Article-Level Metrics

A SPARC Primer

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April, 2013

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Executive Summary

Article-Level Metrics (ALMs) are rapidly emerging as important tools to quantify how individual articles are being discussed, shared, and used. ALMs can be employed in conjunction with existing metrics, which have traditionally focused on the long-term impact of a collection of articles (i.e., a journal) based on the number of citations generated. This primer is designed to give campus leaders and other interested parties an overview of what ALMs are, why they matter, how they complement established utilities, and how they can be used in the tenure and promotion process. Among this resource's key takeaways are the following:

- ALMs offer a new and effective way to disaggregate an individual article's impact from the publication in which it appears.

- ALMs aggregate a variety of data points that collectively quantify not only the impact of an article, but also the extent to which it has been socialized and its immediacy.

- ALMs pull from two distinct data streams: *scholarly visibility* and *social visibility*.

- ALMs provide different markers of an article's reach, beyond just citations. ALMs can incorporate shorter-term data points such as news coverage, blog posts, tweets, and Facebook likes. They can also include longer-term markers such as download statistics and article comments. Taken collectively, these data points can present a much fuller perspective of an article's impact over time.

- Article-Level Metrics are sometimes conflated with "altmetrics", but they are not interchangeable. Article-Level Metrics are an attempt to measure impact *at the article level* using traditional and emerging data sources. These emerging data sources are sometimes called altmetrics, and they can be used to help measure the impact of articles, journals, individual scholars, and other entities.

- ALMs are not owned or controlled by any single company. The community can develop, distribute, and build upon ALM tools in a manner that unlocks impact metrics. In this regard, ALMs dovetail with not just open access but various other "open" movements – open science, open data, and open source chief among them. ALMs that are free to use, modify, and distribute contribute to a world in which information is more easily shared and in which the pace of research and development is accelerated as a consequence.

- ALMs have the potential to complement existing metrics and add critical nuance to the tenure and promotion process. ALMs are both *more granular* and *more immediate* than traditional benchmarks.

- The inclusion of ALMs within the tenure and promotion process is an excellent way to recognize the increasingly diverse ways in which scholarly information is communicated.

- ALMs are not without limitations. They can be gamed by malicious actors, although this takes considerable effort. The biggest limitation at present may be their inability to make distinctions of quality and intent within the collected feedback a scholarly output receives.

Article-Level Metrics (ALMs) are promoting the notion that new tools can be developed and implemented to measure a scholarly object's reach and importance. This primer can be used by interested parties to better understand why this matters, what the results to date have been, and where the ALM path is headed.

Article-Level Metrics Defined

Article-Level Metrics (ALMs) are a new approach to quantifying the reach and impact of published research. Historically, impact has been measured at the journal level. A journal's average number of citations to recent articles (i.e., its impact factor) has for years served as a proxy for that publication's importance. Articles published in highly-cited journals were viewed as impactful by association. As electronic dissemination of scholarly content surpassed print, it became easier to disaggregate an individual article's impact from the publication in which it appeared. It also became possible to track different markers of an article's reach, beyond just citations. ALMs seek to incorporate new data sources (sometimes referred to as "altmetrics") along with traditional measures to present a richer picture of how an individual article is being discussed, shared, and used.

Article-Level Metrics are not simply an alternative way to measure impact. Rather, as this primer will explain, ALMs are a toolkit of heterogeneous data points that can be mixed and matched as circumstances warrant. These data points enhance our ability to measure a wide variety of ways in which research may be reaching and affecting its audience, both within and beyond the scholarly community.

Before the explosion of electronic content dissemination, citation counts were the easiest way to quantify an article's consequence. Tracking how many times a paper was sent from one peer to another, or how many times it was discussed at a conference, was simply not possible. So, too, was it difficult to measure how quickly a new research concept or theory took hold within the scientific community. Today, however, Article-Level Metrics open the door to measures of both the *immediacy* and the *socialization* of an article. These are critical components of impact that have not previously been captured.

The dissemination of research is more immediate and occurs across more channels than ever before. Article-Level Metrics are an attempt to better reflect an article's impact under these new circumstances. ALMs can incorporate shorter-term data points such as news coverage, blog posts, tweets, and Facebook likes. These are "shorter-term" metrics insofar as they tend to fade quickly as the buzz around an article wanes. ALMs don't simply focus on these in-the-moment mentions, however. They can also incorporate longer-term markers such as download statistics and article comments. Taken collectively, these data points can present a much fuller perspective of an article's impact over time.

Finally, it is important to distinguish between two similar but not synonymous terms – Article-Level Metrics (ALMs) and altmetrics. ALMs are an attempt to measure impact at the article level. In doing so, ALMs draw from a variety of different data sources, some traditional (e.g., times cited) and some new (e.g., tweets). The attempt to incorporate new data sources to measure the impact of something, whether that something is an article or a journal or an individual scholar, is what defines altmetrics. Altmetrics are about the data sources, not the level of aggregation. ALMs are about the incorporation of altmetrics and traditional data points to define impact *at the article level*.

Article-Level Metrics and Open Access

Article-Level Metrics (ALMs) are not inherently part of the open access movement. They are tools that can be applied in a variety of ways. As this primer will outline, a number of commercial entities are productizing ALMs. However, ALMs are not owned or controlled by any single company. The community can develop, distribute, and build upon ALM tools in a manner that opens up impact metrics as never before. These community efforts are transparent in the methodologies they use to track impact, as well as the technologies behind the processes. In this manner, ALMs dovetail with not just open access but various other "open" movements – open science, open data, and open source chief among them. ALMs that are free to use, modify, and distribute contribute to a world in which information is more easily shared and in which the pace of research and development is accelerated as a consequence.

What Article-Level Metrics Capture

Article-Level Metrics (ALMs) aggregate a variety of data points that, when taken together, quantify the impact of an article, the extent to which it has been socialized, and its immediacy. To do so, ALMs incorporate information from a range of different sources. These sources, as outlined by Richard Cave of Public Library of Science (PLOS), can be broken down into five distinct categories:

- Usage. How many times has an article been viewed on the publisher's site? How many times has the full-text been accessed and/or downloaded? How many times has it been viewed and/or downloaded in PubMed Central? How many times has its supplemental data been accessed? These counts give a concrete, quantifiable sense of the extent to which an article is actually being read.
- Captures. How often has an article been bookmarked on CiteULike? How frequently has it been shared within Mendeley? These and other "recommender systems" provide a unique window into what research scholars seek to highlight among their peers.
- Mentions. What is the discussion centered around an article? How many times has it been blogged about? How many news stories have been written about it? How frequently is it mentioned in Wikipedia? How many comments did it generate on the publisher's site and elsewhere? This element seeks to quantify the extent to which the article has seeped beyond a narrow academic audience and generated a broader conversation.
- Social Media. How many Facebook likes does the article have? How many times has it been shared on LinkedIn and other networks? How many tweets about the article have been generated? These data points can contribute to a sense of an article's immediacy.
- Citations. What articles are citing this article? This is a traditional metric that complements the above by demonstrating the long-term contribution an article makes to the scientific literature.

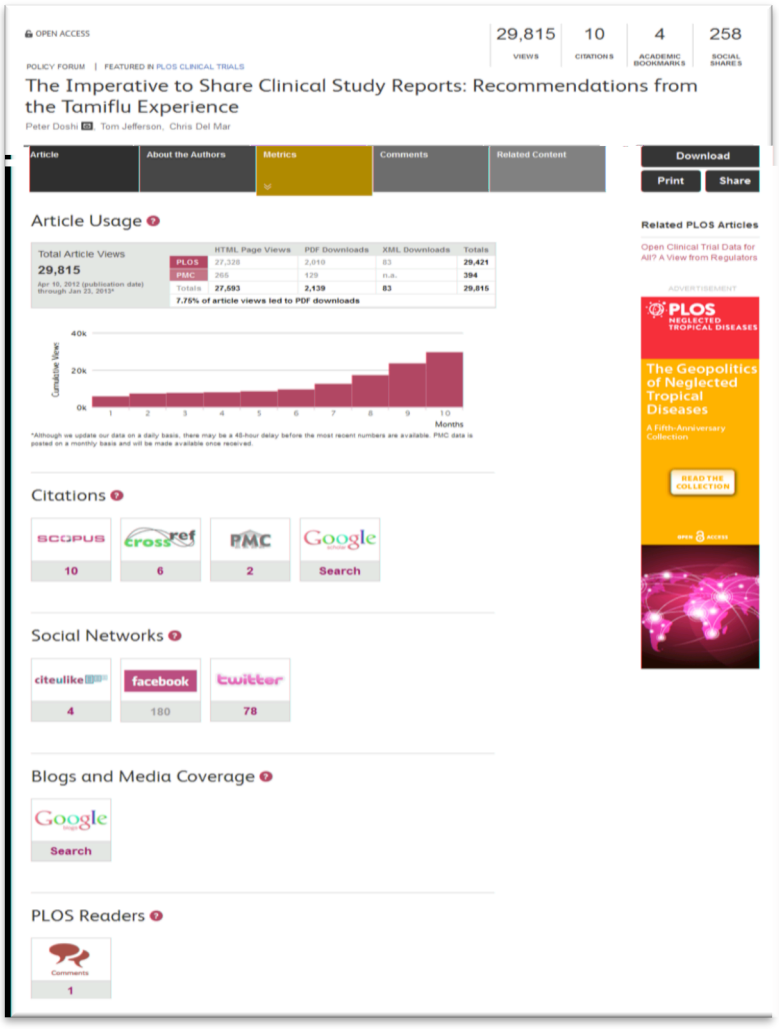
The categories above draw from two distinct data streams. One focuses on *scholarly visibility*. The extent to which an article is shared within Mendeley, rated highly on the Faculty of 1000 site, cited by other scholarly articles, and accessed on publisher websites can paint a picture of an article's consequence within the research community. The second data stream focuses on *social visibility*. This stream encompasses tools that spill beyond the traditional confines of the research

community. Interactions and/or mentions on Twitter, Facebook, LinkedIn, and Wikipedia potentially extend an article's reach to a broader audience. ALMs capture and marry these data streams.

Article-Level Metrics in Action

A number of scholarly information providers have incorporated Article-Level Metrics (ALMs) into their user experiences. Among the representative examples are the following:

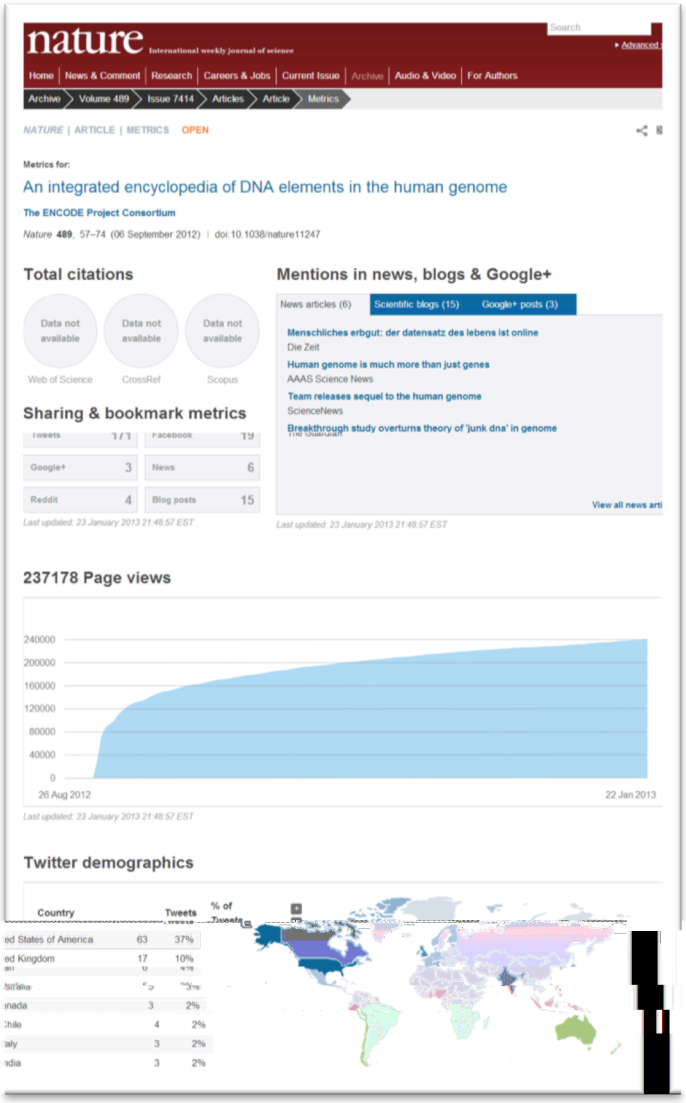
- Public Library of Science (PLOS). Article-Level Metrics are available, upon publication, for every article published by PLOS. These ALMs present a broad range of snapshot and cumulative information, including HTML page views; PDF downloads; XML downloads; PubMed Central usage; citations computed by third party databases and search engines (including Google Scholar and Scopus); mentions on social networks such as Facebook and Twitter; mentions in blogs, as reported by aggregators such as Researchblogging.org and Nature Blogs; and feedback within the comments section of the PLOS website. A sample ALM overview for a PLOS article looks as follows:



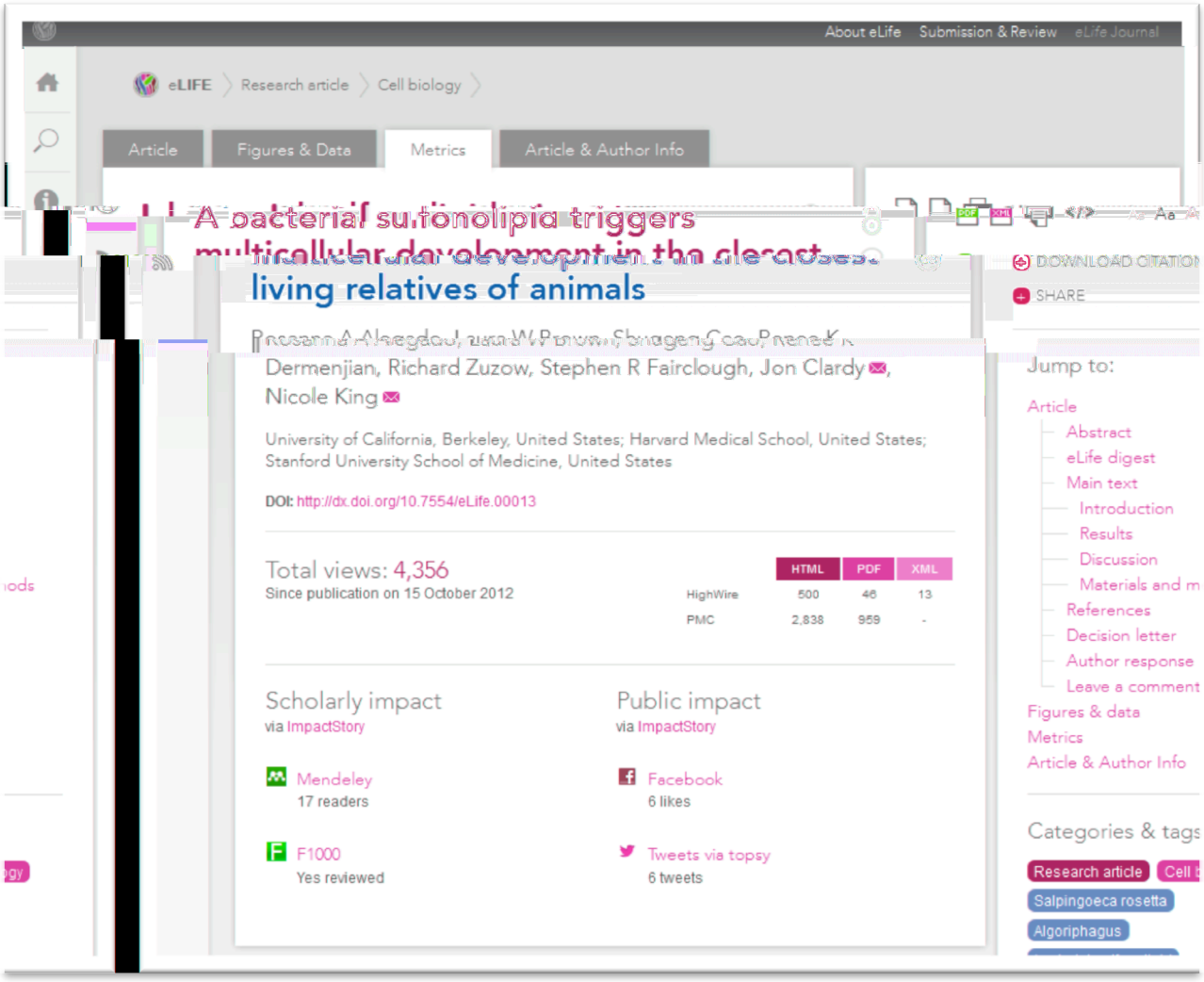
PLOS also makes its application programming interface (API) for Article-Level Metrics freely available. This allows other content providers and interested parties to use and further develop the ALM tool that PLOS has built. For further information on accessing the API, please visit the PLOS site.

- Scopus. Scopus, an Elsevier product, is a large abstract and citation database. It has incorporated ALMs into its search results in collaboration with the company Altmetric (see Appendix A). The inclusion of ALMs expands the range of information that indexes traditionally provide, factoring in the concepts of immediacy and socialization. The range of data sources includes social media sites (e.g., Twitter, Facebook, Pinterest, and Google+), scientific blogs, reference managers and social bookmarking sites (e.g., Mendeley, CiteULike), scientific publications such as *Scientific American,* and even mainstream media outlets (including the *New York Times*, *The Guardian*, and non-English language publications like *Die Zeit* and *Le Monde*). The Scopus implementation includes a demographics tab that displays the geographic breakdown of where the attention for a given article originates.

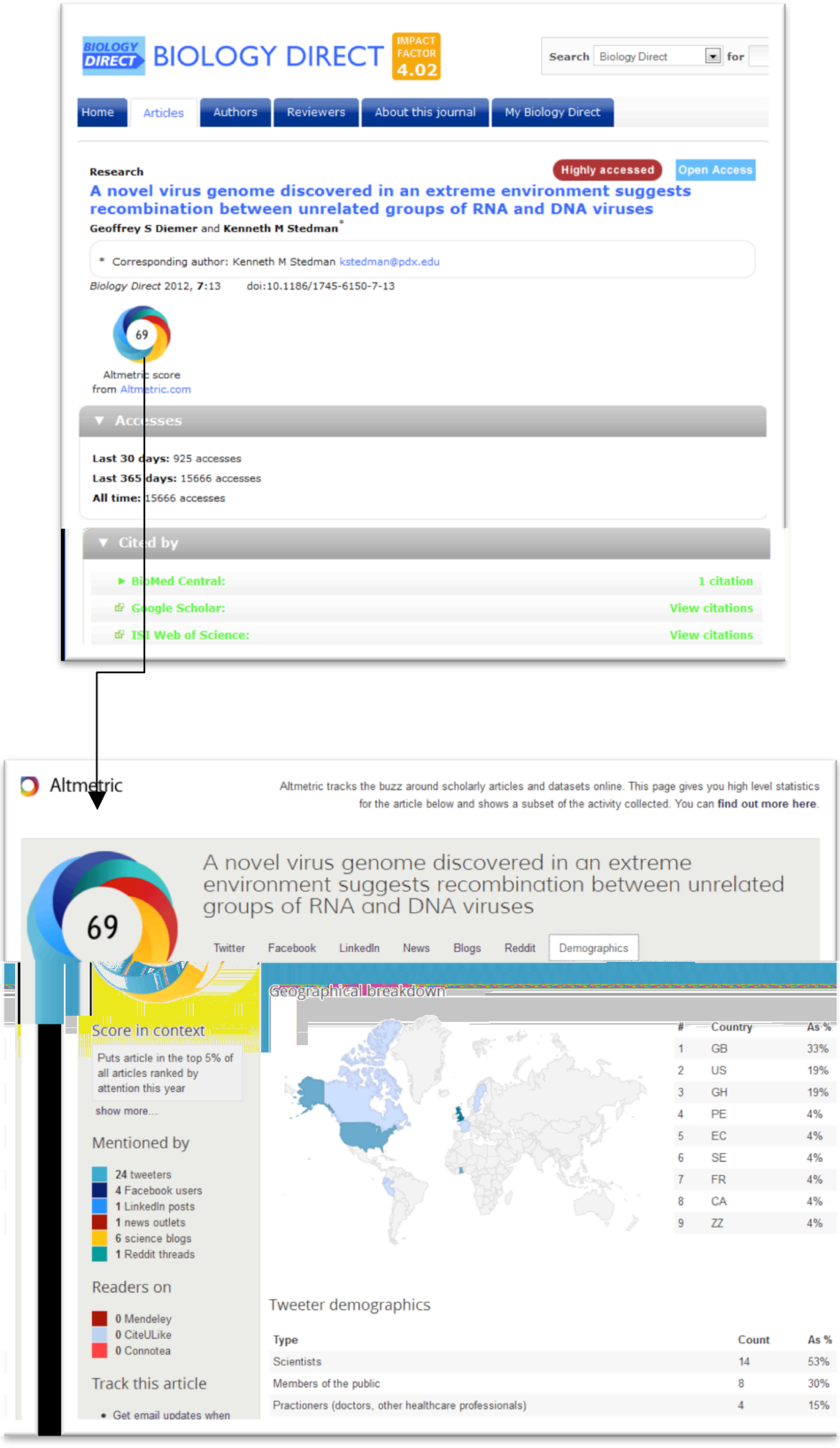
- Nature Publishing Group (NPG). *Nature*, the Nature research journals, *Nature Communications*, and *Nature Scientific Reports* are among the more visible publications to adopt ALMs. Like Scopus, NPG utilizes Altmetric tools to display quantitative and qualitative data regarding an article's social and scholarly reach.



- HighWire. HighWire is a publishing platform that delivers scholarly content on behalf of learned societies, university presses, and other publishers. In collaboration with the non-profit ImpactStory (see Appendix A), HighWire is making ALMs an optional feature for publishers using their platform. This will allow dozens of scientific societies and other not-for-profit content providers to implement ALMs. The first publisher to implement HighWire's ALMs is *eLife:*



- BioMed Central. Like Scopus and Nature, BioMed Central has incorporated the Altmetric utility into its publishing platform. The Altmetric "score" (explained in the Appendix below) appears on the article detail page, alongside traditional metrics such as the number of accesses and the citation chain. Users can click the score and get details about the ALM data for that article via the Altmetric site.


BIOLOGY DIRECT
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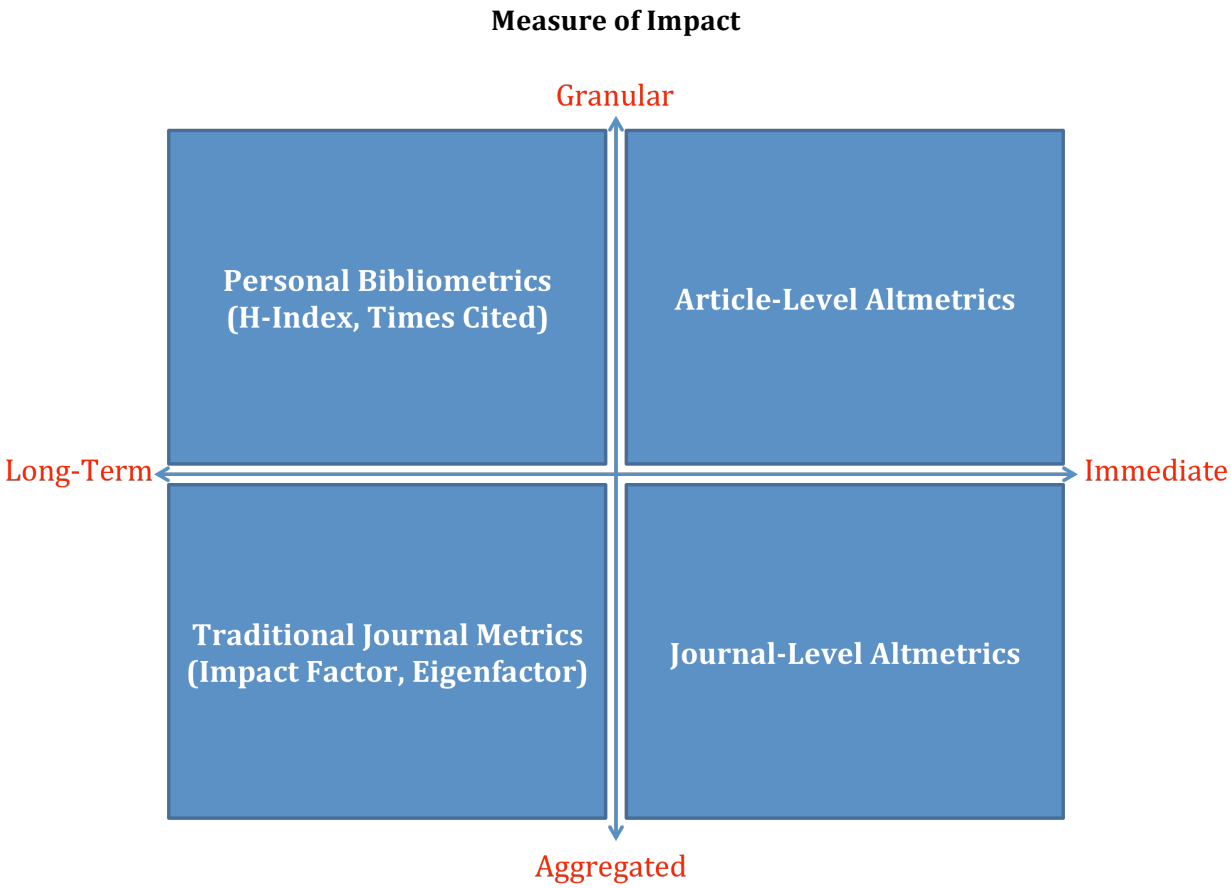
A novel virus genome discovered in an extreme environment suggests recombination between unrelated groups of RNA and DNA viruses
Geoffrey S Diemer and Kenneth M Stedman*
* Corresponding author: Kenneth M Stedman kstedman@pdx.edu
Biology Direct 2012, 7:13 doi:10.1186/1745-6150-7-13
69
Altmetric score from Altmetric.com
Accesses
Last 30 days: 925 accesses
Last 365 days: 15666 accesses
All time: 15666 accesses
Cited by
BioMed Central: 1 citation
Google Scholar: View citations
ISI Web of Science: View citations
Altmetric
Altmetric tracks the buzz around scholarly articles and datasets online. This page gives you high level statistics for the article below and shows a subset of the activity collected. You can find out more here.
A novel virus genome discovered in an extreme environment suggests recombination between unrelated groups of RNA and DNA viruses
69
Twitter
Facebook
LinkedIn
News
Blogs
Reddit
Demographics
Score in context
Puts article in the top 5% of all articles ranked by attention this year
show more...
Mentioned by
24 tweeters
4 Facebook users
1 LinkedIn posts
1 news outlets
6 science blogs
1 Reddit threads
Readers on
0 Mendeley
0 CiteULike
0 Connotea
Track this article
Get email updates when
Geographical breakdown
Country As %
1 GB 33%
2 US 19%
3 GH 19%
4 PE 4%
5 EC 4%
6 SE 4%
7 FR 4%
8 CA 4%
9 ZZ 4%
Tweeter demographics
Type Count As %
Scientists 14 53%
Members of the public 8 30%
Practioners (doctors, other healthcare professionals) 4 15%

Article-Level Metrics and the Tenure and Promotion Process

The reach of a scholar's output can now be measured in increasingly sophisticated ways. Traditionally tenure and promotion committees have relied upon the long-term impact of a scholar's work (i.e., a journal article) within the context of a larger set of works (i.e., a journal). This has been measured by tools such as the journal's impact factor, or more recently, its Eigenfactor. These tools, as well as more subjective measures such as the prestige of a monograph's publisher or the number of "big names" on a journal's editorial board, are indirect measures of a researcher's impact. A scholar's work is associated with something of value, and therefore it has value by association.

Article-Level Metrics (ALMs) have the potential to complement these traditional measures and add critical nuance to the tenure and promotion process. ALMs are both *more granular* and *more immediate* than traditional benchmarks. They are more granular in the sense that they can focus on the impact of individual articles and other scholarly outputs as standalone entities, distinct from the publications in which they may appear. ALMs are more immediate insofar as they track real-time social and professional conversations about a scholar's work, in a manner that citations chains cannot. Review committees looking to rely on data-driven indicators of a scholar's impact can incorporate ALMs to paint a fuller picture of the reach and influence of a scholarly output.



The inclusion of ALMs within the tenure and promotion process is an excellent way to recognize the increasingly diverse ways in which scholarly information is communicated. The hesitancy within the academy to include less established channels such as tweets, Facebook likes, blog posts, and the like is understandable. It has been difficult to confidently place a value on the impact a given scholarly output generates through its socialization. ALMs, however, offer a valuable toolkit for quantifying these data points. This is particularly true for disciplines in which a research output's immediacy and socialization are important markers of its impact. In fields such as life sciences, medicine, and technology, the amount of "buzz" a new article generates – the extent to which it is discussed, debated, and recommended in the days and weeks after its release – provides helpful information about that article's communal value. In other disciplines where immediacy is less ingrained (e.g., the humanities), ALMs may tell a smaller part of the story.

Institutions interested in exploring ALMs can take a number of concrete actions:

- Incorporate ALMs into the institution's research assessment exercises
- Ask researchers to report their article-level metrics in all professional evaluation activities (hiring, promotion, etc.)
- Inform academic departments of the value of article-level metrics
- Encourage display of ALMs across departmental researcher and laboratory pages
- Feature relevant metrics when showcasing noteworthy researchers
- Enlist librarians to communicate the value of ALMs in their work with researchers
- Display ALMs for materials in institutional repositories
- Capture ALMs across labs, departments, and professional schools to better track outcomes and return on investment

  (List adapted from Public Library of Science)

Limitations of Article-Level Metrics

Article-Level Metrics (ALMs) are constrained by a number of factors, some pertinent to all quantitative measures and some specific to this tool. At a general level, malicious actors may distort ALM data. A person with sufficient motivation and technical skill could, for example, build a program that regularly tweeted links to a certain article. On an industrial level, robot activity may impact online usage data that helps define certain altmetrics. Many websites seeks to exclude this type of traffic, and new tools such as DataTrust are emerging, but their degree of success is uneven. This automated attention can distort ALMs. Attempts to game the system and robot activity are issues that impact many types of metrics and are not a disproportionate problem for ALMs.

More specific to ALMs, the biggest limitation at present may be their inability to make distinctions of quality and intent within the collected feedback a scholarly output receives. A research article that is widely hailed as the single worst bit of science in the modern era is likely to generate a large number of tweets, blog posts, and the like. Its ALM figures may therefore tally higher than a less controversial article based on sounder scientific principles. Similarly, a new paper that receives Facebook likes from a dozen Nobel laureates may be of higher impact than another paper that

receives 50 likes from undergraduates at the local junior college. ALMs at present lack the nuance to reflect these important distinctions.

Along related lines, new data sources emerge and establish ones wax and wane in their importance. An ALM tool from 2006 would have focused heavily on MySpace, Friendster, and Digg. The data sources measured by ALMs, as well as the relative weight given to these sources, must be regularly evaluated for relevance and normalized.

The Potential of Article-Level Metrics

Article-Level Metrics (ALMs) complement existing tools to present a more complete picture of an articles' true impact. As the Measures of Impact graph above demonstrates, ALMs can account for the tools that the scholarly community uses to share and discuss content. ALMs can measure impact immediately, from the moment an article is published. Further, ALMs are promoting the notion that new metrics can be developed and implemented to measure a scholarly object's reach and importance. This opens the possibility that other types of output, including datasets, presentations, and software, can be similarly tracked via altmetrics. To the extent that these instruments are free to use, modify, and distribute, they can be used as building blocks for interesting tools, experiments, and advancements.

Appendix A: Altmetrics Tools

As explained in the first section of this report, Article-Level Metrics (ALMs) incorporate data points from a variety of different data sources, some traditional (e.g., times cited) and some new (e.g., tweets). There are a number of tools that have emerged to capture and display these alternative metrics, or altmetrics. This appendix enumerates several of the more prominent ones.

- Altmetric. Backed by Digital Science, Macmillan's technology incubator, Altmetric has been adopted by Springer, Nature Publishing Group, Scopus, and BioMed Central, among others. Altmetric tracks social media sites, newspapers, and magazines for any mentions of hundreds of thousands of scholarly articles. Altmetric then creates a score for each article. This is a quantitative measure of the quality and quantity of attention that a scholarly article has received. It is based on three main factors: the number of individual mentioning a paper, where the mentions occurred (e.g., a newspaper, a tweet), and how often the author of each mention talks about scholarly articles. Altmetric is a for-profit entity.

- ImpactStory. ImpactStory is an open-source altmetric tool, its code available freely for anyone to use. ImpactStory (formerly Total Impact) draws from a variety of social and scholarly data sources, including Facebook, Twitter, CiteULike, Delicious, PubMed, Scopus, CrossRef, scienceseeker, Mendeley, Wikipedia, slideshare, Dryad, and figshare. ImpactStory normalizes metrics based on a sample of article published the same year; altmetrics are reported in both raw scores and percentiles compared to other articles. ImpactStory offers a free widget to embed metrics on any web page. It is a nonprofit entity.

- Plum Analytics. A Seattle-based technology startup, Plum Analytics aims to track metrics for nearly two dozen types of outputs, including journal articles, book chapters, datasets, presentations and source code. Its focus product provides custom reports intended to quantify departmental productivity, support grant proposals, and address other impact-related questions. PlumX is marketed to universities and other research institutions a way to track researchers' productivity.

- PLOS. PLOS has developed and released a Ruby on Rails application that stores and reports user configurable performance data on research articles. The open source utility can be customized to track ALMs for specific articles, and to include additional data sources for deriving the metrics. The code has been available since 2009.