Impact Measures and How to Use Them

What Can Research Metrics Really Tell Us?

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The enterprise of scientific research continues to grow: more collaborative, more international, more competitive and more expensive. At universities, government installations, and private laboratories, those who make decisions and set policy face an array of challenges in the face of limited resources.

They must determine priorities; set out clear strategic objectives and determine the best means to attain them; make difficult decisions concerning where and how support will be allocated and how staffing will be maintained; and marshal appropriate tools to assess their progress and, if necessary, modify their activities and policies as necessary to maintain the proper course.

Practical questions abound: How to decide which research and researchers to support and promote? How to deepen, and demonstrate, competence in key strategic areas? How to monitor and fine-tune collaborative activities with other institutions? And how to benchmark one's performance against peers?

Using Bibliometrics to Benchmark

Bibliometrics (sometimes called scientometrics) represent a powerful answer to the challenges posed by the need to steer and evaluate research activities. Via the study of published scholarly literature and its characteristics, bibliometrics actually harnesses science's primary tool—precise quantitative analysis—to examine the dynamics of research itself.

Thomson Reuters Web of Science™ and its related suite of resources, covering upwards of 12,000 of the most essential scientific and scholarly journals, along with books, conference proceedings, and other materials, provides a sweeping vantage point from which to assess research performance, from individual authors to comparisons among countries.

In the Web of Science, the basic operation of capturing citations to published works—and thereby documenting the progression and influence of ideas and advances over time—has undergone constant refinement and expansion. This capacity now affords deeper and multifaceted insights into research performance and the complex interrelationships between authors, subject fields, institutions, and nations.

One practical advantage of this comprehensive view of world research is the ability to not only gauge the performance of, for example, a single institution, but to benchmark and compare that performance against current or aspirational peer institutions. The ability to assess exactly how one's organization fits into the larger scheme of peer entities provides an invaluable resource for adjusting priorities and the allocation of resources.

This capability is embodied in InCites™, a citation-based research evaluation tool built on the backbone of the Web of Science, designed for benchmarking, institutional profiling, and generating customized analysis and reports.

The advantage of this resource extends to institutions in the process of preparing for accreditation. Armed with precise figures on institutional performance and how it compares with peer organizations, administrators have a secure footing from which to adjust activities as necessary to obtain the desired outcome.

These resources far exceed the mere tallying of citations. For example, the measures found in InCites include:

Impact Relative to the World: A measure that compares an institution's citation impact, generally or in a given field, against a baseline score representing the world average. By controlling for the varying quantities of papers produced by different institutions, this measure allows smaller institutions to be judged equitably against larger entities.

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Rankings: Their Place and Value

The practice of comparing, benchmarking, and ranking holds an abiding fascination in all areas of society, from popular culture to science and academia.

As noted above, InCites provides a solid numerical basis by which individuals as well as larger entities can be ranked. At the same time, however, it is important to recognize that rankings have their limitations, and that the exact attribute or attainment being measured should be clearly understood and applicable to the task at hand.

A ranking of individual researchers according to total citations, for example, will invariably favor older researchers whose work has had a longer period in which to accrue citations. Similarly, rankings of institutions by total citations will favor larger organizations with higher research outputs. This is where the Web of Science's array of metrics and their ability to control for varying attributes can be of particular value. These resources have been harnessed in a variety of rankings from Thomson Reuters, such as the Reuters listing of the World's Most Innovative Universities.

To be meaningful and valid, rankings should reflect a controlled and balanced design that assesses comparable entities in a consistent way. And such rankings should not be taken to signify more than the specified measurement.

Collaboration Indicators: Provides precise numerical and graphic data on the individuals, institutions, and nations/regions that make up one's collaborative network. This resource demonstrates which collaborations have produced notably high-impact work, and helps to identify existing gaps and possible new opportunities for collaboration.

Institutional Profiles: Collects a range of data, including citation-based metrics and analysis, results from reputational surveys, and attributes pertaining to the number of degrees awarded, faculty income from research, and other factors.

% of Documents Cited: As the name implies, shows the number of documents that have been cited at least once. With its corollary measure, "% of Documents Uncited," this metric provides a precise picture of which research has wielded at least some influence in the wider community, as opposed to little or none.

Documents in the Top 1% and Top 10%: Shows the extent to which publications have attained notable distinction and impact by ranking among the most-cited papers in a given field. This measure provides a direct demonstration of utility and significance as judged by the research community.

These data points, and the others furnished by the resources within Web of Science, provide precise, quantified information by which to formulate, monitor, and guide research strategy.

Journal Metrics: Loved, Hated, and Here to Stay

Along with the basic matter of deciding what to publish, scientists and scholars are perennially consumed with the question of where to publish.

For more than four decades, Thomson Reuters has published its Journal Citation Reports™, annually imparting the Journal Impact Factor (JIF) of the titles covered in its indexing. And for nearly as long, the JIF has been a source of controversy. Originally a metric intended to help librarians track the usage of journals in their local collections, JIF was soon seized upon by publishers and authors alike for purposes of publicity and prestige.

Although Thomson Reuters has unswervingly maintained that JIF is a specific measurement of a journal's utility as viewed by the research community, much has been made of the figure in a manner beyond the company's control and approval. One particularly

erroneous application is the use of JIF as a proxy for an author's overall performance. In other words, an author notes that his paper appeared in X journal, which carries a JIF of Y, and therefore his work must automatically be judged as superior. This is a misperception that Thomson Reuters has consistently endeavored to correct.

In fact, as noted above, JIF provides a specific measurement of journal impact over a specific time period. As with other resources within InCites and built on Web of Science data, the Journal Citation Reports (JCR) now feature an expanded array of metrics to provide a more extended, nuanced picture of journal impact. To briefly describe a few:

Journal Impact Factor: The original metric, calculated by dividing the total number of citations to items in the JCR year by the total number of citable items published by the journal in the previous two years. For example, a JIF of 1.0 means that, on average, the articles published in the journal within one or two years ago have been cited one time.

5-Year Journal Impact Factor: This measurement, available from 2007 onward, provides a longer view of journal impact, reporting the average number of times articles from the journal published in the past five years have been cited in the JCR year. It is calculated by dividing the number of citations in the JCR year by the total number of articles published in the five previous years.

Journal Impact Factor Percentile: Previously, because different fields display different citation patterns, attempting to compare the impact of journals in disparate categories was impractical. By transforming the rank in category by JIF into a percentile value, this measurement now permits more meaningful comparisons across disciplines.

The Measure of a Researcher

As a matter of course in their careers, researchers must undergo evaluation and assessment. In securing grants, for example, researchers must demonstrate achievement in their field. Similarly, in preparing for tenure and promotion, researchers must document the scope and significance of their professional activities.

In these instances, bibliometric data provides crucial support. A researcher's count of publications, for one, is a marker of productivity. The collective count of citations to those papers is another measure—although one which, as noted above, generally penalizes younger researchers who have had less time in which to amass citations.

Librarians: Building Your Collections

Librarians can embrace the JCR and its compendium of journal impact in the use for which it was originally intended: providing a solid basis for gauging the influence and utility of journals, and thereby serving as an aid in building and maintaining a journal collection in the face of finite resources.

Along with the JCR, Web of Science provides additional metrics that go beyond traditional citation counts. One such figure is the Item Level Usage Metric (ILUM), now part of the standard record display in Web of Science. Because papers in some disciplines (e.g., mathematics) take more time to accrue citations than do their counterparts in the life sciences, the ILUM can gauge interest in a given paper in a different, more-immediate form: tracking instances in which Web of Science users have clicked through the initial entry to access the full text, or have loaded the paper into a bibliographic-management program, such as Thomson Reuters EndNote.

Another available tool grounded in Web of Science data is the Local Journal Utilization Report (LJUR, found within InCites), a statistical database to help manage collection development and identify the journals most relevant to one's own research community. For a given journal, for example, LJUR will track the number of articles indexed in the Web of Science from 1981 onward in which at least one of an institution's affiliated researchers is credited as an author. Reports can also track the number of times an institution's authors have cited articles, or have had their own work cited by articles, in a specific journal. In other words, hard data by which to determine the titles of greatest interest and utility to local users.

Measures that are firmly grounded in consistent, quantitative analysis, along with newer analytics, must be combined and balanced with the oldest evaluative tool of all: sober, clear-eyed human judgment.

REUTERS/ALI JAREKJI

Researchers: Where to Publish

Despite the controversy that has surrounded the Journal Impact Factor and instances of its misuse after being published by Thomson Reuters, one application of the JIF stands true: pointing authors to the most appropriate and advantageous places to publish their work. JIF directly reflects the overall significance and utility of a journal as viewed by researchers in the particular specialty area covered by the journal. Authors understandably want to target their publications to the most visible and respected venues in the field. Journal Citation Reports provides concrete guidance in this process.

Assessing impact via an "average citations per paper" calculation can provide a truer sense of influence on a paper-for-paper basis.

A comparatively recent metric for assessing a researcher's impact is the h-index, a measure that achieves an intersection of productivity and impact. It assesses an author's publication and citation history to determine that the author has produced X number of papers cited X number of times. (For example, an h-index of 65 denotes that a researcher has published 65 papers that have each been cited at least 65 times.) The figure is useful in that it prevents the scenario in which one or two very highly cited papers by a given researcher might cause the researchers cites-per-paper score to artificially skew upwards.

More measurements are available to divine the impact of an author's work. Along with citations to a given paper, Web of Science can track the paper's "second generation" citations, or the total citations to all the papers that cited the original report. This suggests the extent to which the influence of the first paper is expanding through the literature.

The Rise of Altmetrics

As scientific publishing has undergone rapid change in recent years, new forms of monitoring and evaluation have arisen. These "altmetrics" seek to go beyond citation counts and other traditional forms of impact assessment, reflecting the expansion of the scholarly landscape into the worlds of open access and social media. Altmetrics, for example, track ongoing discussions of research in blogs or on sites such as Twitter or Facebook. Monitoring the bookmarking of items provides another altmetric index. Proponents argue that altmetrics provide a much more real-time aspect to impact assessment, in contrast to citations, which may take years to meaningfully accrue.

Certainly, the world of social media has repeatedly demonstrated its power in disseminating information and cataloguing public opinion, and researchers correctly harness its power in promoting consideration of their work.

Altmetrics, however, as an evolving phenomenon, suffer from a lack of uniformity and consistency (not to mention the capacity to be "gamed"), making a wary approach advisable.

Pieces of the Puzzle

As altmetrics demonstrate, the landscape of research is changing at a dizzying pace. Along with established bibliometric measures, altmetrics tools are pieces of an ever-enlarging puzzle. There is no ultimate, be-all/end-all form of assessment. Measures that are firmly grounded in consistent, quantitative analysis, along with newer analytics, must be combined and balanced with the oldest evaluative tool of all: sober, clear-eyed human judgment.

Researchers: Protect Your Research Reputation

With the worldwide population of scientists possibly numbering upwards of 9 million, and numerous instances of authors who happen to share the same name, distinguishing and protecting one's identity is critical. Thomson Reuters has taken the lead in this with its ResearcherID program, in which participating authors are assigned a unique identifier, ensuring that their output of published work will never be confused or diluted with that of other researchers. Especially when used in concert with ORCID, another Thomson Reuters-supported system for securing author identity, ResearcherID removes ambiguity and allows researchers to claim credit where it is due.

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