Scholar or such other citation databases.[8,12] To compute this index, a set of articles is ranked in decreasing order of the number of citations.[8] The resultant score is the largest number of top g articles cited at least g^2 times. g-index, thus, can be high even with a few highly cited articles.[8]

Other indices

The i10-index is the number of publications with at least 10 citations listed in the author's profile on Google Scholar.[8] Zhang has proposed the e-index to rank researchers with identical h-index scores but different total citations.[8] Namazi (n)-index, the field-normalization approach to evaluate researchers with identical h-index, proposed to compare researchers' impact considering citation patterns in related scientific fields, has not gained much traction.[8] PageRank index evaluates the impact by correcting for possible citation manipulations using the PageRank algorithm of Google.[8] It helps distinguish early career researchers with few but innovative publications that attract high citation interest.[8] Individual world researcher ranking using standardized citation indicators with the big data from the Citation Reports has recently thrown up some interesting results.[13] Academic networks

Table 1: Significance of h-Index in categorizing a researcher[4,11]		
h-index	**Number of years in a career as a scientist (scientific age)**	**Characterization of the scientist**
20	20	Successful
40	20	Outstanding (likely to be found only at the top universities or major research laboratories)
60	20	Truly unique individuals
90	30	Truly unique individuals

Adapted from Agarwal A, Durairajanayagam D, Tatagari S, Esteves SC, Harlev A, Henkel R, *et al.* Bibliometrics: tracking research impact by selecting the appropriate metrics. Asian J Androl. 2016;18:296-309.[4]

such as ResearchGate (https://www.researchgate.net) and Academia (https://www.academia.edu), peer-nominated review groups (F1000Prime, http://f1000.com/prime), and research sharing platforms (Mendeley, https://www.mendeley.com) are the newer tools to estimate article-level impact.[4]

Databases

Databases, such as Scopus and Web of Science, aggregate citations and provide bibliometric measures. Google Scholar is the only online citation database free to the public and includes multidisciplinary books and journals.[4] Databases can provide raw information for innovative and targeted analysis of research impact.

Journal impact metrics

Journal impact metrics such as Journal Citation Reports (Impact Factor) from Web of Science, CiteScore from Scopus, Eigenfactor Article Influence Scores, SCImago Journal Rank, Source Normalized Impact per Paper (SNIP), journal h-index, and Google Scholar h5 index can be used as surrogate measures of an individual author's academic reputation by correlating publications in high-impact journals.[2] Metrics originally developed for academic journals can also be reported at the researcher level, such as the author-level Eigenfactor and the author impact factor.[2]

Altmetrics – Tomorrow's child

Altmetrics, or alternative metrics, are the modern measures that value online access behaviors (including but not limited to mentions on Facebook, Twitter, or online news sites, exports to citation management systems like Mendeley or Zotero, downloads of full-text articles and comments in blogs or other online forums).[2,14] Altmetrics mean speed (gathered and calculated immediately, compared with traditional citations that are slow to accrue) and diversity (capture data from a variety of sources, not just the traditional academic publishing setting), and thus, may reflect an immediate and broader impact of research beyond the scholar community.[2,14] Altmetrics are meant to complement, not completely replace, traditional impact measures.[2,14]

Conclusion

Keen researchers must rise to understand the intricacies of measurement and the utilities of author impact metrics. Publishing new observations in any and every form is important for the progress of science. However, appropriate pegging of research to create optimal impact is a wise strategy, which the researchers may learn to play. Social media behavior, ease of online access, non-traditional access, and citation pattern are rapidly widening the reach and revolutionizing the research impact. A serious researcher must find ways and means to strengthen the digital presence of research and wisely invest in tomorrow.

"My scientific studies have afforded me great gratification, and I am convinced that it will not be long before the whole world acknowledges the results of my work." - Gregor Mendel

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