The Different Meanings and Levels of Impact of Altmetrics

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Abstract

The idea behind altmetrics is that the online mentions and other indicators of awareness and use of research products could indicate something about the impact of that research. Although some earlier research has found evidence to support this, the meaning of different altmetric events is still somewhat unclear. It would appear that while some of the altmetric events are created by scholars, many are created by the public. If these events could be tracked, it is possible that altmetrics could be a fruitful avenue to investigate societal impact of research. This paper will review some of the earlier research and discuss the potential and caveats of altmetrics.

Keywords: altmetrics, impact, societal impact, scientific impact, social media metrics

Topic: Emerging Issues in Scientometrics

1. Introduction

The idea behind altmetrics is that the online mentions and other indicators of awareness and use of research products (e.g., number of tweets, Facebook 'likes', blog entries, and social bookmarks) could indicate something about the impact of that research. Priem (2014) summarizes this in defining altmetrics as "*the study and use of scholarly impact measures based on activity in online tools and environments*." Earlier altmetrics research has found evidence to support this, as studies have found connections between different altmetric events and citation counts (Eysenbach, 2011; Shuai, Pepe & Bollen, 2012; Mohammadi & Thelwall, 2013; Thelwall, Haustein, Lariviére & Sugimoto, 2013). Scientific impact is frequently measured using citations received by other researchers, with the assumption that research receiving more citations has made a greater impact (Moed et al., 1985; Moed et al., 1995). Thus a connection between altmetric events and citations suggests that some altmetric events may be able to reflect scientific impact. If this is the case, altmetrics may have the potential of providing early indicators of later scientific impact. Altmetrics are, however, created by a much wider audience than just researchers, as anyone can share, like, tweet, and comment on various research products. It is possible, and even likely, that while researchers are the main creators of altmetric events, there are also contributions being made from a much broader audience. It is thus possible that different altmetrics may be able to reflect the interests of different types of users. In addition, the sources of altmetrics are very different in regards to the format and context in which research products can be mentioned. While a tweet is limited to 140 characters and thus

does not allow for extensive commenting, a blog entry allows for lengthy discussions and reviews of research products. This of course does not exclude the possibility that a single tweet could not demonstrate a high level of impact, or that a blog entry could merely mention a research product without demonstrating any impact. This article will review some of the earlier works conducted in these areas and discuss the potentials and the caveats of altmetrics.

2. Different altmetric indicators

Citations have traditionally been used as a proxy for scientific impact (Moed et al., 1985; Moed et al., 1995), but scientific articles may also be read and used by a non-academic practitioner. Various research products can also be discussed and shared online by the public. The quantitative metrics, the altmetrics, of the traces that these events leave online may be able to tell something about the wider, societal impact that the research products have had. Different altmetric indicators may vary greatly from citations and also from each other (Haustein, et al., 2014), hinting at the possibility that different altmetric events may be able to reflect different types of impact from different audiences. For instance, Mendeley readership demonstrates mainly an academic impact while tweets may show a broader impact on the public. Moreover, some of the metrics may contribute to actual usage of a research product, either in an academic or a non-academic context, while some other metrics may not have any connection to usage in a scientific context. Next we review some of the altmetric indicators and focus on the audience creating them and the perceived level of impact that they may reflect.

2.1 Blogging

Blogs enable extensive discussions and commenting on scientific outputs. Main motivations for researchers to blog are that blogs can be used for linking the scientific community to the general public and for knowledge sharing with a wider group of audiences (Hsu & Lin, 2008). Many scientific blogs contain references to scientific articles, demonstrating their value as a source of altmetric events. Shema, Thelwall, and Bar-Ilan (2012) found that blog entries from ResearchBlogging.com often reference articles in high impact journals such as Nature and PLoS ONE. The authors also discovered that these so called blog citations might be able to predict later citations. Although a connection between blogging about scientific articles and their scientific impact has been discovered (Shema, Thelwall, & Bar-Ilan, 2012; Hoang, McCall, Dixon, Fitzgerald, & Gaillard, 2015), it is still unclear whether blogging increases online visibility and thus contributes to higher citation counts, or if the articles that have been mentioned in blogs are just “better” and would thus have received more citations without having been included in blogging activity.

2.2 Microblogging

Microblogging on social media sites such as Twitter or Weibo is not limited to academia. In fact, a great deal of the altmetrics generated on microblogging sites may be due to the public sharing and commenting about research products. Although some early studies have discovered a connection between tweets and citations (Eysenbach, 2011; Shuai, Pepe, & Bollen, 2012; Thelwall, Haustein, Lariviére, & Sugimoto, 2013), it would appear that attention on Twitter is skewed towards humorous or unusual content (Haustein et al., 2014). While there are certainly

many researchers who use microblogs, it would seem that instead of being able to reflect scientific impact or predict future scientific impact, altmetric events from microblogs may primarily reflect general attention or public curiosity.

2.3 Social bookmarking

Social bookmarking sites or social reference managers such as Mendeley, Zotero, and CiteULike are popular among researchers and are used to gather altmetric events regarding readership. Altmetric events captured from these tools can provide information about a wider range of readers than statistics provided by publishers are able to deliver (Haustein & Siebenlist, 2011), making them a more diverse source of altmetrics. Reading an article or bookmarking it does not necessarily mean that it will be cited later, although intention to cite the article has been found to be the main reason for bookmarking (Mohammadi, Thelwall, & Kousha, 2015). Also, moderate correlations have been found between article readership rates (as measured by readership in social bookmarking sites) and citation counts (Bar-Ilan, 2012; Haustein et al., 2014; Mohammadi, Thelwall, Haustein, & Larivière, 2015). In a study of Mendeley readers, Mohammadi, Thelwall, Haustein, and Lariviére (2015) found that the tool was particularly popular among PhD students, postgraduate students, and postdoc researchers. Thus, examining these types of tools may reflect the interests of younger researchers instead of a broader societal impact of research.

2.4 Wikipedia

Wikipedia, a massive online encyclopedia to which anyone can contribute, is a popular site for many people seeking information about various topics. While the quality of Wikipedia articles has been considered good (Anthony, Smith, & Williamson, 2005; Giles, 2005), referencing a Wikipedia article in a scientific publication is a bit more troublesome as the content of Wikipedia is highly dynamic—Wikipedia articles may be edited by anyone at any point in time. The fact that scientific articles from high impact journals are often referenced in Wikipedia (Nielsen, 2007; Lin & Fenner, Nd) could be seen as evidence of the quality and high standards employed by contributors to the online encyclopedia. In addition, it has been found that scientific articles mentioned in Wikipedia have been found to have a higher citation impact compared to articles not mentioned in Wikipedia (Shuai, Jiang, Liu, & Bollen, 2013). While Wikipedia is most likely being used and edited by both scholars and the public, the connection between Wikipedia articles and scientific articles suggests that Wikipedia may be a valuable source of altmetric events. What kind of impact it would reflect, however, is somewhat unclear.

2.5 Social networking sites

Besides search engines, social media sites have now become the biggest drivers of online traffic (Wong, 2015). The online social networks create efficient spaces for news, information, and other online content to be shared, recommended, and disseminated through social connections around the world. Various social networking sites are efficient tools for scholarly communication, and as such altmetric events such as Facebook likes, comments, and shares, among other things, could reveal some information about how and what kind of research is being consumed and disseminated. While it is unclear what the actual impact of a Facebook

like, or of 10,000 likes for that matter, would be, one might assume that increased visibility of science would have a positive effect on the impact of the research being discussed.

General social networking sites such as Facebook are widely used by the public, but include some scholarly activities. In addition to these general sites, there are academic social networking sites (e.g., ResearchGate or Academia.edu), which seem to be used primarily by scholars. While the academic social networking sites do not (at the moment) provide access to their data via an API, these sites may be interesting for small-scale qualitative studies examining how scholars use these sites and how their work is being used. From an open science point of view, sites such as these may have impact in incentivizing researchers to increasingly share their work openly and to promote public access to scientific work.

2.6 Recommendation systems

Another type of source of altmetric events is the so-called social recommendation system, such as Reddit and Digg. These types of sites, although covered by the data collection efforts by some of the aggregators of altmetric events, have not yet been extensively researched. The idea of the recommendation site is that people can vote (either up or down) on news stories and other online content they find valuable or interesting in some way, in order to allow for more visibility of highly voted content within the site. In theory recommendation systems hold great promise for altmetric events, yet little is known about the people voting or of their motivations to vote. This lack of information undermines the usefulness of using the voting events to evaluate the impact of research. Closely related to this kind of recommendation systems are the scientific recommendation systems like F1000 Prime. On F1000 Prime invited researchers give their evaluation and vote to publish scientific articles they find useful and valuable. It would appear, however, that the recommendations on F1000 Prime are better at reflecting the perceived value of research from the practitioners' point of view (Li & Thelwall, 2012; Bornmann, 2014).

All of the above mentioned types of online services are potential sources of altmetric events, and aggregators of altmetrics already monitor many of them. To fully understand the meaning of altmetrics, more research on users and their motivations to interact with research products in these contexts is needed.

3. Measuring influence in social media

Social media analytics typically refer to a wide range of indicators and social media metrics that are analyzed to measure, for example, the reach and influence of marketing campaigns. In the context of analyzing the performance of marketing campaigns, these indicators are referred to as Key Performance Indicators (KPIs). KPIs are very similar to those used to evaluate impact of scientific outputs, as both measure level of engagement, influence or impact. Various KPIs (such as page views, tweets, retweets, likes, etc.) are usually grouped together based on what they reveal about consumer behavior and potential consumers interaction with the brand, product, or the company. Murdough (2009) grouped the KPIs into reach (number of mentions in general), discussions (online conversations and the sentiment of them), and outcomes (measures of engagement). Hoffman and Fodor (2010) took a similar approach and grouped the KPIs into

awareness (including page views, unique visitors, tweets, followers, and reviews), engagement (including number of members, comments, replies, likes, subscribers, and active users), and word-of-mouth, which refers to how consumers are communicating about the product or the brand to other consumers (including number of retweets, incoming hyperlinks, bookmarks, etc.). All of these approaches roughly group various indicators based on the level of engagement or influence they are capable of indicating.

Different altmetric events are also being grouped together by the different aggregators and service providers. On Impactstory (https://impactstory.org/) the altmetric events are labeled according to the activity they represent; viewed, saved, discussed, recommended, and cited. These are then further divided between those that are most likely created by scholars and those that are most likely being created by the public. For instance, while citations and bookmarks on Mendeley are assumed to be made by scholars, views on Slideshare and tweets on Twitter are assumed to be made by both the public and scholars interacting with the research products—there is no evidence available suggesting that these tools are used only by scholars. At the time of writing, PlumAnalytics (http://www.plumanalytics.com/) collects metrics from over 30 different sources and the different metrics are grouped into usage (e.g., clicks, downloads, views), captures (e.g., bookmarks, favorites, readers), mentions (e.g., blog posts, comments, reviews, and Wikipedia links), social media (e.g., likes, shares, and tweets), and citations (collected from e.g. PubMed Central, Scopus and patents). PLoS (http://article-level-metrics.plos.org/alm-info/) has a similar approach and groups the altmetric events that they track into viewed (page views and pdf downloads of the article from PLoS, and views of connected datasets on Figshare), saved (Mendeley and CiteULike), discussed (e.g., Twitter, Facebook, Wikipedia, Reddit, and blogs), recommended (at F1000Prime), and cited (e.g., Scopus, Web of Science, and Google Scholar). Lin and Fenner (2013a; 2013b) suggest that the approach taken by PLoS reflects engagement from different audiences and different purposes for that engagement. For instance, while the majority of page views come quickly after the publication of an article and may be due to a substantial volume of interactions by the interested public, later interactions reflect a deeper level of engagement (and of impact) and come from a more narrow audience, possibly consisting mainly of scholars.

4. Levels of impact

Different altmetric events may contain information about different levels of impact. Events such as a simple page view, a click on a “Tweet this”-button next to an article, or simply sharing an article on Facebook without commenting on it do not reveal much about article influence, they instead simply record the event of a person sharing the information; this does not record whether the person (or bot) has read or utilized the article in some way, it merely indicates that it has been seen. These events indicating awareness, such as the example mentioned above, do not allow for scholars to uncover whether the research product has influenced the viewer in any way, whether they have changed their behavior in some ways after viewing the product, or whether the research product has had any impact. Some other altmetric events can reveal a certain level of impact or engagement, such as measuring downloads, bookmarks, or comments, as they can suggest that the research product has had some impact, but not how profound that impact has been. Other metrics can contain more information about impact or engagement

including blog entries, news articles, and tweets, as they may contain commentaries about the perceived value of the article and therefore provide an indication of the impact the research product. This kind of information is usually qualitative and thus more difficult to process on a large scale. Because of this difficulty and the vast amount of data being collected, counts of mention events are typically used in altmetrics (as is also the case with citations). More research into these (and other) altmetric events is needed in order to measure and theorize about the kind of impact research products are having both on scholars and the public.

By conducting more qualitative research about altmetric events we can gain a better understanding of the meaning of different altmetrics. When we are able to better understand different altmetric events, we will be able to better aggregate the events into categories based on the level of impact or level of engagement they demonstrate. Haustein, Bowman, and Costas (in press) present a framework that categorizes the interactions with research products based on the level of impact they represent. The categories–access, appraise, and apply—reflect the activities people can have with research products, and thus the level of impact they demonstrate. *Access* refers to the metrics derived from events corresponding to awareness of particular research products. *Appraise* refers to events related to mentions, recommendations, and the sharing of research products and indicate a somewhat higher level of engagement and impact. *Apply* is defined as "a*ctively using significant parts of, adapting, or transforming the research object*" (Haustein, Bowman & Costas, in press), indicating some clear signals of a high level of impact.

5. The impact spectrum

As reviewed above, different altmetric measures are generated from different types of events, thus representing various levels of engagement with, or impact of, research products. Aggregators of altmetrics categorize different altmetric events into groups that roughly reflect these activities, but there are no current standards regarding the categorization of these events; each altmetrics aggregator varies their categorization of the events making comparisons between different aggregators difficult. Building on the current understanding of how altmetric events are created as a by-product of interactions with research products, a simple categorization (as presented in Table 1) can be deducted from the available information based on the level of engagement or level of impact.

This classification reflects the average level of impact that is possible to extract from the available data. On average, tweets (for instance) do not contain clear indications of level of impact or how the mentioned research products have influenced someone. Tweets and other indicators of low engagement are only able to reflect awareness or online visibility. Other indicators reflect an increased level of engagement, influence, and impact. These can contain more qualitative information about the interaction or reflect actions that have required more effort than simply clicking on a button to semi-automatically send a tweet. Indicators that come attached with an increased level of information can provide a more complete image of the engagement and the impact a research product has had. The classification presented in Table 1 emphasizes that different altmetric events cannot be aggregated into a single value, as they represent the different levels of impact and different levels of influence the research products have had on different audiences.

Table 1. The impact spectrum

	Altmetrics			Bibliometrics
Level of impact	Low	Medium	High	Assumed to be high
Level of reach	Usually high	Medium	Usually low	Usually low
Example activities	Awareness, visibility	Influence, interactions, sharing	Usage	Usage
Example metrics	Tweets, retweets, likes, shares, …	Mentions, downloads, bookmarks, …	Blog posts, blog citations, conversations, …	Citations

In addition to impact the altmetric events can also demonstrate aspects of reach, including information about the number of people that had the possibility of viewing the communications and how wide the information has been disseminated. Reach, although related to impact, does not reveal anything specifically about impact; it instead indicates only how many potential views the message has received. Yet there appears to be some connection between reach and impact; on average when impact is low reach is high, and vice versa.

6. Conclusions

One main problem facing scholars is that it is difficult to identify who (or what) is interacting with the research products and thus creating the altmetric events. Citations are currently the only events where one can be certain that other scholars create them. The results from earlier studies emphasize the need to develop standards for interpreting and categorizing altmetric events or, at minimum, an agreed set of concepts of practice regarding how altmetric events are measured and aggregated. In addition, both quantitative and qualitative methods are needed to confirm what level of impact different types of events in different social media reflect and how they relate to each other. Only through more research can we fully understand the meaning and utilize the full potential of altmetrics.

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