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**Introduction to Altmetrics for Science, Technology, Engineering, and Mathematics
(STEM) Librarians**

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Abstract

Quantifying scholarly output via citation metrics is the time-honored method to gauge academic success. Altmetrics, or alternative citation metrics, provide researchers and scholars with new ways to track influence across evolving modes of scholarly communication. This paper will give librarians an overview of new trends in measuring scholarly influence, introduce them to altmetrics tools, and encourage them to engage with researchers in discussion of these new metrics.

Introduction

Identifying relevant, quality, scholarly literature once consisted of browsing a few respected journals and skimming the departmental copy of *Current Contents*. With an exponentially increasing number and variety of venues for publishing scholarship, it is more and more difficult to select the most appropriate venues to share scholarly content and to keep up with important work in one's field. Along with increasing opportunities to bypass traditional publishing mechanisms and take advantage of social media, there is a paradigm shift occurring in scholarly research output. Is there a way to selectively find, evaluate, and track literature and other scholarship relevant to one's area of interest while also maximizing the exposure and impact of one's own scholarship in an increasingly cluttered world of information? How can librarians become leaders and powerful allies in this new landscape? Enter the world of altmetrics.

Altmetrics, or alternative citation metrics, provide new methods to track scholarship across a wide range of media and platforms. Jason Priem, one of the leaders in this area, defines altmetrics as “the study of scholarly impact measures based on activity in online tools and environments” (Priem, Groth, and Taraborelli 2012). Furthermore, altmetrics can help track the influence of other forms of scholarship, recently defined by the National Science Foundation (NSF) as citable and accessible products not limited to publications, data sets, software, patents, and copyrights (“Grant Proposal Guide, Chapter II” 2013). Engaged scholars use altmetrics as a type of readers' advisory service by providing research support and suggestions. Using the social media components of altmetrics tools, it is possible to follow other experts in the field, join interest groups, and share both references and actual research output. In a sense, some of

these nearly real-time interactions allow anyone to take part in the conversations that advance knowledge. And since librarians have always been in the knowledge business, it is very important that they understand and find a role for themselves in the conversation as well (Lankes 2011).

This article reviews the traditional citation metrics and discusses a few of the promising altmetrics tools, including current research that connects social networks with citation metrics (Eysenbach 2011). It also suggests ways that information professionals can promote the use of altmetrics in citation analysis. Altmetrics is a fast-moving and dynamic area, so it is important to keep abreast of recent developments in the field before advising constituents.

What are altmetrics?

Altmetrics are the tools that help track a scholar's influence and relevance beyond traditional citation metrics. Altmetrics provide immediate feedback because they rely on real-time data and interactions and can be quantified quickly. These interactions can take the form of article downloads or saves, Tweets, analysis and review, or simply article views. The importance of quantifying these interactions is evident as scholars begin to communicate more frequently and meaningfully via social media outlets.

Besides gauging scholarly influence, these tools can provide researchers with powerful and successful filters to help them stay abreast of literature in their field. For example, scholars can join the interest groups embedded in citation management tools that allow users to contribute citations or documents. These documents are then discussed, ranked, and reviewed by a community of peers or interested scholars. While

citations to scholarly works take years to accrue and reflect their influences on other scholars' research and publication, the interactions that take place in the altmetrics arena occur in nearly real-time and can be measured immediately.

Traditional measures of influence, such as peer review and citation analysis, provide valuable information that have informed research and personnel decisions for many years. This data will continue to be utilized. However, these measures are no longer sufficient because they exclude many emerging forms of scholarly communication native to the Web. Altmetrics can complement and enhance traditional citation metrics by measuring scholars' meaningful interactions with social media.

Traditional Tools

Quantifying scholarly output via traditional citation metrics is the time-honored method to gauge academic success. The impact of a scholar's work can be measured by evaluating several factors, including the number of peer-reviewed publications, citations to these publications, and the influence of the publications. These metrics take a relatively long time to accumulate, some are available only via subscription resources, and often these data measure influence only on a specific scientific community, ignoring the increase in interdisciplinary work. Although these accepted tools provide a means to weigh scholarly output, they do not tell the entire story.

Some of the traditional citation metrics are based on journal rankings. Researchers consider these metrics when they target a journal as a venue of their publication. The most well-known of these metrics, is the Impact Factor. The Impact Factor "is a measure of the frequency with which the 'average article' in a journal has been cited in a

particular year or period” (Thomson Reuters 2013). To calculate the Impact Factor, Thomson Reuters averages the number of times articles from the journal in the past two years have been cited in the past year. This information is available through their Journal Citation Reports (Thomson Reuters 2012). Because it is a frequently used metric, it is often considered as the only metric to evaluate journal quality. It is important to recognize that the only titles that are included in the Journal Citation Reports and given an Impact Factor are titles indexed by the Web of Knowledge database. Not only does this exclude some journal titles, it also excludes book chapters and conference proceedings, which are important sources in some disciplines (Cameron 2005).

Another title level metric is the SCImago Journal & Country Rank. The SCImago Journal rank differs from the Impact Factor because it is based on data from the Scopus database instead of Web of Knowledge (Scimago Lab 2012). According to a study, the SCImago metric is “calculated with the largest and most nearly complete bibliographic database and using a citation window of 3 years that is wide enough to include most of the citations, and dynamic enough to measure the evolution of scientific journals” (Gonzalez-Pereira, Guerrero-Bote, and Moya-Anegon 2009). This study compared the datasets of both Web of Knowledge and Scopus and the metric tools derived from the data (the Impact Factor and SCImago Journal Rank). In addition to counting the number of citations a journal receives, SCImago also takes into account the prestige of the citing journal in its algorithm.

Additional traditional methods of gauging academic success focus on individual articles rather than the journal in which an article is published. Simply counting the number of later articles that cite the original article is one of those metrics. While the

metric is not complicated, gathering the data to count the citations is. Both Scopus and Web of Knowledge databases include citation linking, and with that linked data one can create reports of the number of times an article, or all articles by an author, have been cited. Neither set of data generated with these traditional methods is complete.

A free resource for tracking citations is Google Scholar. Search results include a “cited by” count in its display of an individual article. Google Scholar Citations displays cumulative citation counts for a single author. This tool allows an author to create a profile displaying various citation indices. There are a number of criticisms of Google Scholar’s citation counting. The numbers may be inflated if citations to articles are counted multiple times; for example, if the citing paper is published in a journal and also posted to a researcher’s website then a citation may be counted twice. Conversely, Google Scholar does cover many more conference papers and book chapters than either Scopus or Web of Knowledge (Jacso 2006).

The h-index is another method for evaluating the scholarly output of a researcher. This metric does not just evaluate one journal or one article but tries to give a broader view of the impact of a researcher’s work. “A scientist has index h if h of his/her N_p papers have at least h citations each and the other $(N_p - h)$ papers have $\leq h$ citations each.” (Hirsch 2005). The h-index is calculated in all of the above mentioned tools and is subject to the limitations mentioned above due to incomplete or over reported data.

These traditional methods have been the standard by which research impact is measured. They are still important, including for promotion and tenure purposes, but they do not provide the full picture. The data is slow to accumulate and is often contained within proprietary systems. These methods also fail to take into account the diversity of

publication mechanisms now available and the forms that scholarship takes beyond formal journal articles. In addition to the research products mentioned by the NSF, grey literature, such as technical reports, working papers, and white papers, is also not well represented in traditional bibliometric systems. As grey literature and additional forms of scholarship increase, this scholarly output is now more readily found and cited, making it a good candidate for inclusion in a scholar's body of work using altmetrics tools.

Altmetrics Tools

There are a number of tools available to track the influence and relevance of a scholar's work beyond the traditional citation metrics. Traditional methods of measurement take a long time to accumulate, some of them require subscription resources, and they very often measure influence only on a specific scientific community. Perhaps more accurate assessments of influence is the number of readers of an article, the discussions surrounding the article, and the other ideas, research, or innovation the publication sparks. In some disciplines, engaging with a community of scholars via PowerPoint presentations, academic blog posts, and invited lectures reflect significant contributions to advancing a field of study. Altmetrics can help by quantifying this relative importance.

The most mature and promising altmetrics tools to track readership and influence include the following resources:

- Mendeley is a free reference manager and social network that was recently acquired by Elsevier. Mendeley is described as “one of the world's largest crowd-sourced research catalogs” (Mendeley Ltd. 2012). Users create an account to store

and annotate articles, join interest groups to share references, and browse papers. Among the readership tools available are “Popular” papers that shows the number of readers as measured by saves in a Mendeley library. There are also discipline and sub-discipline groups; for example, the sub-discipline Biochemistry has about 32,000 papers and the most popular paper has 4,000 readers. One can join a Group that is essentially a loosely curated bibliography of articles and functions as a type of readers’ advisory service.

- Zotero is a robust and growing citation management and sharing resource. It is likely that in the near future it will begin incorporating more of the readership tools that Mendeley and F1000 offer. Zotero is a free, open source, and open access citation management tool (Roy Rosenzweig Center for History and New Media 2012).
- CiteULike permits users to store, organize, and share scholarly papers (CiteULike 2013). Participants can post articles of interest to their libraries and organize their research with tags. This tool is less popular in most disciplines than Mendeley and the groups this author checked contain many fewer participants and papers than similar Mendeley libraries.
- F1000 is a subscription-based recommendation service for curated articles in biology and medicine. F1000 offers four different services that include an open access journal titled F1000Research, and an open access poster and presentation repository, F1000Posters (Faculty of 1000 2013).

Altmetric aggregators attempt to make sense of the diverse metrics and tools that provide data to gauge influence and relevance. The most well developed aggregators are:

- Altmetric.com “identifies, tracks, and collects article-level metrics on behalf of publishers” (Adie and Roe 2013). This platform is a fee based business solution that collects data about an individual article and supplies this data to publishers. The publishers, who can subscribe to various Altmetrics products, store and present article-level metrics to their readers and authors. The data Altmetric.com collects includes reference manager counts, Tweets, and discussions in social networking sites such as Facebook, Reddit, and blogs. Subscribing publishers can drive traffic to their own websites and publishing platforms by displaying altmetrics data alongside traditional article level metrics.
- In the opinion of the authors, the best aggregator tool for scholarly authors is a free, open source, and open access resource. ImpactStory, funded by the Alfred P. Sloan Foundation, aggregates data from research products including articles, datasets, blog posts, PowerPoint presentations, and more (Priem and Piwowar 2013). A user creates a collection and adds articles and products from sources such as ORCID or Google Scholar, or by inserting DOI’s or PubMed IDs. Next, additional products, including datasets, slides, and other items available via DOI or URL identifiers are collected. A report is generated for an author that details the influence and use of specific scholarly works. It is important to note that the developers of ImpactStory have found that the number of identifiers for scholarly work and the lack of a unique researcher identification system make the data more difficult to collect.
- Plum Analytics is a commercial platform that is marketed to libraries. It collects data similar to ImpactStory, but it is a closed system, as is Altmetric.com, so the

collection methods are proprietary. This system measures influence using five categories; usage, captures, mentions, social media, and citations (Bushman and Michalek 2013). This system seems both very ambitious and promising for institutional subscribers.

A good aggregator collects relevant data from diverse sources, adds value to the information, and delivers the content in an organized format. The tools mentioned above are all in their infancy and likely will evolve as collection and utilization of altmetrics data becomes more common.

Connecting Scholarship with Social Media

For as long as scholarly output has been measured, scholars have thought about ways to increase their impact. Two ways to do so are by maintaining an online presence and by active involvement in social media. These forms of engagement offer scholars a means to disseminate their research, increase their professional profile, and communicate their findings with the public (Bik and Goldstein 2013). A study of materials posted to ArXiv concluded that Twitter mentions of articles led to article downloads (Shuai, Pepe, and Bollen 2012). Scholars are also encouraged to maintain their online profiles so they do not run “the risk that undesirable search results appear before desirable ones” (Bik and Goldstein 2013). Additionally, outreach to the public through social media is one strategy for meeting broader impacts criteria required by the National Science Foundation (Bik and Goldstein 2013).

How do individuals decide which medium is relevant in the cloud of ephemeral electronic communication: “Likes” on Facebook? “Saves” in a Mendeley group?

Relevance is dependent on the context, purpose, and intended use of the communication. In one academic environment, relevant communication may take the form of a Tweet to a very specific, highly interested follower group. In another discipline, a LinkedIn news story may be a targeted method to reach the intended audience. To successfully mount a social media campaign, researchers must be aware of the available tools and familiar with the current practices in a discipline.

Some of the most obvious social media interactions have different impacts, which are important to track for a variety of reasons. The altmetrics aggregator ImpactStory collects data that is directly related to the content and application of the information accessed. For example, in the sample Impact Profile (ImpactStory 2012), data collected from a study on scholars' use of Twitter, and posted in the open source data and code repository, GitHub, includes:

- discussed by public (on Twitter): this metric reports the number of influential and non-influential Tweets about the referenced GitHub collection.
- saved by public: includes the number of bookmarks in Delicious.
- cited by public: in the example given, the repository was “forked” or copied to another user’s GitHub account.
- recommended by public: number of users who have given this GitHub repository a star.

Alternatively, data collected on articles in the sample profile include the more familiar, but uniquely interpreted metrics:

- downloaded by scholars: from PubMed Central, the Public Library of Science, etc.

- saved by scholars: bookmarks in CiteULike, saves in Mendeley, and/or Zotero libraries.
- cited by scholars: in PubMed Central and Scopus in this example.
- recommended by scholars: using F1000 or other tools.

And the less familiar, social-media metrics:

- discussed by public: on Twitter, Facebook, or on other web platforms.
- saved by public: web bookmarks.
- cited by public: in this example, cited by Wikipedia articles.

The authors urge readers to view the latest version of ImpactStory's website for the most up-to-date and exhaustive list of social media tools tracked. ImpactStory also can help one visualize the connections between familiar citation metrics and social media interactions.

Engaging Constituents

Engaging faculty in newer forms of tracking scholarly influence will take more effort than sending a link to ImpactStory.org. A multi-pronged approach to generate faculty interest in altmetrics is necessary. The easiest population to engage is faculty entering the tenure track. While altmetrics may not be used in promotion and tenure decisions today, the scholarly landscape will be very different five years from now.

Conversations with faculty can begin by describing some of the limitations of traditional, individual scholarly metrics. Citations to published works take several years to appear, measure influence only on a select group of researchers, and are skewed toward the STEM (science, technology, engineering and medicine) fields. In addition,

inconsistencies in author and institutional naming systems can lead to incorrect attribution of scholarly works.

Altmetrics, while still developing, can provide a more robust picture of scholarly influence. Altmetrics can measure the buzz surrounding a scientific article – including the discussion in blogs, article views, data or article downloads, and saves to Mendeley libraries. Demonstrating a researcher’s profile using an altmetrics aggregator, such as ImpactStory, can impress even the most recalcitrant faculty member. The varied research outputs aggregated by ImpactStory can help faculty recognize the importance of unified profiles across the scholarly landscape and accurate author attribution. Finally, altmetrics can help demonstrate the wider impact authors can have by aiding in the discovery, access, and use of a scholar’s work.

Limitations

Both traditional citation metrics and altmetrics data are dependent upon accurate attribution of research products. A new initiative, the Open Researcher and Contributor ID (ORCID) project, aims to disambiguate authors by assigning a unique identifier to each individual author. This system is supported by many publishers and research universities and provides links between identifier systems such as Thomson Reuters’ ResearcherID and Scopus’ Author Identifier. The ORCID registry, available free to individuals, is used to unify data from diverse platforms to help correctly link together research activities. Organizational members and funders can explicitly link their records and data to individuals. ORCID is intended to integrate unique identifiers seamlessly throughout the research ecosystem (ORCID Inc. 2012).

Conclusion

Paying attention to and collecting alternative metrics about research products will vary according to one's field and scholarly community. Authors should be encouraged to explore and engage with social media tools already in use in their disciplines and be mindful of emerging tools. Scholars are beginning to go "beyond the paper" and engage with their colleagues via Twitter, blogs, and reference managers (Priem 2013). These types of interactions will continue to increase and those who remain unengaged will likely be left out of important discussions. Increasingly, it is important to not only read the newest journal article, but to follow the chatter about the research in social media platforms. Reluctant social media adopters may be encouraged to engage once they understand that it is perfectly acceptable to simply read or observe, rather than post or Tweet.

Awareness of new metric tools and how they relate to social media is important knowledge for producers of scholarly output. These tools complement existing readership, promote work to new readers, and measure outputs in concert with traditional scholarly metrics. As a complement to traditional citation metrics, altmetrics can provide a more rapid assessment and arguably a more complete picture of an individual's scholarly influence. Altmetrics tools can also help illustrate the value of scholarly output beyond publications.

Tracking the relevance and significance of these research products requires knowledge of the practices within a discipline and the foresight to predict what may be

important to track in the future. While altmetrics can help researchers by vetting, organizing, and adding value to information products retrieved, it is essential to contextualize this data. Information professionals, with knowledge of both traditional and emerging scholarly metrics, are able to bridge the divide between these forms of scholarly engagement.

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