Overview of Metrics that evaluate the impact of Scholarly work

Kuldeep Singh Shekhawat[1*], Shruthi Golai[2], Sakthidevi S[3], Basavaraj Nimbeni[4], Arunima Chauhan[5]

[1]Assistant Professor, Dept. of Public Health Dentistry, Srinivas Institute of Dental Sciences, Mukka, Karnataka, India.
[2]Specalist Pedodontist, Agmal Ebtsama Dental Clinics, El-Eskan, King Salman Road, uraidah, Al-Qassim, Kingdom of Saudi Arabia.
[3]Assistant Professor, Dept. of Periodontics, Indira Gandhi Institute of Dental Sciences, Sri Balaji Vidyapeeth, Puducherry, India
[4]Specalist Pedodontist, Agmal Ebtsama Dental Clinics, El-Eskan, King Salman Road, uraidah, Al-Qassim, Kingdom of Saudi Arabia.
[5]Associate Professor, Faculty of Dentistry, Melaka Manipal Medical College (Manipal Campus) Manipal University, Karnataka, India
[*]Corresponding author email: drkuldeepss@gmail.com

Abstract

The life span for any research begins with an idea and ends in a scientific journal which may or may not be cited by researchers. Counting citations is a part of scholarly communication in the scientific world. The easiest technique to use is a citation count, and when applied to articles published in journals, it permits to compare the impact of journals. Use of new techniques in citation analysis has been made possible by the availability of new tools. If one assumes that citations are indicators of importance, then one can use such analyses to determine the most important scholars, publications and even departments. However, most of the researchers are unaware of the various newer tools available which can help their work seen in the scientific community. The ramifications of research may be diverse, wide-ranging, and long-term, and so intrinsically tough to measure. This paper will review some of the metrics that will help fill this lacunae and also provide a gist of various metrics available. In addition newer concepts which are in the experimental phase are also mentioned.

Keywords: Bibilometrics, Blogging, Crowdsourcing, Metric system, Social media

If I have seen farther, it is by standing on the shoulders of giants: by Issac Newton

‒ [Merton, 1965]

Introduction

An essential part of research paper, particularly in the biomedical sciences, is the list of references pointing to prior publications. As Ziman observes," a scientific paper does not stand alone; it is embedded in the 'literature' of the subject (Ziman, 1968; p58). A '*reference*' is the acknowledgement that one document gives to another. A '*citation*' is the acknowledgement that one document receives from another (Francis et al, 2008]. In general, citation implies a relationship between a part or the whole of the cited document and a part or the whole of the citing document. Citation analysis is that area of bibiliometrics which deals with the study of these relationships.

The traditional pressure in academia for faculties to "publish or perish" has crept into almost every educational institution. Successful Publication in high impact journals garners more attention and provides a platform for the research scholar to showcase their talent. This may or may not bring in more funding for the institute, but definitely ensures progress in their respective field of expertise. However, those with the intention of publishing quality research need to ensure their work is seen by their peers.

Researchers worry about their places in the web of references — whom they should cite and who should cite them (Burchill, 2008). But in the face of publication overload, researchers are forced to improve their strategies to be seen among the prospective readers and funding institutions. Every author wants their research to be published in a prestigious journal. Once you become an author in such prestigious journals, the researcher may wish to evaluate how much impact has their article had on the research community. Following which the researcher would also want to know how many other researches have cited the article for their respective research works. Since the world of published science has become crowded and confusing (Burchill, 2008), this simple acknowledgement from another document has transformed to a full blown industry.

However, this industry has enabled the researchers to project their work in the scientific community without any bias. The present paper makes an attempt to outline the various metrics

used to evaluate the importance of journals. These areas (metrics) are often unexplored by many authors.

1. Hunting for Journal Metrics

Journal Metrics allow comparison of journals for purposes of choosing a journal in which to publish, for comparing journal performance & trends and for evaluating publication in these journals. There are many different metrics to measure and compare journals. Though the Journal Impact Factor is the most widely known, there are several tools where these metrics can be found. Figure 1 provides a conceptual design involving the possible metrics that can be used by a prospective author.

1.1 Journal Impact Factor (JIF) (Konikel, 2013)

It is often used to measure or describe the importance of a particular journal in an academic discipline. JIF were initially developed by Institute of Scientific Information (ISI, now Thomson Reuters). The uses are:

- It acts as a shorthand measure of quality to allow scholars to understand the value of content published in a journal relative to other journals in a particular field.

- It represents the average number of times that an article published in a picky journal has been cited within the before 2 years.

- Over the years, reports have surfaced of editorial boards requiring authors to cite articles previously published in their journal in order to inflate the total number of citations received, thereby ever-increasing their JIFs. Other critics have pointed out that JIFs are only an estimate of quality and that true measures of an article's quality should be determined by an article-level metrics.

Calculating JIF:

For example, *Journal of xxxxx xxxxx* (for example only) has 2012 IF of 4.714, which means that on an average each of its 2010 and 2011 articles was cited approximately 5 (round figure) times in 2012. (Table I)

Table 1. Determining the JIF of Journal xxxxx xxxxx (only for example)

Cites in 2012 to items published in	2011	294	Number of items published in	2011	84
	2010	531		2010	91
	Sum	825		Sum	175

Calculations	Cites to recent items	825/175	4.714 (IF)
	Number of recent items		

1.2 Journal Citation Reports (JCR) [Journal Citation Reports, n.d; Clarivate Analytics, n.d]

A product of ISI Web of Knowledge. JCR provides impact factor and rankings of many journals in social and life sciences based on millions of citations. It also offers numerous sorting options like impact factor, total cites, total articles and immediacy index. In addition, JCR provides a 5 year impact factor. By compiling articles' cited references, it helps to measure research influence and impact at the journal and category levels. It also shows the relationship between citing and cited journals. It enables the researcher to trace a journals impact over time.

1.3 Eigenfactor and Article Influence [Eigenfactor, n.d; Article Influence score, n.d]

The *Eigenfactor score* (ES) is based on the number of cited references, with citations from highly ranked journals weighted more than from poorly ranked journals. It is essentially a ratio of number of citations to total number of articles. But unlike the impact factor, the ES:

- Counts citations to journals in both the sciences and social sciences.

- Eliminates self-citations. Every reference from one article in a journal to another article from the same article is discounted.

- Weights each reference according to a stochastic measure of the amount of time researcher spend reading the journal.

ES are scaled so that the sum of the ES of all journals listed in Thomson's Journal Citation Report (JCR) is 100. The top thousand journals, as ranked by ES have scores above 0.01.

The *Article Influence* score (AIS) determines the average influence of a journals articles over the first 5 years after publication. It is calculated by multiplying the *Eigenfactor Score* by 0.01 and dividing by the number of articles in all publications. This measure is roughly analogous to the 5 year *IF* in that it is a ratio of a journals citation influence to the size of the journals article contribution over a period of 5 years.

The equation is: 0.01 x *EigenFactor Score* divided by X,

Where X = 5 year *Journal article count divided by 5 year article count from all journals*. The *mean article influence score* for each article is 1.00. A score >1.00 indicates that each article in the journal has above-average influence. A score <1.00 indicates that each article in the journal has below-average influence.

For examples, in 2006, the top journal by Article Influence score is Annual Reviews of Immunology, with AIS of 27.45. This means that the average article in that journal has 27 times the influence of the mean journal in JCR. AIS uses Thomson Reuters (ISI Web of Knowledge) [Bibilometrics and Citation Tracking, n.d].

1.4 Impact per Publication (IpP) [Metrics, n.d]

Impact per publication measures the ratio of citations in a year to scholarly papers published in the three previous years divided by the number of scholarly papers published in those same years. The three years is the citation window considered optimal time period to accurately measure citations in most subject fields.

1.5 Source Normalized Impact per Paper (SNIP) [Metrics, n.d]

It's defined as," the ratio of a journals citation count per paper and the citation potential (average length of lists of reference list in a field) for the journals subject field. SNIP corrects for differences in publication rated among disciplines. It weighs citations to a journal based on the number of citations in that field.

Citation potential is shown to vary not only between journal subject categories, but also between journals within the same subject category. For instance, journals covering emerging topics show higher citation potential than periodicals in classical subjects or more general journals. SNIP corrects for such differences.

1.6 SCImago Journal Rank (SJR) and Country Rank

This metric measures the 'prestige' of a journal by both counting the number of citations a journal receives and the importance of the other journals in which those citations appear. It ranks journals by their 'average prestige per article' and is used for journal comparisons.[11] Another way to look at it is, SJR indicator assigns different values to citations depending on the importance of the journals where they come from. This way, citations coming from highly important journals will be more valuable and hence will provide more prestige to journals receiving them. (Wikipedia, accessed 2016).

It is a publicly available portal that includes the journals and country scientific indicators developed from the information contained in the SCOPUS database. These indicators can be used to assess and analyze scientific domains. Journals can be compared or analyzed separately. Country rankings may also be compared or analyzed separately. Journals can be grouped by subject area, category or by country. Citation data is drawn from 21,500 titles from more than 5000 international publishers and countries performance metrics from 239 countries worldwide. According to the portal, India is ranked ninth with 7.41 citations per document. (SCImago, SJR accessed 2016)

1.7 Google Scholar Metrics (GSM) [Google Scholar Metrics, accessed 2016]

Google scholar metrics provide an simple way for authors to quickly estimate the visibility and influence of recent articles in scholarly publications. Scholar metrics summarize recent citations to many publications, to help authors as they consider where to publish their new research. GSM currently cover articles published between 2011 and 2015 (both inclusive). The metrics are based on citations from all articles that were indexed in google scholar in June 2016. This also includes citations from articles that are not themselves covered by GSM Google scholar has applied their h-index to journals and uses h5 index to look at last 5 calendar years of a publication output. They also list their top 100 English Language Journals.

2. Author Metrics

Authors' metrics attempt to measure and compare researchers' impact. An author's impact on their field or disciplines has traditionally been measured using the number of academic publications one has authored and the number of times these publications are cited by other researchers. Therefore, a most simple way is: to create a comprehensive list of publication and the number of times it has been cited. The following are few metrics which represent the same:

2.1 h-index

It was proposed by JE Hirsch in 2005. The h-index is the number of papers (h) that have received h or more citations. An h-index of 3 means that an author has 3 papers that have each received at least 3 citations. It is a measure of cumulative impact of a researcher's publication that attempts to measure both quantity (number of publication) and quality (number of citations) [Author Impact, Berkeley Library, n.d]. The letter h is often thought to stand for the h in Hirsch, the name of the physicist who developed it, although it is actually short of 'highly cited'. The h-index was an attempt to overcome the shortcoming of JIF.

Author impact can be calculated using SCOPUS, Web of Science and Google Scholar database that will provide an h-index for an individual based on publications indexed in the tools. However, the h-index tends to favor those in a later stage of career or those in fields that actively cite and publish. It can only increase over time and is not a measure of current productivity [Research Impact, Monash Library, n.d].

2.2 g-index

g-index has evolved from its predecessor, the h-index. It has all the advantages and simplicity of h-index, but also takes into account the performance of the top articles. Developed by Professor Leo Egghe in 2006, it differed from h-index that, while the top h papers can have many more citations than the h-index would suggest, the g-index is the highest number g of papers that together received g^2 or more citations. This indicates that g-index score will be higher than h-index and reflect the impact between authors that was not apparent with h-index (Egghe L, 2007).

2.3 i10-index

This very simple measure is only used by Google Scholar and, is another way to help gauge the productivity of a scholar. Introduced in 2011, it determines the number of publications with at least 10 citations.

2.4 Author Impact Factor (AIF) (Pan and Fortuanto, 2014]

Author Impact Factor (AIF), is the extension of the IF to authors. The AIF of an author A in year t is the average number of citations given by papers published in year t to papers published by A in a period of Dt years before year t. the Author Impact Factor (AIF), which is computed just like the IF, where instead of the papers published in a journal one considers the papers of an author. Basically AIF expresses the current impact of papers published by authors in recent years, so it is a tool to monitor the evolution of the performance of the impact of a scholar's output.

The advantages of AIF over other competitive indicators are:

- AIF is a dynamic index, so it can follow the evolution of the impact of a scholar, and state how ''hot'' the author currently is, if the scholar is in a rising or declining phase and if there is room for improvement. Such considerations might be decisive in hiring decisions, especially for young scientists. Current metrics, like the h-index, are not able to do that.

- AIF averages the number of citations received by all papers published by an author in a given time window, so it is high if those papers are well cited, whereas low quality work would keep the score down. This might incentivize focusing on high quality research.
- AIF is defined just like the IF, so its computation can easily be implemented on most bibliographic portals, like the Web of Knowledge.

3. Tracking and measuring your impact

3.1 Article level metrics – Altmetrics

As Stacy Konkiel puts it, 'Altmetrics is a new approach' for determining the quality and popularity of research more quickly than ever before. The value can be assessed by tallying online shares, saves, reviews, adaptations, and social media usage related to research outputs of all sorts—not only traditional publications but also gray literature, digital scholarship, research blogs, datasets, and other modes of scholarly communication. When paired with *usage statistics* (downloads and page views) and *traditional measures of impact* (journal impact factors and citation counts), they can be an excellent way to help sift through high-quality and popular search results to zero in on what researchers and others seek (Konkiel S, 2013]. A number of studies have shown that scholars are increasingly using the social web to share and discover research. It follows that the ways in which they share, discover, and annotate others' research should be studied to track research impact.

Altmetric Resources

3.1.1 Article Level Metrics – PLoS [Track impact with ALM, accessed 2016]

Public Library of Science (PLoS) as emerged as the leading open access journal repository. In addition PLoS also offers an alternative to traditional impact in the form of Article level metrics, which tracks the influence of individual PLoS articles, from the number of times downloaded to mentions in social media and blogs. It also maintains an internal audit of its internal articles being rated, commented and noted. The benefits of alternative means is only limited to PLoS articles.

3.1.2 Article Level Metrics – PoP [Harzing, Publish or Perish, n.d]

Publish or Perish (PoP) is a software program was created by Anne-Wil Harzing to retrieve and analyze academic citation. It is a free downloadable program that harvests data from google scholar and Microsoft Academic Research to obtain raw citations. Users can manually remove records to refine the data, similar to what is now offered by google scholar citations. PoP can also calculate metrics like h-index, g-index, the contemporary h-index, the age-weighted citation rate, and three variations of individual h-indices among other things. The results are available onscreen and can also be copied to Windows clipboard or saved to a variety of output formats.

3.1.3 ReaderMeter [Digital Curation Center, Reader meter, n.d]

Created by Dario Taraborelli, it is a free tool that 'crowdsources' impact by processing readership data from Mendeley. Its focus is on readership rather than citation. It functions by compiling reports based authors names, which are then processed through Mendeley Application Programming Interface (API). Information such as an author's "HR-index", "GR-index and Top publications by Readership are some of the features. However, it has been critically analyzed regarding ReaderMeter drawing its data from specific sources only.

3.1.4 Altmetric.com

This free website provides information about 'altmetric movement' and defines as "the creation and study of new metrics based on social web for analyzing and informing scholarship". Other important features include altmetric 'manifesto' which provides information on the growing altmetric movement [What is Altmetrics, n.d]. They have separate domains for publishers, institutions, Research and Development, researchers and funders.

3.1.5 ImpactStory

ImpactStory is an open source, web based tool that provides altmetrics to help researcher measure and share the impacts of all their research outputs - from traditional ones such as journal articles, to alternative research outputs such as blog posts, dataset and software. It is a nonprofit organization funded by Alfred P. Sloan Foundation and National Science Foundation (Jason and Piwowr, 2012).

There are many other tools available for tracking and measuring the research impact. However, comparison across different tools is not advised since not all citations are available in any one tool, and each tool has its own algorithmic pattern to calculate impact. Brief information about two such tools are provided below:

3.2 Web of Science Citations

Thomson Reuters Web of Science is today's premier research platform which can help a researcher to quickly find, analyze and share information in the sciences, social sciences, arts and humanities. You get integrated access to high quality literature through a unified platform that links a wide variety of content and search terms together, creating one common vocabulary and one seamless search [Clarivate Anlytics, n.d].

3.3 Google Scholar Citations

Google Scholar provides a simple way to broadly search for scholarly literature. From one place you can search across many disciplines and sources, peer-reviewed papers, thesis, books, abstracts and articles, from academic publishers, professional societies, universities and other scholarly organizations. To keep track of your publication, researcher can also establish an account where number of published articles can be added along with their citations. In addition google scholar also provides for h-index and i10 index for a particular researcher [Google Scholar Metric, accessed 2016].

Conclusion

Counting citations is a part of scholarly communication in the scientific world. No research metric is dependable, and no single metric can evaluate full value of scholarship. Today there are many new forms of scholarly publishing and collaborating which are beyond the borders of traditional citation metric system. In addition, there are new tools called 'Altmetrics' which can be used as a non-traditional supplemental aid. Of lately these new forms of scholarly communications are being tapped for impact metrics. Nevertheless, we also need to take care of the possible short-comings of these newer tools and not brand them as a new separate entity for determining the impact of any research. Altmetrics need time to be tested across various spectrum and at every level in the world of citation. This paper does not advocate any specific

metric system to researcher, rather, provides a platform on which young researchers can make use of such metrics for their academic advancement.

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