Altmetrics as new indicators of scientific impact

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Abstract
In recent years, researchers and academics in growing numbers are starting to move their everyday work onto the Web, exploring new ways to spread, discuss, share and retrieve information outside of the traditional channel of scholarly publishing. As scholarly communication moves increasingly online, there is a growing need to improve the ways in which the impact of scientific research output is evaluated. Altmetrics, even if they are still in an early stage, have the potential to develop as complements to traditional metrics and to provide a useful insight into new impact types not included in existing measures. This paper summarises the major trends, opportunities and challenges of these new metrics for both researchers and academic research libraries.

Key words: Internet; social media; information dissemination; evaluation studies as topic.

Introduction
Due to recent developments in information technology and the advent of the social media, researchers and academics in growing numbers are starting to move their everyday work onto the Web: they interact through collaborative tools, utilise online reference managers such as Zotero and Mendeley to bookmark interesting resources retrieved on the Web and share information about their work through Twitter or blogs. These developments amount to a new way to spread, discuss, share and retrieve information that is outside the traditional channel of scholarly publishing.

This also creates the possibility of measuring and quantifying the impact of scientific works in new ways. These novel techniques are grouped under the umbrella term "altmetrics", defined as "social media based metrics" (1). Altmetrics is still in its infancy: the term was coined only in 2010 by Jason Priem, a doctoral student in information science at the University of North Carolina, but there are more and more publishers involved in testing and discussions related to the feasibility of these alternative metrics. This paper summarises the major trends, opportunities and challenges of altmetrics to both researchers and academic research libraries and is intended to be a starting point for further discussions.

A new way to establish the impact of a publication
Traditionally the evaluation of a research article was made counting citations it received by other articles. In the last few years, with the advent of webometrics, new indicators were developed based on web usage statistics. However, as online scholarly communication takes on an increasing variety of forms, conventional methods of assessing the quality of research output are becoming obsolete. Traditional citation metrics are still important but are increasingly incapable of showing the full picture as they do not measure new forms of scholarly output, such as datasets and software, and new ways of disseminating content through social media.

In 2009 PLoS was the first publisher to develop a system, called Article-Level Metrics (ALMs), based not only on traditional measures of impact but also the extent to which an article has been discussed, shared and used. ALMs are an attempt to measure the impact at the article level and, to do so, they aggregate traditional and alternative sets of online metrics including usage, citations, social bookmarking, media and blog coverage and ratings.

The Altmetrics Manifesto, issued in 2010, lays out an approach to this new situation, recognizing the need to find new filters to assess the quality of an exponentially growing quantity of research literature, and suggests a solution in a novel set of indicators to complement citation analysis (2).

In 2012, a group of researchers from the American Society for Cell Biology (ASCB), along with editors and publishers, issued a declaration calling for the need to

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improve the ways in which scientific research output is evaluated. This declaration, known as the San Francisco Declaration on Research Assessment (DORA), lays out the argument that the impact factor is no longer suitable for its present role in evaluation, and that research should be assessed on its own merits, not only on the basis of where it is published (3).

Altmetrics and its tools

In order to assess the online influence of research output, altmetrics incorporate data coming from a wide range of sources, for example databases (Scopus and PubMed), social networks (Facebook, Twitter), social bookmarking tools (Delicious), blogs, research data repositories (Dryad and Figshare), reference management systems (Mendeley and Zotero) and many more. This makes it possible for altmetrics to function as a real time indicator of online impact of research output.

A number of tools to track a researcher's relevance beyond traditional metrics have been created or are under development: these are web applications, some free and some for profit, that measure scholarly and public interest for research output from a quantitative point of view. To reach this goal, these tools register the online activity of usage, capture, mention, share, citation and diffusion of many types of research output through social media. These outputs can be articles, books, datasets, videos, presentations, conference proceedings, slides etc., and, to be properly collected, must be

	Altmetric.com	ImpactStory	PlumX
Products tracked	Papers, datasets, books	Papers, blog posts, datasets, software, slides	Papers, blog posts, book chapters, books, case studies, clinical trials, conference presentations, datasets, figures, grants, interviews, letters, media, patents, posters, presentations, source code, theses/dissertations, videos, web pages
Output or user interface methods	Free Bookmarklet, Explorer, metrics badges, API	Profile page, metrics widgets, API	Profile page, Widget Builder, API
Organization type	For profit	Nonprofit	For profit
Sources			
Usage stats			
Dryad		X	X
Figshare		X	X
GitHub		X	X
PLoS ALMs		X	X
SlideShare		X	X
Social web shares			
Facebook	X	X	X
Google+	X	X	X
LinkedIn	X		
Reddit	X		X
Twitter	X	X	X
Bookmarks			
CiteULike	X	X	X
Delicious		X	X
Mendeley	X	X	X
Scholarly citations			
PubMed		X	X
Scopus		X	X
Non scholarly citations			
ScienceSeeker			X
Wikipedia		X	X

Table 1. *Comparison of altmetrics tools*

identified by a Digital Object Identifier (DOI) or other unique codes (e.g. Open Researcher and Contributor ID (ORCID) or PubMed ID (PMID)).

Usually, these tools summarise the impact of research output in real time and take into account (and sometimes distinguish between) data which can be taken to reflect the impact on two different audiences: the scholarly community (e.g. Mendeley bookmarks) and the general public (e.g. Facebook shares) (4). These tracking tools include specific dashboards and widgets designed to meet the needs of different types of users such as individual researchers, research groups, academic departments, research institutions, publishers, etc. These tools vary widely, especially in terms of the functions which are offered.

Currently the most used altmetrics tools are: Altmetric.com (www.altmetric.com); ImpactStory (http://impactstory.org/) and PlumX (https://plu.mx/). Altmetric.com, analysing the online impact of research articles based on a variety of sources, generates a score and conveys this information through small donut shaped visualisations for fast comprehension. One limit is that mentions of articles published before July 2011 may be missed, leading to an inaccurate score. The product offered is oriented towards publishers and institutions, and is free for libraries. Altmetrics also provide a free book market oriented towards individual users, allowing them to obtain article level metrics for any recent paper.

ImpactStory is a free open source web application collecting data from a variety of sources related to a broader set of resources including preprints, datasets, presentation slides and other research output formats. It allows users to create a personal profile and to track the Web impact of their work, impact that can be divided into two categories: scholarly or public.

PlumX is an impact dashboard created by Plum Analytics collecting data from a particularly wide variety of sources and dividing them into five categories: usage, captures, mentions, social media and citations. This tool summarises and compares the impact of not only individual researchers but also of research centers, departments and institutions. Table 1 provides a comparison of these tools highlighting their main characteristics.

As a sign that altmetrics are quickly coming of age, more and more publishers are now adding to their websites the Altmetric.com “donut” to visualise the online attention related to the whole or a part of their published articles. In January 2014 the last big publisher to join Altmetric.com was Springer, who added altmetrics information to every article available online. Other major publishers such as the Nature Publishing Group, Wiley, BiomedCentral etc. are already implementing this service.

HighWire, the e-publishing platform of Stanford University, in mid February announced an agreement with Altmetric.com to offer altmetrics integration for publications hosted on their widely used Open Platform.

Opportunities and controversies

Supporters of altmetrics claim that these new metrics provide several advantages:

- immediacy: data can be retrieved immediately whereas citations take time to accumulate;
- coverage of many different types of research output, as they allow measurement of the visibility of less conventional materials such as slides, datasets and conference presentations;
- measurement of impact on the general public, not just the scholarly community, by means of indicators related to the social web;
- harvesting of more reliable data than download statistics, for example data from reference tools such as Mendeley and Zotero which offer a measure of the active interest on a document.

A number of observers have pointed to what they see as flaws intrinsically related to several of these supposed strengths:

- immediate collection of data related to impact can be problematic as it may take time for the quality of the research to be clearly understood;
- social media and usage statistics in general are vulnerable to manipulation (“gaming”), for example by commercial services such as Social Media Likes (http://socialmedia-likes.co.uk) which sell tweets, Facebook likes and blog mentions (it should be noted that the impact factor can be, and has been, manipulated by journals in a variety of ways (5, 6));
- research in different disciplines, and different subjects within the same discipline, can be more or less likely to produce a measurable impact in social media for reasons which are unrelated to the scientific impact of the work.

In addition, there are several factors which limit the usefulness of presently available techniques, which are not intrinsic to the concept of altmetrics but have yet to be satisfactorily resolved:

- there is a lack of standardization across different metrics, which are quite diverse in their basis and methods.

- the significance of the appearance of a research output in social media can vary greatly depending on the context, something which present systems do not take into account (7, 8).
- the appearance of new social media platforms, and changes in usage patterns, are both very frequent. As a result, metrics based on these platforms can easily become obsolete in a short period of time.

The National Information Standards Organization (NISO) is presently working on these issues in order to identify and advance standards and/or best practices related to this new suite of potential metrics (9).

Conclusions

As the interest in altmetrics grows, librarians can participate in this debate by conducting more research about the use of alternative metrics in determining value, quality, and impact in the research process and to start building infrastructure and developing ways to expose metrics at, for example, the dataset level that can support the archiving, reuse, and evaluation of an array of research assets (10). Research is also needed on the usage of social tools by researchers in order to clarify the meaning that should be attributed to associated statistics.

Librarians can also provide support to users in three main ways: informing emerging conversations with the latest research, supporting experimentation with emerging altmetrics tools, and engaging in early altmetrics education and outreach (11). As a complement to traditional metrics, altmetrics can provide a more rapid assessment and a more complete picture of an individual's work influence even if further investigation is needed to understand the reliability and significance of the resulting measures, and necessary improvements will no doubt come to light. For example much of the infrastructure required for these tools to function optimally is still in the construction process: DOIs and PubMed IDs are needed for reliable tracking but often documents lack these.

Other topics in need of clarification are the differences in the ways in which different disciplines discuss and share research findings, the potential impact of these metrics on peer-review (12), the need for anti-gaming mechanisms and ways to put metrics into context. If, as seems likely, these obstacles can be overcome, future aggregate level altmetrics promise to provide a powerful complement to traditional methods by incorporating new types of impact.

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