

Postprint: Social Media Event Analysis in Altmetrics

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Abstract

[Purpose/Significance] To clarify the connotation and significance of behaviors such as attention, dissemination, and utilization of scholarly outputs in social media, and to conduct an in-depth analysis of currently used and potentially available altmetrics indicators.

[Method/Process] From an event ontology perspective, we abstract behaviors related to scholarly outputs in social media and construct a social media event model based on the event's subject, object, output, type, motivation, time, location, and source. Using Mendeley and Twitter as examples, we conduct an in-depth analysis of social media events.

[Results/Conclusions] Currently, indicators provided by altmetrics aggregators are derived only from partial events on social media. Through analyzing social media events and their constituent elements, we find that future frameworks should incorporate additional indicators with academic evaluation value, such as the number of Mendeley discussion groups a document is added to and tweet likes. In utilizing these indicators, it is necessary to evaluate the applicability of each indicator in different academic evaluation contexts based on the various elements of events, while also considering data collection methods, frequency, and constraints to ensure the accuracy and scientific rigor of indicator values.

Full Text

Preamble

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Analysis of Social Media Events in Altmetrics

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Abstract

[Purpose/Significance] To clarify the connotation and significance of academic achievements being noticed, disseminated, and utilized on social media, this paper conducts an in-depth analysis of altmetrics indicators that have been used and can be mined. **[Method/Process]** From the perspective of event ontology, this study abstracts behaviors related to academic achievements on social media and constructs a social media event model based on the event's subject, object, output, type, motivation, time, place, and source. Using Mendeley and Twitter as examples, the study carries out a deep analysis of social media events. **[Result/Conclusion]** Current altmetrics aggregators only provide indicators from partial events on social media. Through analyzing social media events and their elements, the study finds that other indicators with academic evaluation value should be incorporated in the future, such as the number of Mendeley discussion groups a document is added to, the number of likes on tweets, etc. When utilizing these indicators, it is necessary to evaluate the applicability of each indicator in different academic evaluation contexts based on the various elements of events, while also considering data collection methods, frequency, and limitations to ensure the accuracy and scientificity of indicator values.

Classification Number: G253

Keywords: Academic evaluation; Altmetrics; Social media; Events

1. Introduction

Academic evaluation refers to the value judgment of academic activities and their achievements [1]. Through academic evaluation, the influence of evaluation objects can be measured to inform decisions on promotion, research funding allocation, and other matters, thereby promoting academic development. Currently, the methodological system for academic evaluation continues to develop and improve, with new indicators for quantitative evaluation constantly emerging. Altmetrics is an evaluation method that has emerged in the Web 2.0 environment, with its indicators primarily derived from social media data, providing a new perspective for measuring the influence of academic achievements. Since its formal proposal in 2010, discussions on whether and how altmetrics can be applied to academic evaluation have continued. Some studies analyze numerical aspects, such as literature coverage on social media [2] and correlations between altmetrics indicators and citations [3], to explore the usability of altmetrics. Other studies examine user preferences for achievements in different fields to discuss the data value of altmetrics [4]. Although current research continues to advance the theoretical and practical development of altmetrics, how to scientifically and rationally apply it in academic evaluation remains worthy of further exploration.

Compared with altmetrics, citation theory and methods are relatively mature. The fundamental reason why citations occupy a place in current academic eval-

uation is that the essence of citation behavior lies in the recognition of the value of an academic achievement, which is reflected in the citer's identity, motivation, and the contextual situation of the citation. To determine the utilization value of citation data, many scholars have classified and summarized citation motivations. Wang Wenjuan et al. [5] divided citation motivations into "fair," "neutral," and "unfair" categories. Fair motivations include enhancing literature authority and strengthening persuasiveness to readers; neutral motivations include self-citation and citing important peers; unfair motivations include citing due to self-interest, political factors, or internal disputes. Some studies decompose citation events, primarily analyzing citation position and citation text in depth. B.C. Peritz [6] analyzed the correlation between citations appearing in the introduction, methods, results, discussion, conclusion, and appendix sections of different journals and their citation functions, finding that the correlation between citation position and function varies across journals but is generally low, indicating that whether citation position can represent citation function requires further discussion. To explore the emotion, motivation, and distribution of citation behavior, S. Teufel et al. [7] used natural language recognition technology to classify citation text sentiment, building a system for automatically identifying citation functions that categorizes them into four types: pointing out shortcomings, comparison, continuation, and neutrality.

Similar to citations, research on altmetrics should not remain at the surface level of indicator values but should reconstruct the context from which indicator values are generated and continuously change, exploring whether the associated subjects, objects, operations, and behaviors have academic evaluation value. Some studies have explored the behaviors and motivations that generate altmetrics indicators. To discuss the traces these behaviors leave online, the 2014 PLOS ALM Workshop agreed on a series of generic terms including research objects, events, sources, and consumers [8]. To better understand heterogeneous online behaviors, R. Costas et al. [9] argued that altmetrics indicators mainly include three elements: events, agents, and interaction methods, extending co-citation and bibliographic coupling from citation analysis to altmetrics to construct a citation framework for social media events. In 2016, S. Haustein et al. [10] classified online behaviors related to research objects into access, appraisal, and application, introducing relevant theories to discuss the behavioral motivations of different event types. Additionally, S. Haustein et al. [11] noted that motivations for the same altmetrics indicator may also differ; for example, Twitter mention counts may consist of author self-promotion, approval, or criticism of literature, while Mendeley reader counts may represent either quick reading or careful reading. M. Thelwall et al. [12] found that few tweets explicitly praise or criticize an article, and tweets themselves rarely provide in-depth evaluation of literature.

Exploring the application of altmetrics in academic evaluation requires not only measuring the influence reflected by event types but also further decomposing events to analyze the matching degree between event components and evaluation. Some studies, although not explicitly proposing or using the concept

of events, essentially analyze the constituent factors of events associated with altmetrics. Among these, user-related research is more common. Some studies explore the platform preferences of users from different professions. Z. Zahedi et al. [4] noted that F1000's main users are expert faculty in specific fields, while Mendeley's main users are young scholars or students. Some studies examine how users from different professions favor different academic achievements. L. Bornmann et al. [13] used Mendeley's user profession information and F1000's literature tags to explore this, finding that Mendeley users are not very interested in papers labeled "confirmation" or "interesting hypothesis" in F1000 but are very interested in papers labeled "good for teaching." Postdocs, PhD students, and professors show significant differences in their interest levels in papers labeled "new finding," indicating that papers with this label have a greater impact on altmetrics values.

Although current research has gradually begun to explore altmetrics from an event perspective, and citation event research can serve as a foundation, altmetrics events are more diverse, complex, and ambiguous than citation events. Related events include reading, bookmarking, downloading, commenting, forwarding, etc. Event objects may include papers, books, software, patents, presentations, etc. Event subjects are not only scholars capable of publishing academic achievements but also research institutions, universities, and the general public. The diversity of subjects and objects determines the complexity of event motivations. In current research or applications, often only certain indicator values provided by aggregators are directly utilized, while the generation process of these values remains a black box, making their utilization somewhat "blind" to a certain extent. Moreover, the range of usable altmetrics indicators is limited by the functionality of current commercial aggregators. While these indicators are considered to have the most academic evaluation value, they are also constrained by data availability and technical capabilities.

Social media is the primary source of altmetrics indicators. Therefore, this paper focuses on constructing an analytical framework for social media events. Since Mendeley and Twitter have the highest altmetrics coverage [14] and are considered the most promising platforms for indicator data sources [15], this paper uses these two platforms as examples to 梳理 various events related to academic achievements, analyzing each event's subject, object, type, motivation, and output to determine which events can serve as data sources for academic evaluation and whether biases exist in capturing these events, thereby providing support for the application of altmetrics in academic evaluation.

2. Social Media Event Model

To fully reconstruct event contexts, existing event ontologies can be reused when analyzing social media events related to academic achievements, such as the event ontology proposed by University College London, which includes six elements: event/sub-event, agent, factor, output, space, and time [16]. Combining the characteristics of altmetrics, this paper constructs a social media event

model with elements including subject, object, output, type, motivation, time, place, and source, as shown in Figure 1 [Figure 1: see original paper].

Subject refers to the agent interacting through social media, such as Twitter users or Mendeley users. The actor performing the behavior is the core of event motivation. Ideally, if we could record his/her attitude toward the academic achievement when performing an operation, this could be combined with evaluation scenarios in academic evaluation. However, this is often difficult to achieve in reality, so we need to obtain as many subject attributes as possible, such as identity, discipline, and region, to judge their motivations and attitudes.

Object refers to the academic object, including papers, books, patents, and other academic achievements. Compared with citations, academic achievements involved in social media are more diverse, especially including a large number of informally published achievements, whose value in academic evaluation should be fully considered.

Output refers to the result or product after an event occurs, including direct and indirect outputs. The direct output of citation behavior is citation text, from which citation counts can be derived, leading to the h-index, journal impact factor, etc. Similarly, the output of social media events includes both the direct presentation results of an operation, such as a tweet mentioning an academic achievement, and altmetrics indicators extracted and integrated by social media APIs or aggregators, such as mention counts. It should be noted that not all outputs of social media events can be captured, sometimes due to permission issues, and because different platform APIs have different update times and frequencies, the outputs obtained may have certain lags.

Type refers to the interaction type between the agent and the academic object. Due to the variety of social media platforms with different positioning and functions, social media event types are more diverse than citation events. From an academic evaluation perspective, events can be classified according to the motivation and level of subject's utilization of the academic object: 1) **Access**: behaviors that access or utilize academic objects or show interest in them, such as viewing or downloading documents; 2) **Appraisal**: expressing attitudes toward academic objects through ranking, voting, mentioning, etc. on social media; 3) **Apply**: the deepest level of utilization of academic objects, creating new achievements based on existing theories, methods, and conclusions, such as in-depth discussions of an article, using article content in presentations, and expanding research collaboration networks [10].

Motivation is the psychological tendency or internal drive for a subject to perform a behavior, i.e., why the subject performs an operation on an object and whether it is related to academic evaluation goals. Only by fully understanding the motivations behind different social media events can we reach the essence of altmetrics indicators and explore their application in academic evaluation.

Time refers to various times related to events, including both the time when the event occurs and the times involved in the event's subject and object. In citation

analysis, the publication time (online and formal publication) and citation time of academic achievements are involved, with time granularity mostly at the year, month, and day level. In social media events, time factors are more complex, with social media responding to academic achievements more quickly, and time granularity can reach hours, minutes, or even seconds.

Place refers to the space involved in the event and related elements, such as the countries and institutions of the event's subject and object, and the location information of the event source platform. Geographic differences help deeply understand the reasons and background of event occurrence.

Source refers to the platform where social media events occur, such as Twitter, Facebook, and Mendeley. Different platforms have different functions and audiences, and the data that can be obtained also differ.

The above analysis model is an abstraction of social media events from an academic evaluation perspective. The characteristics of each element in the model may affect the value and application method of the event in academic evaluation. In subsequent research, this model can be used to instantiate various social media events for in-depth discussion and judgment of whether and how these events can be applied in academic evaluation.

3. Social Media Event Analysis

Among numerous altmetrics indicators, the academic social network platform Mendeley and the public social network platform Twitter are two important and representative sources. Many scholars have discussed and analyzed the altmetrics indicator values generated by these two platforms, with the main conclusion being that they have certain correlations with citation counts. However, existing research mainly analyzes Mendeley and Twitter from the numerical level without delving into the essence of events. Therefore, this paper uses these two platforms as examples to apply the social media event model for in-depth analysis.

3.1 Mendeley

Currently, Mendeley has 30 million literature records and over 6 million users, making it a popular social media platform in academic circles. The feasibility of applying Mendeley to academic evaluation mainly comes from its user group and functional positioning. Users can search for, save, and tag literature, share literature in discussion groups, and connect with peers. These events reflect users' interest in, recognition of, or application of academic achievements. This section mainly analyzes three types of events: saving, tagging, and joining discussion groups, exploring the connotation of events at the micro level and judging the academic evaluation application value of these events.

Saving Event in Mendeley refers to users adding an academic document to their library, which is used by aggregators such as Altmetric.com and Lagotto

to construct the indicator $reader_count$, indicating how many users have read the document. Based on the proposed social media event model, the saving event is analyzed (see Table 1), evaluating the academic evaluation application value of the event based on each element and reflecting on the current interpretation and utilization of the $reader_count$ indicator by altmetrics.

- (1) **Subject:** Mendeley registered users are the performers of saving events. Their purpose for saving documents in their library truly reflects the academic value of the literature. When the purpose cannot be precisely identified, user profiles become important reference information. New registered users must select their position (professor, associate professor, lecturer, librarian, undergraduate, master's student, PhD student, postdoc, etc.), discipline/sub-discipline (27 options including arts and humanities, computer science, design, economics, etc.), and optionally fill in country information from lists provided by Mendeley. These options ensure that Mendeley's user base basically belongs to academic circles, and their behavioral motivations inevitably have academic characteristics.
- (2) **Object:** Refers to literature added to Mendeley by users. Due to different literature sources, there may be different unique identifiers, including arXiv ID, DOI, ISBN, ISSN, PMID, Scopus ID, etc.
- (3) **Type:** Users' saving operation on literature belongs to a relatively shallow level of utilization, i.e., the access type.
- (4) **Output:** One saving operation on a document indicates a potential new reader of that document. The Mendeley API provides the number of times a document has been saved for each document, and can also count by user's profession, discipline, and country/region. It should be noted that since multiple users may add the same document to Mendeley at different times, saving operations on the same document are actually dispersed and need to be aggregated. However, not all documents have identifiers such as DOI, arXiv ID, or PMID. Therefore, Mendeley does not use unique identifiers as the aggregation basis but instead clusters documents with the same title, author, and publication year into the same literature cluster, identifying them as the same document.
- (5) **Motivation:** Why users save certain academic documents. Some scholars have investigated Mendeley users' saving motivations through questionnaires (see Table 1), which can serve as a basis for evaluating their academic value.
- (6) **Place:** The location where the saving event occurs can characterize the geographical scope of the document's dissemination impact, which can be extracted from user profiles.
- (7) **Time:** The time when users add documents to their Mendeley library can be accurate to the minute.

In addition to saving events, Mendeley events where users tag literature and add

literature to discussion groups also have academic evaluation application value. These events mainly differ from saving events in type, output, and motivation, as shown in Table 2 .

Although the outputs of the above three events can be obtained through the Mendeley API, there is a lag between the data obtained and the actual occurrence of events. To handle uploads of the same document by different users at different times in different forms, Mendeley performs a batch aggregation process approximately every month to aggregate indicator values for the same document. Between two batch aggregation processes, for documents newly added to a user's library, if the document has identical metadata records in the original literature cluster, the document's indicator value will increase in real time. However, if the document is being added to Mendeley for the first time, its indicator value will be zero until the next batch aggregation process. When a user deletes their account and all their documents, that user will still be counted in the document's readership until the next re-aggregation [19].

3.2 Twitter

As of March 2018, Twitter had 336 million active users, posting approximately 340 million tweets daily. Twitter's main functions include posting and reading tweets. When posting tweets, users can enrich content by adding hashtags, URLs, and @-mentioning others. When reading tweets, users can retweet, like, and comment on tweets of interest. Based on Twitter's functions, events related to academic achievements on Twitter mainly include: posting tweets, retweeting, adding hashtags to tweets, liking tweets, following tweet authors, replying to tweets, and @-mentioning others when posting tweets. The relevant elements of the tweet posting event on Twitter are shown in Table 3 .

- (1) **Subject:** Twitter registered users are tweet authors. Country/region and profession/identity help understand the background and purpose of users posting tweets. This information can be extracted from user profiles. For example, Altmetric.com refines profession/identity information into categories such as the general public, scientists, science communicators (journalists, bloggers, editors), and practitioners (doctors, other healthcare professionals).
- (2) **Object:** Refers to academic objects mentioned in tweets. The method for identifying literature on Twitter is to determine whether there is a direct link to the unique identifier of the literature in the tweet, currently mainly based on the DOI of the literature. However, different aggregators have different algorithms and perform different degrees of tweet cleaning. For example, CED (Crossref Event Data) uses DOIs issued by Crossref or DataCite to identify literature. If a document's DOI does not fall into this category, the document cannot be identified.
- (3) **Type:** When users post tweets about a document, they express some attitude toward the document, and the tweet may also trigger in-depth

discussion. Therefore, this event can be classified as appraisal or application type.

- (4) **Output:** The direct output of posting a tweet event is a tweet. Twitter tweets originally contained a maximum of 140 characters, which was increased to 280 characters in November 2017 (except for Chinese, Japanese, and Korean). This can be directly obtained through the Twitter API. The indirect output is an additional tweet mention count for that document. Current aggregators mainly determine whether a document is mentioned through the URL pointing to the unique identifier in the tweet.
- (5) **Motivation:** Why users mention certain academic documents in tweets has been studied by some scholars, as shown in Table 3.
- (6) **Place:** Reflects the geographical scope of the tweet author, which can be extracted from Twitter user profiles.
- (7) **Time:** The time when users post tweets can be accurate to the second.

On Twitter, user retweeting, adding hashtags to tweets, liking tweets, following tweet authors, replying to tweets, and @-mentioning others also have academic evaluation application value. These events mainly differ from the tweet posting event in type, output, and motivation, as shown in Table 4 .

Similar to Mendeley, the output extraction of Twitter-related events is affected by the Twitter API and different aggregator data collection mechanisms, and the output obtained may deviate from and lag behind reality. For example, according to official website introductions, Altmetric.com can provide tweet data after June 2011 and updates in real time; Lagotto provides data after June 2012 and collects every 6 hours; PlumAnalytics provides data after January 1, 2011, and updates in real time.

4. Conclusion and Outlook

Through the 梳理 and analysis of related events, the following main conclusions can be drawn:

- (1) Currently, aggregators and some applications only use indicators generated by partial events on social media, such as *reader_{count}* from saving events in Mendeley and *twitterDOImentions* from Twitter. However, many other social media events also have academic evaluation application value, including marking academic documents as liked and joining discussion groups in Mendeley, and posting tweets mentioning academic achievements, retweeting, adding hashtags, liking tweets, following tweet authors, replying to tweets, and @-mentioning others on Twitter.
- (2) Different social media events have different participating subjects, and the academic achievement influence they reflect varies significantly. For example, Mendeley users are mostly researchers with literature management needs, and indicators generated on this platform tend to reflect the

academic influence of literature. Twitter users have a broader range and tend to reflect the dissemination capacity or social influence of literature among the general public. However, subjects' identities and backgrounds can only roughly reflect their attitudes in events. Only by deeply analyzing subjects' motivations during event occurrence and connecting them with evaluation goals can altmetrics indicators be effectively applied.

- (3) The output of social media events, i.e., the final indicators used for evaluation, has extraction strategies and calculation methods that are crucial for indicator accuracy, scientificity, and timeliness. We should utilize APIs provided by various platforms for data acquisition and construct reasonable indicator calculation models. For example, when calculating altmetrics indicators, various motivations of events generating indicators can be considered. When calculating tweet mention counts, tweets with self-promotion or malicious motivations can be removed, negative evaluations of documents can be assigned negative values, or different attitudes can be given different weights. In practical applications, the extraction of event outputs is affected by technical, ethical, and commercial factors. Therefore, on the one hand, interference from these factors should be minimized, and on the other hand, there should be a clear understanding of output biases and objective treatment in applications.
- (4) The original intention of social media is not to serve academic evaluation but to provide platforms for sharing opinions, insights, experiences, and viewpoints. Therefore, the essence of related events must be analyzed to determine whether they are consistent with academic evaluation goals for rational utilization. Academic evaluation levels include academic achievements, individuals, institutions, and journals, where academic achievements include papers, books, software, and patents. What is measured may be social influence or academic influence. Evaluation goals may include promotion decisions, award acquisition, research funding allocation, institutional evaluation, and discipline rankings. The evaluation scope may be limited to a certain discipline or time period. The complexity of academic evaluation scenarios determines that specific operational contexts vary greatly and cannot be generalized. Therefore, when using altmetrics for evaluation, comprehensive consideration should be given from the characteristics of social media events themselves and their elements. For example, platform selection can be filtered using subject characteristics and their matching degree with evaluation disciplines, and object matching degree with evaluation objects. Then, event types, outputs, and motivations can be combined with evaluation goals, comprehensively considering objective factors such as event time and place, as well as data generation frequency, collection frequency, and accessibility, to make the final indicators used for evaluation more scientific and reasonable. In addition, we find that social media events related to academic achievements share many similarities with traditional citation events, and relevant citation theories and methods can be fully borrowed in altmetrics research.

In future research, besides the social media events analyzed in this paper, we can incorporate direct or indirect outputs from more sources and more events into the academic evaluation system and analyze their applicable scope and degree. However, this paper also has some limitations. The social media event model constructed only reveals the elements associated with events but does not reflect the deeper relationships between elements. Only events from Mendeley and Twitter, which are frequently mentioned in relevant research, are selected for illustration, without 梳理 events from more other platforms, lacking more comprehensive and in-depth comparisons between platforms. Motivation is a key issue in altmetrics research, but this paper only summarizes it through existing research. In the future, we will adopt content analysis and interview surveys to further advance this work.

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Author Contributions

Liu Xiaojuan: Responsible for topic selection, proposing research direction and basic framework, guiding and revising the paper.

Wei Yu: Responsible for writing and revising the paper.

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Analysis of Social Media Events in Altmetrics

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Abstract: [Purpose/significance] In order to clarify the connotation and significance of the attention, dissemination and utilization of academic achievements in social media, to make a deep analysis of the altmetrics indicators that have been used and can be mined. [Method/process] From the perspective of event ontology, the acts related to academic achievements in social media are abstracted. Starting from the subject, object, product, type, motivation, time, place and resource of the event, the event model of social media is constructed. And the deep analysis of social media events is carried out with Mendeley and Twitter as examples. [Result/conclusion] At present, altmetrics aggregators only provide indicators from some social media events. Through the analysis of social media events and their elements, it is found that some other indicators with academic evaluation value should be included in evaluation system in the future, such as Mendeley group_{count}, Twitter favorite_{count} and so on. When using these indicators, it is necessary to evaluate the applicability of indicators in different academic evaluation contexts according to the elements of events. Meanwhile, the methods, frequencies and limitations of data acquisition should be taken into account to ensure the accuracy and scientificity of the indicators.

Keywords: academic evaluation; altmetrics; social media; events

Note: Figure translations are in progress. See original paper for figures.

Source: ChinaXiv — Machine translation. Verify with original.