Using Altmetric Data Responsibly

A Guide to Interpretation and Good Practice

Guide Authors

Rachel Miles, MLS
Virginia Tech

Robyn Price
Imperial College London

Additional Contributors

Rebecca Welzenbach, MLIS[1]
University of Michigan

Carola Blackwood and the Product Team at Digital Science[2]
Digital Science

Peer Reviewers

Timothy Bowman, PhD
Dominican University

Kim Holmberg, PhD
University of Turku

Nicolas Robinson Garcia, PhD
Universidad de Granada

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[1] *One additional contributor was initially involved with the project in its first few months and drafted the two introductory sections: Introduction to Altmetric and the Altmetric Attention Score, and Output Types Tracked by Altmetric. CRediT Role: Conceptualization*

[2] *Carola Blackwood and her team provided valuable comments and feedback on the guide. In addition, Digital Science provided the data from Altmetric Explorer and Dimensions Analytics via the Virginia Tech institutional subscription. CRediT Role: Resources*

Introduction to the Guide

Intended users / audience

This guide is intended for use by librarians, practitioners, funders, and other users of *Altmetric data* or those who are interested in incorporating altmetrics into their bibliometric practice and/or research analytics. It can also help researchers who are going up for annual evaluations and promotion and tenure, who can use the data in an informed and practical application of the data on their evaluations and portfolios. It can also be a useful reference guide for research managers and university administrators who want to understand the broader online engagement with research publications beyond traditional scholarly citations, or citations that occur between two academic outputs, usually in formal publications (e.g., books, journal articles, book chapters) but who also want to avoid misusing, misinterpreting, or abusing Altmetric data when making decisions, creating policies, and evaluating faculty members and researchers at their institutions.

Altmetrics defined

The term "altmetrics," coined in a 2010 tweet / X post by Jason Priem and used later that year in "altmetrics: a manifesto," is defined as "the creation and study of new metrics based on the social web for analyzing, and informing scholarship" (Jason Priem [@jasonpriem], 2010; Priem et al., 2010).

It's easy to assume that altmetrics are all about social media (people tend to think of X (formerly known as Twitter) in particular), but that is only part of what they offer. By tracking links from all kinds of websites back to scholarly research, alternative metrics, or "altmetrics," can reveal references to and engagement with scholarship in the news, policy documents, syllabi, scholarly blogs, and beyond.

Intended purpose of this guide

This guide is primarily intended to help users interpret and interact with Altmetric data in an informed and practical manner. This guide focuses specifically on data produced by the company, Altmetric, not to be confused with the broader research field of altmetrics (defined in the previous subsection). However, there are some pointers in the guide to seek out other sources of altmetrics data, such as mentions to research outputs on course syllabi on Open Syllabus, which now has its own database and no longer provides a source of data or API to Altmetric. Another example is policy document mentions, which have better coverage on the policy citation database, Overton, which is discussed in the public policy section.

This guide was created in the spirit of two previous guides written about the responsible use and practical application of metrics produced by two research analytic tools by two companies: Elsevier, which owns SciVal, and Clarivate Analytics, which owns InCites. Therefore, this guide primarily focuses on the data from one company, Altmetric, which has a subscription database and analytic tool, Altmetric Explorer, as well as a number of free tools and badges incorporated

on institutional repositories and publisher sites. Consumers of research articles are likely to have seen or even recognize the Altmetric Donut (see next section), even if they are not familiar with the company Altmetrics or the concept and field of altmetrics. Therefore, the authors of this guide hope that novice users who are curious about the meaning behind the Altmetric Donut, the badge, the Altmetric Attention Score, or altmetrics more generally may search for answers, find the guide, and have a better understanding of the data. The primary and first author of this guide, Rachel Miles, hopes to create more guides focused on altmetrics data from other companies. This is the first of such guides, and because it is the most popular source of altmetrics data (used by many publishers and institutions); there is currently more research on Altmetric data than other companies' altmetrics data. It is also the only company that currently offers a subscription to an altmetrics database, Altmetric Explorer; Plum Analytics (known as PlumX) used to offer subscriptions to its competing database, but Elsevier discontinued the database a few years ago. PlumX still offers integration of the PlumX widgets on its platforms, such as Scopus, Digital Commons, Pure, SSRN, and Mendeley as well as free widget integration on non-commercial Open Access journals and regional repositories.

This guide is also intended to help with responsible research evaluation and analytics, which is a topic that has launched many important initiatives that are mainly focused on the use of bibliometric data, such as the Declaration on Research Assessment (DORA), the Leiden Manifesto, The Metric Tide, revisited, the SCOPE Framework, and many others. In other words, an informed approach to Altmetric data, and altmetrics more broadly, can and should lead to a more responsible use of altmetrics, such as when incorporating such metrics in decision-making and strategic planning in universities and research institutions, tenure and promotion decisions, faculty and research staff evaluations (e.g., annual evaluations, faculty activity reports, researcher reports submitted to the Research Excellence Framework in the United Kingdom), as well as to avoid questionable incentive practices for more science communication and social media presence (e.g., X/Twitter posts earning clout or rewards in a department, which can indeed lead to many X posts and reposts but not necessarily advance science communication to the public). Librarians and practitioners presenting Altmetric data and/or reports to research administrators and leaders can use the guide to better frame their analytics, interpretations, and caveats to the data. Researchers undergoing reviews, promotion and tenure decisions, and hiring decisions can use the data to support their influence, engagement, or impact beyond academia (e.g., public policy documents, patents, YouTube) or even within academia in more informal communication circles (e.g., academic blogs, X/Twitter, post-publication peer review platforms) but should take care to interpret attention sources and their context, such as the qualitative assessment of a public policy document mention and how it could or even did lead to real policy change or real world impact.

Altmetric and the Altmetric Attention Score

Altmetric.com (or Altmetric) is a tool created by the company Digital Science that searches the web for "mentions" of research outputs, such as journal articles or book chapters, to show how readers are engaging with scholarly publications online. Mentions can appear in social media, scholarly blogs, news outlets, Wikipedia, citation managers like Mendeley, etc. You may have seen Altmetric donuts, badges, and scores embedded into articles on publisher websites or repositories as well as the 'freemium' Altmetric Details Page, available as a free browser bookmark, or the subscriber-only Altmetric Explorer.

The color-coded Altmetric "donut" shows the Altmetric score of attention surrounded by colorful bands. Each stripe of color on the donut represents a different type of engagement. For example, light blue indicates X/Twitter, red indicates news, and yellow indicates blogs. If you hover over the donut, you'll see an abbreviated summary of engagement with the work.

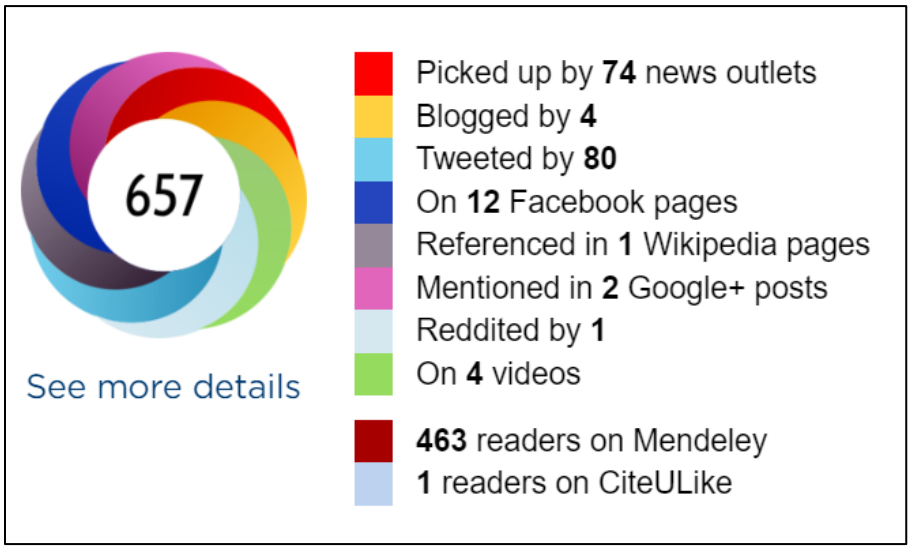


Figure 1. Screen capture of an Altmetric Attention Score (AAS) donut with attention summary. Screenshot taken October 11, 2023, from https://www.thepermanentejournal.org/doi/10.7812/TPP/13-098. Please note that the AAS details on publishers' sites still refer to 'X posts' as tweets, but Altmetric pages refer to them as 'X posts' on the Altmetrics Details Page, such as this one: https://permanente.altmetric.com/details/2252545/twitter

You can click on the donut to view the details page for that item and dig deeper into each instance of engagement. For some types of engagement, such as X, there are also visualizations to show where in the world people are talking about this work.

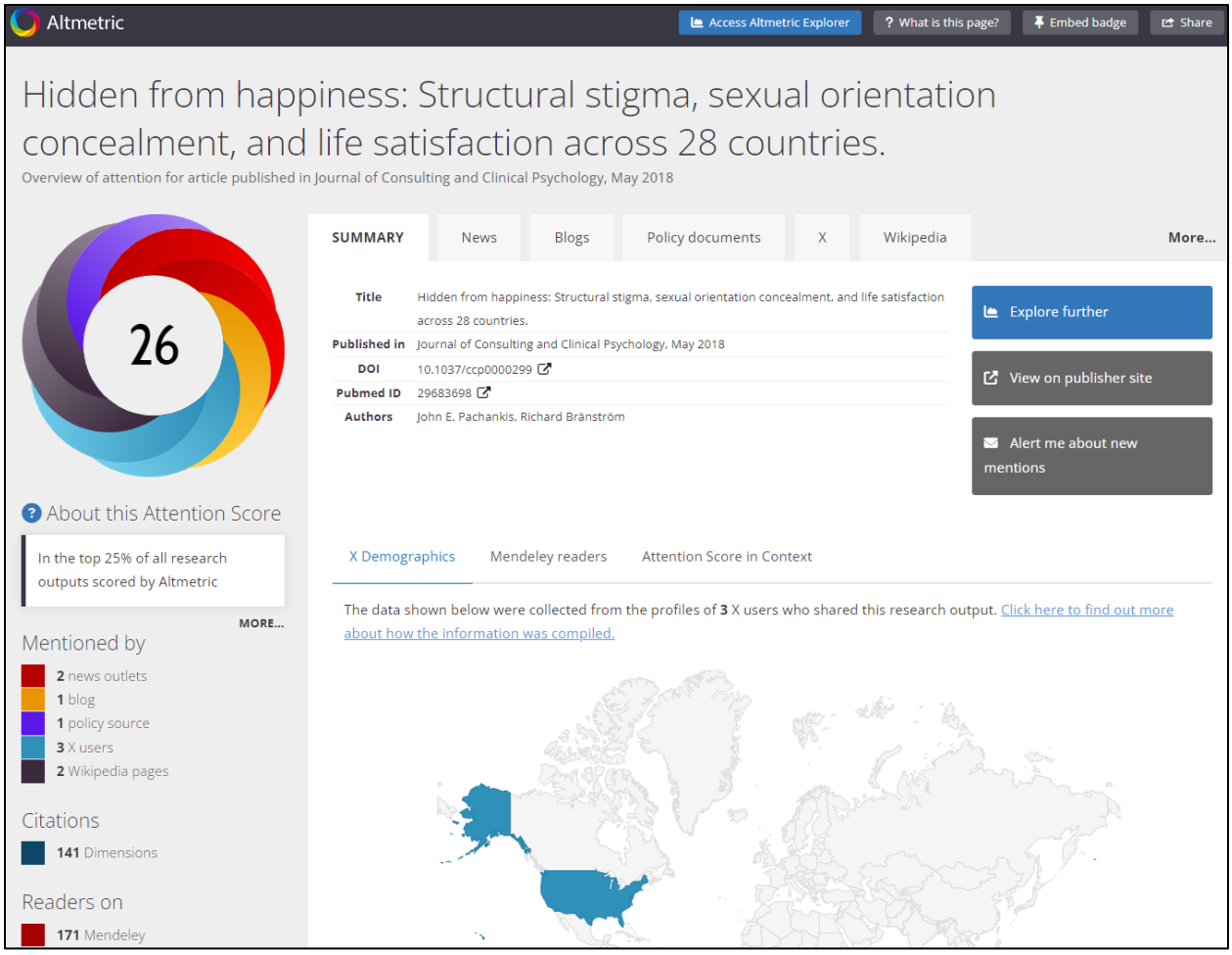


Figure 2. Screen capture of an Altmetric Details Page captured October 11, 2023. See the details page at https://www.altmetric.com/details/58026268

The Altmetric Attention Score (AAS) is a proprietary metric generated by Altmetric by both counting and weighing the value of different types of mentions. For example, Altmetric's formula gives a mention in the news eight times the weight of a post on X. While the most valuable information that Altmetric can provide is the qualitative detail about each interaction with the research output, the score of attention attempts to communicate at a glance a sense of the overall level of engagement with the work. Altmetric describes the attention score as an "indicator of engagement." However, it is important to note that there is a strong opposition towards its use for evaluation or monitoring (Gumpenberger et al., 2016).

Altmetric Attention Score Weighting

The default weighting of the AAS is not reproducible, because Altmetric uses an algorithm to calculate its weighting based on several factors. However, the weighting below represents the *typical* contribution to the score from each source. For example, if a research output receives attention from two news sources (not two articles, but two *sources*, such as the New York Times and The Washington Post), then each source will contribute to the score.

Attention source	Typical contribution to the AAS
News	8
Blog	5
Policy document (per source)	3
Patent	3
Wikipedia	3
Peer review (Publons, Pubpeer)	1
Weibo (not trackable since 2015, but historical data kept)	1
Google+ (not trackable since 2019, but historical data kept)	1
Faculty Opinions (formerly F1000Prime)	1
Syllabi (Open Syllabus)	1
LinkedIn (not trackable since 2014, but historical data kept)	0.5
X (posts and reposts)	0.25
Facebook (only a curated list of public Pages)	0.25
Reddit	0.25
Pinterest (not trackable since 2013, but historical data kept)	0.25
Q&A (Stack Exchange)	0.25
YouTube	0.25
Number of Mendeley readers	0
Number of Dimensions and Web of Science citations	0

Table 1. Altmetric Attention Score (AAS) weighting.

Source: https://help.altmetric.com/support/solutions/articles/6000233311-how-is-the-altmetric-attention-score-calculated-

The Altmetric Attention Score (AAS) will always round to a whole number, so if it receives 0.25 from a post, for example, it will round up to 1 and round up to 2 when it gets more than four posts. Altmetric notes that the calculation is run by an algorithm that uses other logic for its calculation, so the AAS is not reproducible.

The **quantity** and **reach** of the post's source are also crucial to the calculation of the AAS. For example, a mention from a news source will contribute more than a blog, and a blog post will contribute more than a post. In addition, news outlets are assigned a tier based on the reach of the outlet; a mention from a popular news outlet will contribute more to the AAS than a smaller or local publication. The author of the post is also important; for example, Altmetric fetches a Poster's list of followers, list of their past posts, and information about how often their posts were liked and/or reposted to determine the weight of the post or repost to the AAS.

The source of the attention is crucial as well; the same Poster who posts about a research output will contribute the same to the score, no matter how many times they post about the output. The scoring for Wikipedia and Open Syllabus is static, meaning that the contribution of the score will stay the same no matter how many times it is reposted on these sources.

Altmetric can only track attention to publicly available posts, such as news articles and posts. Private forums, listservs, and email groups cannot be tracked. Altmetric can also only track direct attention to the output, i.e., a link or a proper citation to the research output itself, not a secondary citation, such as a mention to a news article that mentions the research output. Without a link, the source must reach Altmetric's text mining criteria (Altmetric, 2020c), e.g., a mention to a research article without a link that simply says 'Smith and colleagues at American University' would not meet the text mining criteria.

For social media mentions, the contribution to the Altmetric Attention Score (AAS) depends on the social media platform, and in the cases of X and Sina Weibo, the reach of the user, the frequency of posting by the user, and the bias towards the journal (e.g., promotional intent). Table 2 shows each platform's contribution to the score (score always rounds up to a whole number) as well as modifiers to the score.

Social Media Weighted Count to the AAS		
Social Media Platform	**Weighted Score**	**Modifiers to the Score**
X/Twitter	1	Reposts count for 0.85 rather than 1, with the total number of the AAS rounding up to the nearest whole number. Other modifiers include: ● the Poster's number of followers (reach) ● the frequency in which the Poster shares research outputs (promiscuity) ● the likelihood of the Poster will promote a specific journal or publisher (bias)
Facebook	0.25	None; the total number of the AAS rounds up to the nearest whole number
Sina Weibo	1	Reposts count for 0.85 rather than 1, with the total number of the AAS rounding up to the nearest whole number.
LinkedIn	0.5	None; the total number of the AAS rounds up to the nearest whole number
Google+	1	None
Pinterest	0.25	None; the total number of the AAS rounds up to the nearest whole number

Table 2. Weighted score and modifiers for social media mentions to the AAS.

Finally, certain sources do not contribute to the AAS:

- Reference managers: Mendeley and CiteULike
- Academic citations from Dimensions and Web of Science
- Only the first mention of a source
    - For example, a news source that publishes multiple stories linking or mentioning a research output will only contribute to the AAS the first time.

Output Types Tracked by Altmetric

Coverage

Altmetric tracks mentions to scholarly outputs provided that they are linked to a document identifier. Indexing is therefore independent of the document type and provides a richer variety of typologies, including journal articles, preprints, datasets, reports or books, as long as they can be uniquely identified by the identifiers listed below in Table 3. Still, despite this range of outputs tracked, Articles represent almost 70% of the total database of tracked research outputs, and over 86% of the total database of outputs with attention. Of the remaining output types in the total database: Book chapters (23%); Books (8%); News (0.1%); Clinical trial studies (0.2%); Datasets (0.1%).

Output type	# research outputs tracked	% research outputs tracked	# outputs with attention	% outputs with attention**
Article*	30,738,899	68.8%	21,229,017	69.1%
Book chapter	10,489,335	22.7%	334,317	3.2%
Book	3,295,172	7.6%	2,637,751	80%
News stories	255,572	0.6%	250,441	98%
Clinical trial records	91,274	0.2%	85,157	93.3%
Datasets	59,257	0.01%	47,809	80.7%
TOTAL	**44,929,509**	**100%**	**24,584,492**	**54.7%**

Table 3. Research output types tracked by Altmetric with number of research outputs tracked and number of research outputs with attention (data retrieved from Altmetric Explorer on October 9, 2023).

**Article type include preprints, journal articles, books, and reports*

***This percentage represents the percent of outputs with attention from that output type. For example, 21.2 million articles have attention out of 30.7 million, which means that 69.1% of articles tracked have been mentioned by an attention source at least once.*

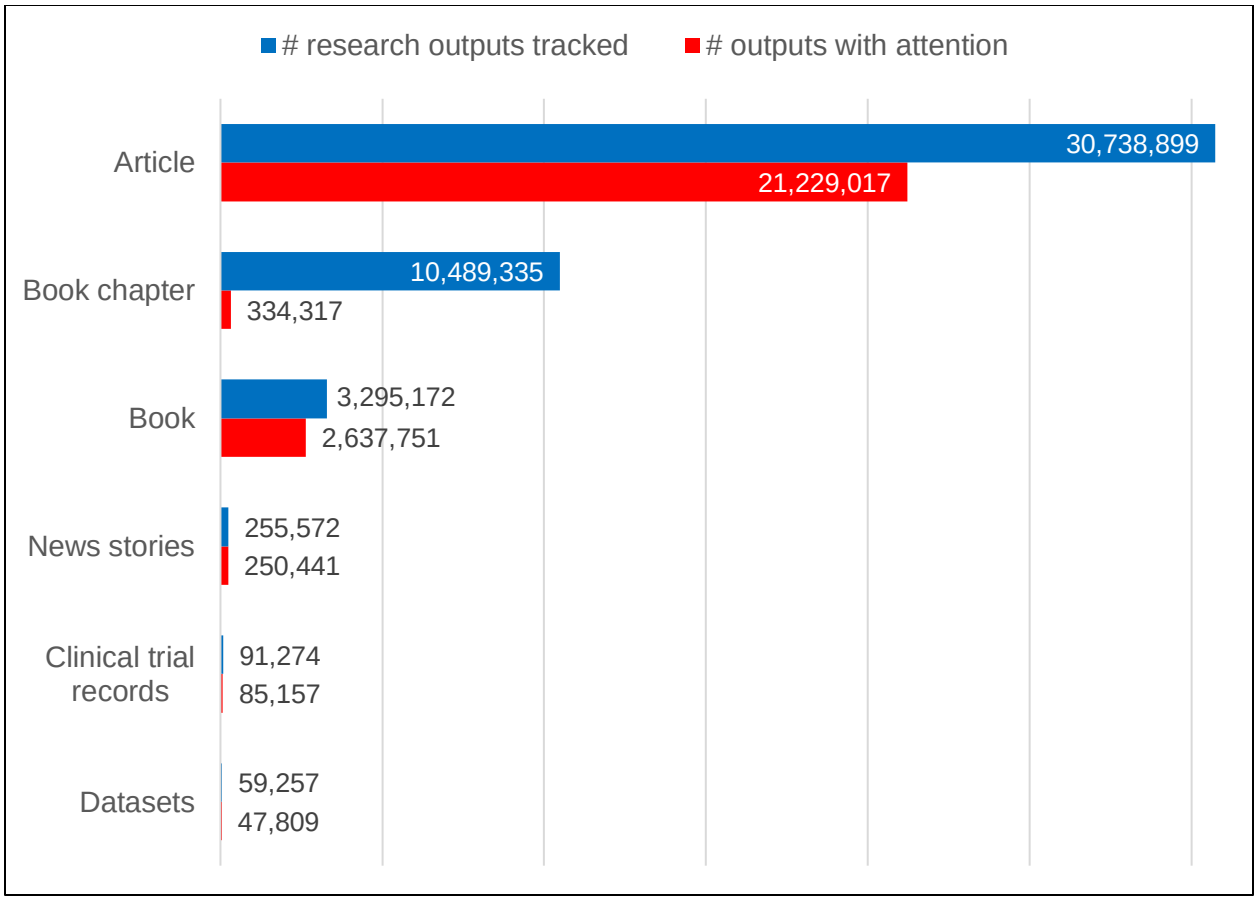


Figure 3. Research output types tracked by Altmetric with number of research outputs tracked and number of research outputs with attention (data taken from Altmetric Explorer on 07 September 2022)

Altmetric relies on persistent identifiers to track mentions in social media. While it originally depended solely on Document Object Identifiers (DOI) and journal website URLs, it has expanded the number of identifiers and currently includes up to 12 different identifiers.

Identifiers	Document types	ID provider
DOI (Document Object Identifier)	Journal articles, datasets, preprints, book chapters	Publishers, repositories (e.g., Zenodo, bioRxiv), data banks (e.g., DataCite, FigShare, Dryad)
arXiv ID	Preprints	ArXiv
PubMed ID / PMC ID	Journal articles and preprints	PubMed, PubMed Central
HANDLE	Preprints and other scholarly works	Institutional repositories
ISBN	Books	ISBN Agency
RePEC ID	Preprints	RePEC
ADS ID	Preprints, PhD theses, datasets	Astrophysics Data System
HLOM ID	Books, journal articles, chapters	Harvard Library's Catalog
HOLLIS ID	Books, journal articles, chapters	Harvard Library's Catalog
NCT ID	Clinical trial studies	National Clinical Trials Network
SSRN ID	Preprints	Social Science Research Network
URI	Any document type without a different identifier	

Table 4. Identifiers used by Altmetric to track mentions

Where a research output exists in multiple versions, e.g. a preprint and published article that are very similar, if Altmetric has found multiple versions with different identifiers it will record them as separate outputs. This is consistent with version control best practice in scholarly communications.

Other sources

As well as the reported reliance on identifiers, Altmetric retrieves data directly from some sources regardless of the document identifier, which includes some publishers. These additional sources are either selected by Altmetric or responses to requests from publishers to index their outputs.

In the case of books and book chapters, the source covering most of them are Springer Nature (>60%) followed by Google Books (>10%). Other publishers included are De Gruyter, Cambridge University Press, CDC, MIT Press, University of Toronto Press, Penn State University Press, University of Hawaii Press and Johns Hopkins University Press.

It should be noted that Springer Nature and the parent company of Altmetric, Digital Science, are both owned by the same group: Holtzbrinck Publishing Group.

Subject coverage

Subject classifications are only visible on the Research Outputs tab in the list view on the Altmetric Explorer database (Figure 4), but they do not display on individual Altmetric Attention Score Details pages. However, users can query the database by Fields of Research (FoR) code in the advanced search; the subject area data are provided by Dimensions, a bibliographic database also owned by Digital Science. AE users can also export their results as a .csv file, which will provide the FoRs and their codes, or they can query the API by the FoR code. There are typically multiple subject headings applied to individual publications, which is common in bibliographic databases. Because AE does not display analytic views of subject breakdown on its database, the next set of data and the corresponding graph (Figure 5) are exported from Dimensions Analytics, which shares significant overlap with AE and also provides the FoR codes to Altmetric (Altmetric, 2022c)

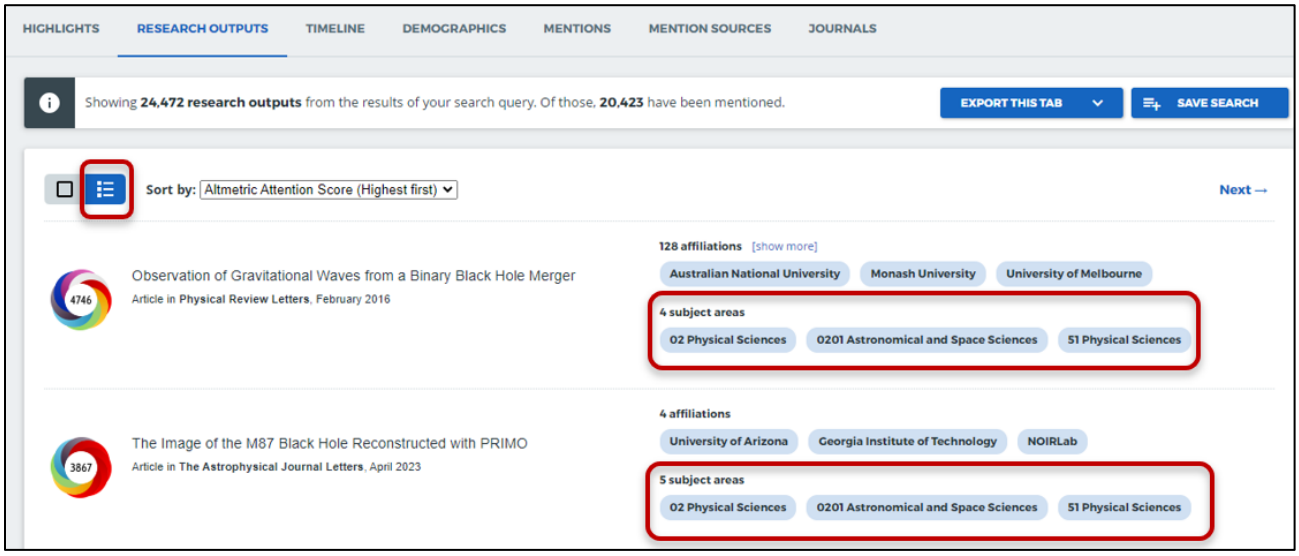


Figure 4. Screenshot of Research Outputs tab in Altmetric Explorer in the list view, which displays the subject areas as well as the author affiliations on the right. Screenshot taken October 11, 2023.

It may be helpful to note that Altmetric subject classification uses the 2020 Australian and New Zealand Standard Research Classification (ANZSRC) FoR classification, which was updated in 2022 (Altmetric, 2022b).

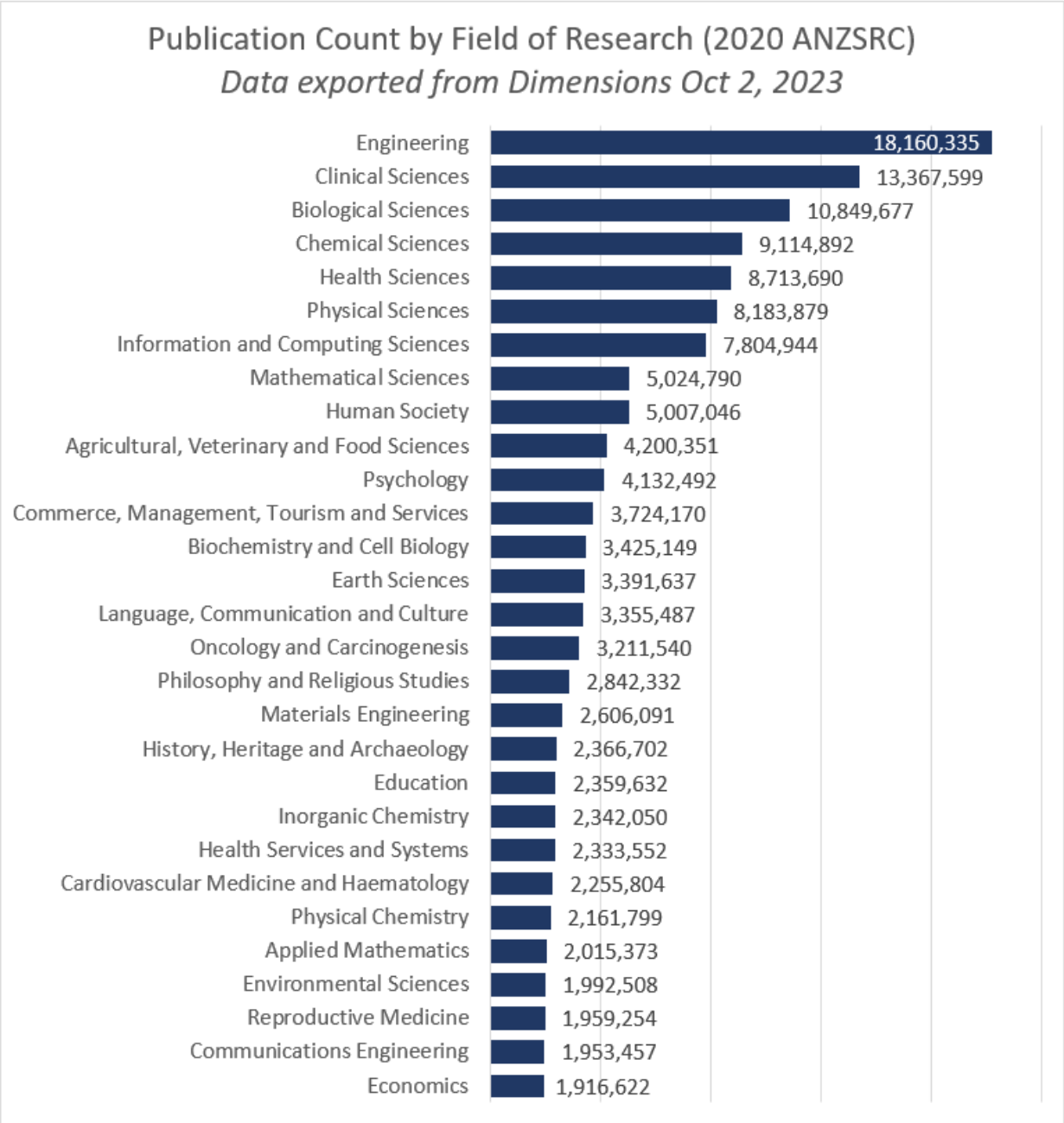


Figure 5. Number of publications by Field of Research (2020 ANZSRC); only the first 30 FoRs are displayed. See the full list in Appendix A. Data accessed from Dimensions Analytics on October 4, 2023.

Attention sources tracked by Altmetric

Altmetric tracks several different attention sources, but most of the attention comes from X (77%). While the vast majority of mentions come from X, and social media more broadly, the reach of posts is arguably not as influential or important as mentions from news media, Wikipedia, policy, and blog sources. For example, a 2016 and 2011 study found that a significant percentage (estimated between 3% to 9% of posts that mention research outputs)

are from bots or automated accounts (Haustein et al., 2016; Ye & Na, 2020). A more recent study found that Social Science papers disseminated on X account for 3.6 percent (28,961 accounts) of mentions (Arroyo-Machado et al., 2023). This study is ongoing and will expand to include others across the Essential Science Indicators fields, which are classifications within the Web of Science.

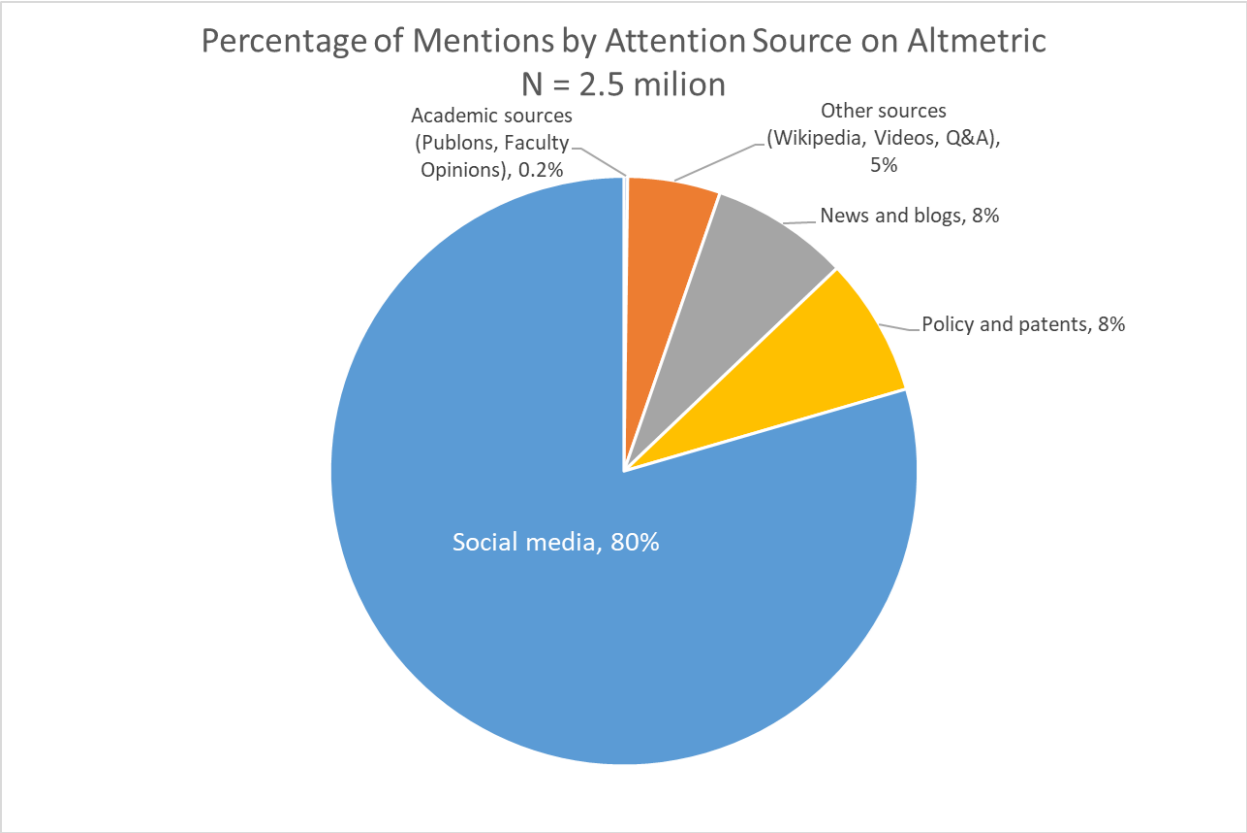


Figure 6. Percentage of mentions to research outputs by attention source type on Altmetric. Data retrieved from Altmetric Explorer on May 30, 2023.

Percentage and Number of Mentions on Altmetric by Attention Source *Data retrieved May 2023*		
Source	***# of mentions***	***% of mentions on Altmetric***
Social media	**199,928,103**	**80%**
X (formerly Twitter)	*192,379,493*	77%
Facebook (public pages only)	*6,116,489*	2.4%
Google+	*945,434*	0.4%

Reddit	*443,463*	0.2%
Sina Weibo	*36,673*	0.01%
Pinterest	*4,674*	0.002%
LinkedIn	*1,877*	0.0007%
Policy and patents	**19,031,317**	**7.6%**
Patents	*15,635,987*	6.2%
Policy documents	*3,395,330*	1.4%
News and blogs	**19,016,500**	**7.6%**
News	*15,732,186*	6.3%
Blogs	*3,284,314*	1.3%
Other sources	**12,844,055**	**5%**
Wikipedia	*12,307,125*	4.9%
Videos	*470,298*	0.2%
Q&A Posts	*66,632*	0.03%
Academic sources	**536,955**	**0.2%**
Peer reviews	*291,582*	0.1%
Faculty opinions	*245,373*	0.1%
Total	***251,356,930***	***100%***

Table 5. Percentage and number of mentions to research outputs by attention source and source type on Altmetric. Data retrieved from Altmetric on May 25, 2023.

Out of all attention sources on Altmetric, social media makes up the vast majority of all mentions to research outputs (80%) with X contributing the most (77%). See Figure 7 for a visual and breakdown of these percentages.

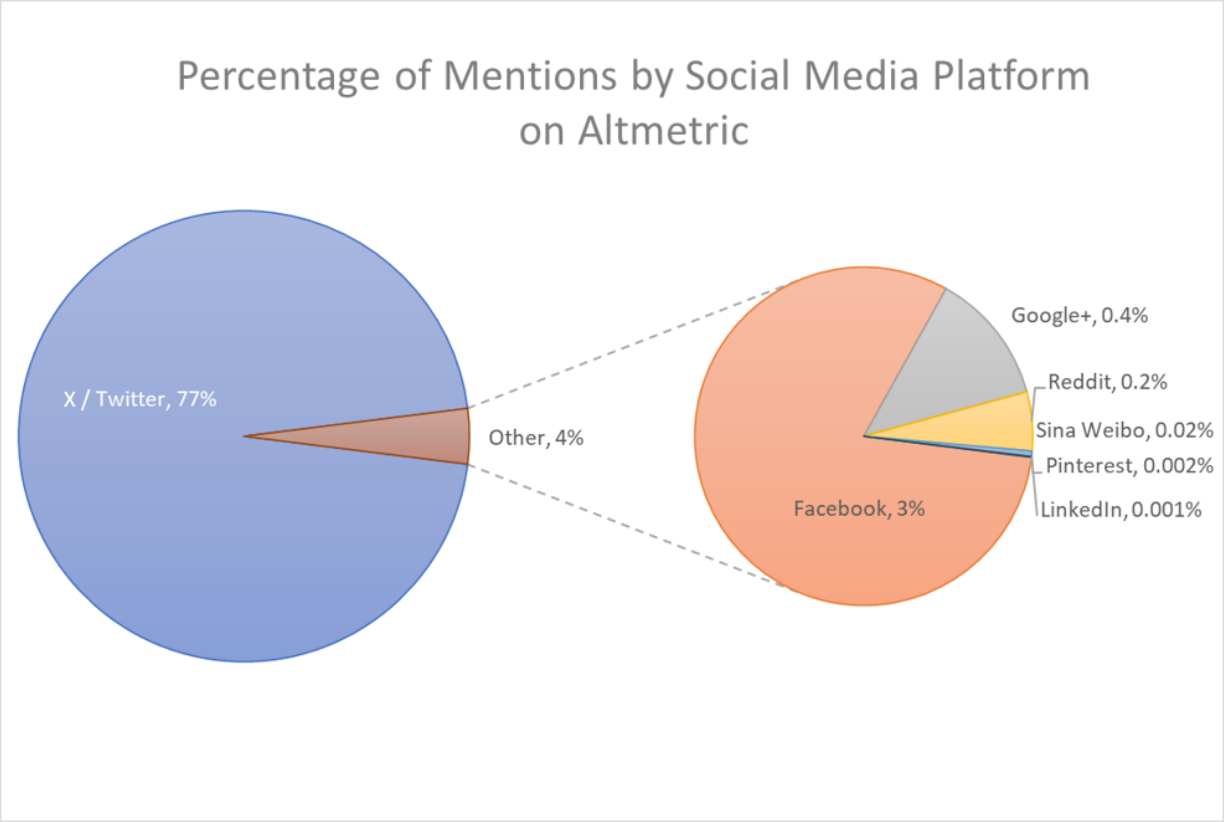


Figure 7. Percentage of mentions to research outputs by social media platform tracked by Altmetric. Data retrieved from Altmetric Explorer on May 30, 2023.

In addition, the majority of the social media mentions tracked are on platforms primarily used by Western and Global North users, with the exception of Sina Weibo. However, Altmetric only provides historical data from Sina Weibo (from 2014-2015) due to inadequate data-sharing policies. See individual sections on social media attention sources for more details.

Practical insight and tips for use

Considering the information above, we make the following suggestions when reporting information extracted from Altmetric:

- Report the total number of publications for which you are going to query the Altmetric Explorer. When querying Altmetric, indicate which identifiers you will be using and how many records include such information.

  EXAMPLE: *The University of Liliput has published a total of XXXX journal articles, out of which YY% include a DOI.*

- Report the number of publications identified by Altmetric as there may be false negatives, that is, publications which are mentioned by Altmetric sources but which Altmetric has not been able to retrieve. Then, include the total number of publications which have received at least one mention according to Altmetric.com

  EXAMPLE: *A total of XXX records were identified by Altmetric, out of which YY% have received at least 1 mention.*

- Bear in mind that Altmetric is not an errorless tool, especially when working with small collections of records or with certain document types (e.g., books and chapters). In those cases, it is important to manually verify that the information provided by Altmetric is accurate. For example, read about potential issues when dealing with books in "The insoluble problems of books: what does Altmetric.com have to offer?" (Torres-Salinas et al., 2018)

- Wherever possible, do not report on the Altmetric Attention Score and never in isolation. If you need to report an Altmetric Attention Score, use the 'Altmetric Attention Score in context' tab to provide more meaningful indicators in context. Altmetric only provides this for Articles.

  EXAMPLE: *This article received attention from sources that place it in the 97th percentile of all research outputs tracked by Altmetric, and in XXX position of YYY number of research outputs from the same journal, and XX position of YY number of research outputs from the same journal of a similar age.*

Further reading

Fang, Z., Costas, R., Tian, W. *et al.* An extensive analysis of the presence of altmetric data for Web of Science publications across subject fields and research topics. *Scientometrics* 124, 2519–2549 (2020). https://doi.org/10.1007/s11192-020-03564-9

Haustein, S. (2016). Grand challenges in altmetrics: Heterogeneity, data quality and dependencies. Scientometrics, 108, 413–423. https://doi.org/10.1007/s11192-016-1910-9

Robinson-García, N., Torres-Salinas, D., Zahedi, Z., & Costas, R. (2014). New data, new possibilities: Exploring the insides of Altmetric. com. El Profesional de La Información, 23(4), 359–366. https://doi.org/10.3145/epi.2014.jul.03

Torres-Salinas, D., Gorraiz, J., & Robinson-Garcia, N. (2018). The insoluble problems of books: What does Altmetric.com have to offer? Aslib Journal of Information Management, 70(6), 691–707. https://doi.org/10.1108/AJIM-06-2018-0152

Zahedi, Z., & Costas, R. (2018). General discussion of data quality challenges in social media metrics: Extensive comparison of four major altmetric data aggregators. PLOS ONE, 13(5), e0197326. https://doi.org/10.1371/journal.pone.0197326

Altmetrics and Responsible Research Assessment

In this section, we compare the Altmetric Attention Score (AAS) to the Metric Tide's key principles for responsible metrics (Wilsdon et al., 2015), and then we compare the use of altmetrics more broadly to the Leiden Manifesto principles.

Evaluating the AAS against the Metric Tide's Responsible Metric Dimensions

Evaluating the AAS against the Metric Tide's key principles for responsible metrics		
Principle	Definition	Altmetric Attention Score evaluation
Robustness	Basing metrics on the best possible data in terms of accuracy and scope	A broad database of sources contributes towards the composite Score, but it is not comprehensive of 'all' sources of online activity and not all activity is captured.
Humility	Recognizing that quantitative evaluation should support, but not supplant, qualitative, expert assessment	Altmetric recommends that the Score should never be used in isolation. We strongly agree with this.
Transparency	That those being evaluated can test and verify the results	This is a severe limitation. Users can see the Score and a breakdown of the engagement but there is not a breakdown of how the calculation behind each Score. Although the weightings are shared, it would not be possible to recreate or verify the Score because they note that the algorithm uses other methods within the calculation.

Diversity	Accounting for variation by research field, and using a range of indicators to reflect and support a plurality of research and researcher career paths across the system	The Score as a single composite indicator is strongly not supportive of a range of indicators. However, if the *range of attention sources* are considered a *range of indicators*, then it is possible. The Score also attempts to reflect plurality of research by including non-journal output types and the, albeit limited, sources that align with teaching, industry, or other career paths (e.g. Syllabi., Patents). There is also no variation or normalization for research fields. Normalization is only provided by Journal or 'Age' for journal articles. In addition, differences over time are also common, possibly due to increasing usage of social media in general (although this may be leveling out more).
Reflexivity	Recognizing and anticipating the systemic and potential effects of indicators, and updating them in response	Altmetric provides guidance on use of the AAS as well as support for responsible use and engagement with bibliometric academic research. It is not clear where there are direct examples of the Score changing in response to known systematic issues.

Table 6. Evaluation of the AAS by The Metric Tide's key principles for responsible indicators

It is important to stress that the AAS does not communicate the quality of the work, so if an article receives a great deal of attention online because it has been widely discredited, then the score will remain high based on the level of engagement. Research outputs that are found to be controversial or erroneous can perform highly in the AAS because they are being discussed online. Papers that have been retracted or issued with an expression of concern or correction will continue to be tracked by Altmetric and can continue to accrue activity. Altmetric Explorer will not identify or flag retracted articles as such, it will only be identifiable in Explorer that the paper has been retracted if as part of the retraction where the publisher has changed the title under the same DOI to include the term 'RETRACTED', and expressions of concern will not typically appear under the same article DOI.

Furthermore, the AAS is a composite indicator, and as such, it does not account for the *types* of mentions when calculating its score; the score merely indicates the volume of attention or the

so-called online “reach” of the research output. Those using and/or interpreting the AAS should pay more attention to the sources of attention rather than the score itself; for example, the reasons and motivations behind mentions of a research output on a social media platform, such as Twitter/X, are quite different from mentions in public policy documents, news media, or patents. For more information regarding the motivations, reasoning, and types of audiences mentioning research outputs, see the individual sources of attention in this guide.

Each attention source section of this guide includes some information about the AAS and how each source contributes to it. To learn more about the AAS, see the relevant Altmetric support pages:

- How is the Altmetric Attention Score Calculated?
- How are outputs scored?
- Putting the Altmetric Attention Score in Context
- Attention Score Modifiers
- FAQ: Why doesn't the Attention Score reflect the popularity of my paper?
- FAQ: Why has the Altmetric Attention Score for my paper gone down?
- FAQ: Why isn’t my article included in the Altmetric Top 100?

Evaluating Altmetrics against the Leiden Manifesto Principles

Altmetrics is still a relatively new type of indicator in the field of scientometrics and research evaluation. Care should be taken when applying them in evaluations and in decision-making, such as funding decisions. Outlined below are the ten principles of the Leiden Manifesto and how to apply altmetrics to them.

How the Leiden Manifesto principles apply to altmetrics	
Principle	**How to apply altmetrics to the principle**
Principle 1: quantitative evaluation should support qualitative, expert assessment	Although altmetrics are not widely used in research assessment, such as in promotion and tenure reviews, they should still not replace traditional peer review processes, especially if someone uses altmetrics to demonstrate public engagement or impact. Context should be derived from altmetrics or the AAS for interpretation and qualitative evaluation purposes. For example, citations in public policy documents may demonstrate policy change, but not all policy documents are necessarily policy; many are governmental reports and *recommended* policy changes.
Principle 2: measure performance against the research missions of the institution, group, or researcher	Researchers work in different fields, projects, institutions, programs, cultures, and countries, which should all be considered before using any metric, including altmetrics, in evaluation. Altmetrics may indeed complement conventional measures, but the individual, group, or institutional mission should be considered to determine if they fit the corresponding evaluation.

Principle 3: protect excellence in locally relevant research	In line with Principle 2, context of the individual and/or unit first is necessary before identifying the relevance of excellence in locally relevant research. Altmetrics may be able to help demonstrate this excellence, but the data tracked specifically by Altmetric (the company) may or may not track online engagement with locally relevant research from locally relevant news media, civil society organizations, health professionals, and so on. For example, the research output itself may not have a DOI assigned and thus not be tracked by Altmetric, or the local news outlet, for example, may not be tracked by Altmetric. In these cases, altmetrics can still apply if a researcher is able to track the engagement through online searching/tracking and/or science communication efforts.
Principle 4: keep data collection and analytical processes open, transparent, and simple	Altmetrics covers a wide variety of data sources, which can be evaluated in different ways, making it more difficult for altmetrics to be transparent and simple. If a user relies on Altmetric for its data, then they should refer to their documentation or this guide for information on the interpretations and practical applications of each data source. In addition, the type of evaluation will affect how the data is presented; an altmetrics report on an academic unit may report on the number of mentions from individual sources (e.g., 87 mentions from news sources) while an individual evaluation may want to report on the context of such mentions.
Principle 5: allow those evaluated to verify data and analysis	This principle may also be more difficult to apply to altmetrics because there are no rules or guidelines on how to cite research output across online sources, such as news, social media, and blogs. However, many sources are getting better at linking to these sources, and therefore, where possible, the evaluated should be given the opportunity to validate such data. In addition, Altmetric cannot track all the online attention, and it lacks in certain areas, such as public policy documents, in which the data provider Overton does a better job of tracking policy documents. In other words, the absence of altmetrics is not necessarily an indicator of a lack of activity, only a lack of activity tracking from a particular data provider, such as Altmetric.

Principle 6: account for variation by field in publication and citation practices	Certain fields produce document types that are more likely to be tracked, such as those in the science, technology, and health fields; engineering fields tend to produce more conference proceeding papers, which do not always have DOIs assigned and thus are not usually tracked by Altmetric or other altmetrics data providers. In addition, scholarly outputs from certain fields receive more online attention than others, especially those in the health sciences, astronomy, climate science, and psychological sciences. In addition, there is variation among subfields; for example, a publication on a promising new treatment for breast cancer is likely to receive more online attention than a publication on an improved corrective surgery of the cartilage of the knee. Certain topics generate more public interest than others, but as mentioned in Principle 2 and 3, the context of the individual and/or academic unit as well as the relevance of the research to local and niche communities, should be taken into consideration. Fields and subfields should not be compared to one another without normalization, which is difficult to accomplish with data from Altmetric. It can, however, be accomplished with usage statistics and such metrics are available in subscription research analytic tools, such as SciVal (the Field-Weighted Views Impact (FWVI) metric). Other normalized altmetrics have been suggested by scientometricians in the literature, such as for Mendeley readership (Bornmann & Haunschild, 2016b), Twitter (Bornmann & Haunschild, 2016a), and downloads (Plume & Kamalski, 2014).
Principle 7: base assessment of individual researchers on a qualitative judgment of their portfolio	This principle connects to and reinforces Principle 1. Academics should be evaluated based on a set of indicators that are used to *support* qualitative expert judgment from their peers. Altmetrics and bibliometrics should not be used in isolation.
Principle 8: avoid misplaced concreteness and false precision	Altmetric data can change; for example, if someone deletes an X post (formerly a tweet), that could lower the AAS, depending on the score. In addition, there are likely errors with respect to Mendeley readership due to how Altmetric aggregates Mendeley readership. In addition, the meaning behind each of these attention sources should be interpreted according to the context of the source and its mention(s), especially because altmetrics research is still in its early stages. Each individual source of attention in this guide provides a brief literature review, limitations and biases, and practical applications, which can help with interpretation and application of the source and/or the AAS. In an evaluation, it should also be stated why particular altmetrics data are used while others are not.

Principle 9: recognize the systemic effects of assessment and indicators	If reviewers, funders, or institutions invite the use of altmetrics in evaluations or funding decisions, they also, by default, invite gaming of such metrics. However, any metric can be gamed. Altmetric, to some extent, tries to prevent gaming of its composite indicator, the AAS, by only allowing contribution to the score based on the source rather than the total number of mentions. However, bot accounts on X can be created by those willing to manipulate the score, for example. To prevent such gaming, funders and evaluators who allow for the use of altmetrics in their proposals or reports should also ask for context surrounding mentions rather than only numbers or an AAS. For evaluations of larger groups of researchers, context can also be derived, such as through text analysis of titles of news articles that mention their researchers' work. If a review or evaluation suggests that an individual altmetric (e.g., number of X posts) or the AAS implies 'societal impact,' they should be cautious.[3] Tools should also be developed to detect intentional manipulation of altmetrics, but even without such detectors, there are advantages to funders' requiring researchers to communicate and disseminate research findings to the public (Holmberg et al., 2019).
Principle 10: scrutinize indicators regularly and update them	Altmetrics data providers, such as Altmetric, should routinely examine the shifting nature of their data sources. For example, X is a platform that has changed drastically since it was acquired by Elon Musk a year ago and, before long, may not have as much relevance or influence among academics or science communicators. Evaluators should also be aware of the changing landscape, what altmetrics have to offer, and how to use them appropriately according to the experts or the literature.

Table 7. Based in part on the Bornmann & Haunschild, 2016c: "*To what extent does the Leiden manifesto also apply to altmetrics?*"

[3] The literature presents mixed findings on whether and how much altmetrics indicate societal impact. Ràfols et al. (2017) suggests that altmetrics can be useful in assessing societal impact by analyzing engagement networks among researchers and stakeholders. However, Kassab et al. (2020) found that altmetrics were not suitable for reflecting the societal impact of research. Bornmann et al. (2019) found that altmetrics had convergent validity with case studies in capturing certain aspects of societal impact, but their correlation with reviewers' assessments was negative or close to zero. On the other hand, Wooldridge and King (2019) found that altmetric data was highly correlated with peer review scores for societal impact. Overall, the papers indicate that altmetrics may have some potential in indicating societal impact, but their usefulness and validity vary depending on the context and specific measures of impact.

Altmetric Sources of Attention

News and Mainstream Media

Definition of source

A manually curated list of news media sources most likely to reference research outputs. The News metric in Altmetric captures mentions in these curated news media sources through the use of APIs or RSS feeds. News outlets are assigned a tier based on their reach or influence; for example, a national news outlet will contribute more to the Altmetric Attention Score (AAS) than a local news outlet, but the score does not increase based on the number of mentions, only with each news outlet. For example, a New York Times article may mention the same research output several times in multiple news articles, but its score will only increase once, when it is first mentioned in the NYT.

Data source and coverage

A full list of data sources for News and their coverage is not currently publicly available from Altmetric, but a list of news sources can easily be pulled from their database Altmetric Explorer using the Mention Sources tab. As of October 11, 2023, AE shows that there are 8,177 news sources with nearly 17 million mentions (see Figure 8 below).

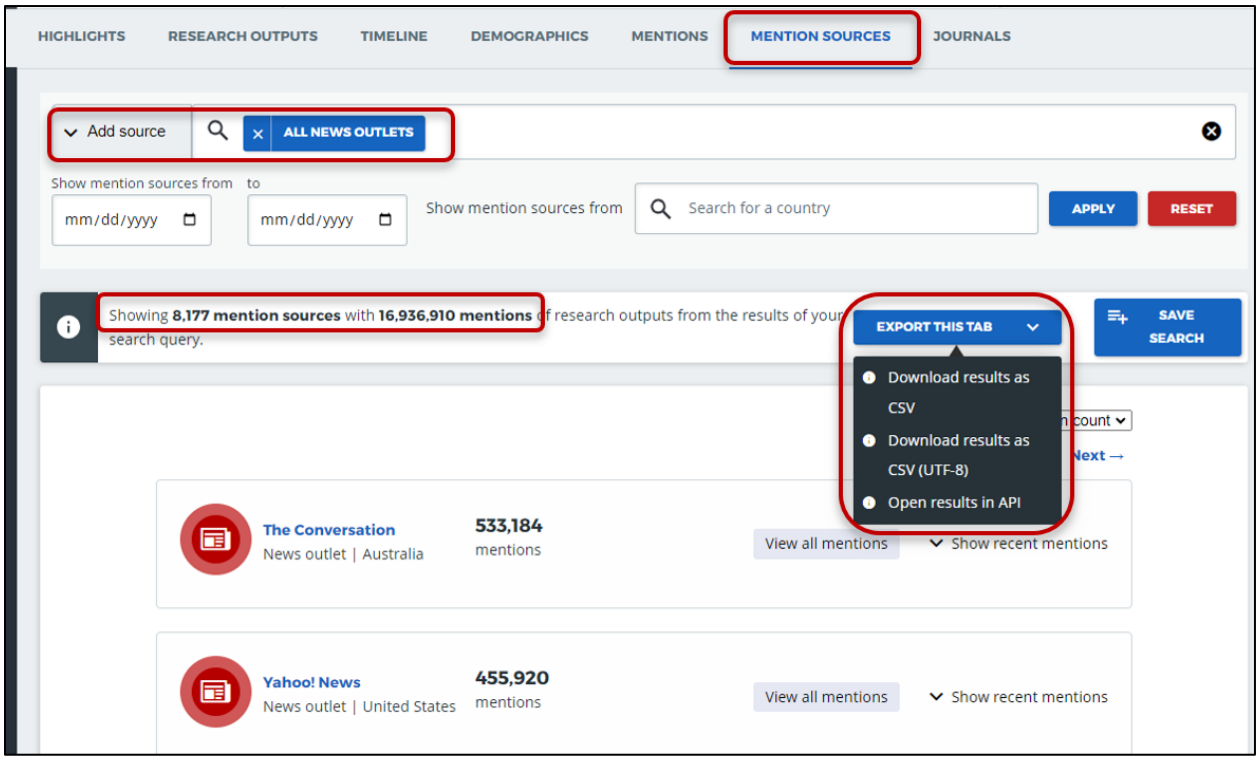


Figure 8. Options for displaying and exporting the news sources from Altmetric Explorer from the Mention Sources tab. Screenshot taken on October 11, 2023.

Altmetric began capturing news media in 2011, however there was a major update in 2015 expanding the news source coverage. According to their website, Altmetric tracks attention from over 4,000 news sources around the world, which are manually curated as "particularly reputable sources likely to refer to research outputs" (Altmetric, 2020b). The list of its news sources is not publicly available. The news source that mentions a research output must either link directly to the output or provide the necessary information for text mining in order to be tracked by Altmetric.

According to a 2020 study by Ortega, after doing an analysis of a random sample of over 100,000 research articles, Altmetric tracks more blogs (2582) than news sources (1435). This study showed that the large majority of news sources are in English-speaking, Global North countries (67.1%) with the United States contributing nearly 50 percent of all news sources (see Table 8) (Ortega, 2020). However, this study also showed that Altmetric has more diverse global coverage from news sources than Plum Analytics (PlumX) and Crossref Event Data (CED).

Altmetric News Sources by Country *Random sample of >100,000 research articles*		
Country	**Number of Sources**	**Percentage of Total Sources**
United States	706	49.2%
United Kingdom	121	8.4%
Germany	63	4.4%
Australia	61	4.3%
Canada	54	3.8%
India	39	2.7%
France	38	2.6%
Spain	31	2.2%
Italy	29	2.0%
Switzerland	20	1.4%
Not assigned	25	1.7%
Total	*1435*	*100%*

Table 8. Number and percentage of news outlets by country (Ortega, 2020, pp. 562).

Similar to coverage by country, English-language dominates the news sources (76.7%), but Altmetric also has more diverse language coverage compared to PlumX and CED (94.6% and 97.7%, respectively).

There is more diversity in Altmetric news sources by news subject categories, with general-interest news sources covering a small majority (28.8%) followed closely by local-interest (26.8%); however, PlumX has better coverage of local news outlets (43.6%, a large majority of their sources). By contrast, blogs deal more with special interest topics, such as science and technology, medicine, and agricultural and biological sciences.

Number and Percentage of News Outlets by Science Journal Classification Code (ASJC) Fields		
Subject	**Number of Sources**	**Percentage of Sources**
General-interest	414	28.8%
Local-interest	386	26.8%
Science and Technology	150	10.4%
Medicine	106	7.4%
Business, Management and Accounting	45	3.1%
Economics, Econometrics and Finance	27	1.9%
Entertainment	26	1.8%
Sociology and Political Science	23	1.6%
Physics and Astronomy	19	1.3%
Finance	18	1.3%
Not assigned	30	2.1%
Total	1439	100%

Table 9. Number and percentage of news outlets by subject (Ortega, 2020, pp. 566).

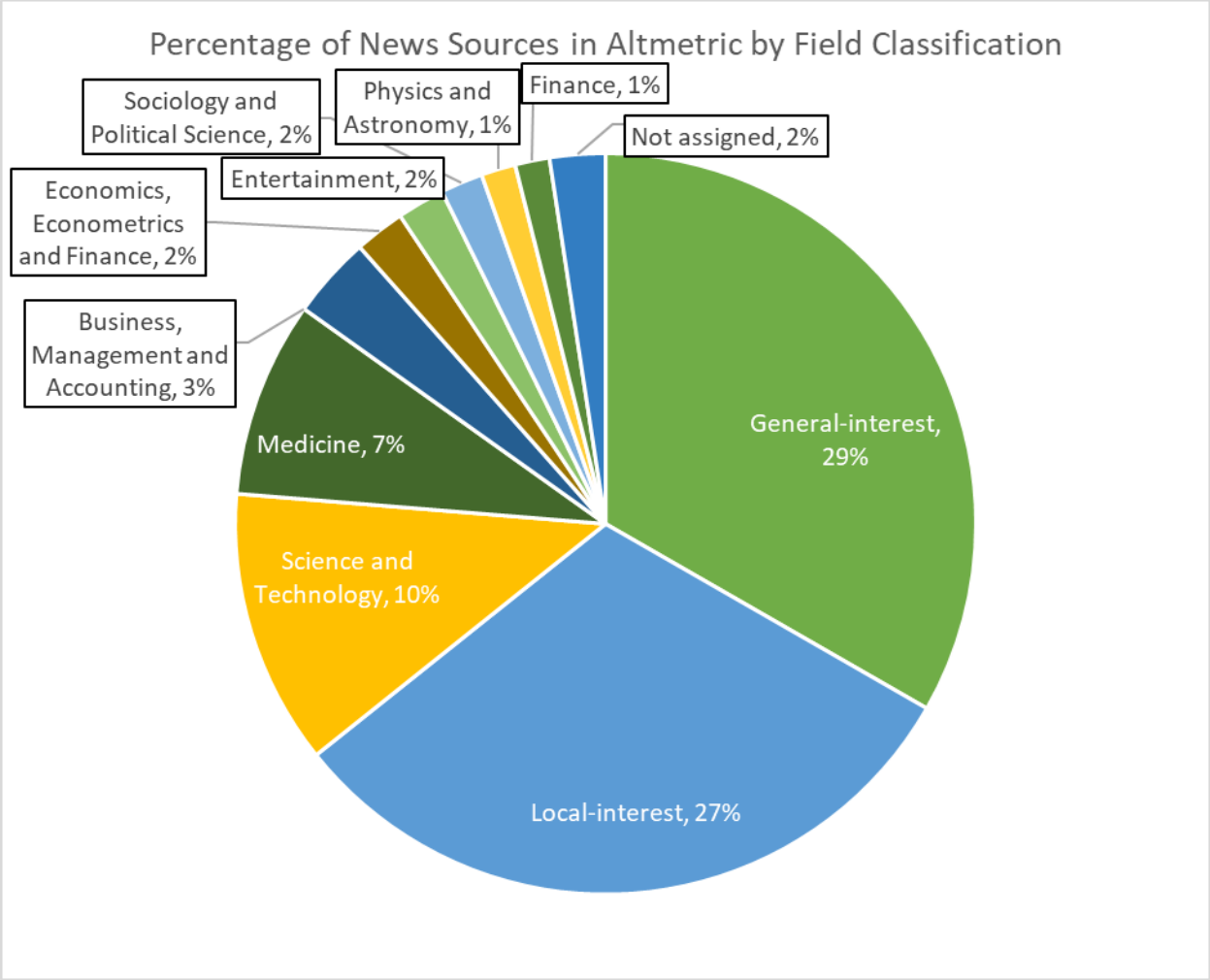


Figure 9. Percentage of news outlets by subject (from Ortega, 2020, pp. 566).

Literature Review

The News metric has the highest weighted count in its Attention Score, at 8 points, among all the attention sources. There is also a tiering in Altmetric that affects the overall contribution of a news source to the score. For example, a news source with an international reach, such as the New York Times, would contribute more to the score than a local news outlet. This typical weighting of 8 also indicates that news media attention also far outweighs the attention from any other source. See Altmetric Attention Score Weighting for more details.

A recent study (Ortega, 2021) found that news media outlets tend to mention the same publications globally, especially ones that have greater social impact, such as medical advances and astronomical discoveries. From 2013 to 2020, Altmetric published the Altmetric Top 100 to highlight the research articles with the most attention. Many of these articles receive considerable news attention, and by skimming through them, it is evident that the articles are of direct interest to the general public, such as climate change, healthcare, fake news, elections, black holes, diets and lifestyles, mental health, dinosaurs, artificial intelligence, and so on. *Side note: Altmetric no longer publishes the Top 100, but they did transition into writing blog posts*

analyzing the data to make conclusions about the most popular research articles (Altmetric, 2021b).

Overall, news mentions tend to me more general-interest oriented rather than focused on specific disciplines or discoveries, which may be an indication of large media conglomerates and global news networks that share similar or verbatim news stories, such as *The Conversation, MSN,* and *Huffington Post.* In contrast, local media outlets and blogs tend to mention different research outputs, but likely for different reasons. For example, local media may cite certain articles due to their relevance and impact on their local communities or because of their ties to their media conglomerates (*Fox, CNN, ABC*). Blogs, on the other hand, tend to cite more diverse content rather than the same publications that global media outlets mention, which could demonstrate the decentralized nature of blogs and their specialized or discipline-specific content, such as a blog focused on aerodynamic physics.

Limitations and Biases

The same source may be classified as both a news source or abBlog source in Altmetrics. However, a 2019 study found the error rate to be only 3.5%, indicating the overlap is rare (Ortega, 2019).

Most of the news sources tracked are in English-speaking countries (Ortega, 2020) and general-interest media. Overall, there is poor coverage of non-English-speaking media, which can have unfortunate consequences on local communities in non-English-speaking countries by underrepresenting local communities and their histories, natural environments, and policies. Similar to the English-language and Global North bias of large commercial bibliographic databases (Visser et al., 2021), news media outlets included in Altmetric are largely English-language and from the Global North. These news sources also largely cite English-language, Global North research outputs. In short, the scholarly literature cited in Global North, English-language news media outlets is also mostly Global North, English-language literature. While an argument can be made that the primary language for communicating scientific results is the English language, much of the scholarly literature is not indexed by major bibliographic sources or assigned a digital object identifier (DOI), and thus not tracked by data companies, such as Altmetric.

The geographic and English-language bias presents challenges for making broad conclusions about the most important or popular research topics in news media, because there is a clear bias in terms of what gets mentioned and how much attention is given to it. Those topics with clear interest from the public will always get more attention in the media (e.g., ranging from fun studies on the health benefits of coffee to papers about the dire consequences of global warming), but blogs and local news outlets may give attention to less generalist areas; blogs tend to focus more on special interest areas (see Blogs for more details) while local news outlets focus more on locally relevant research.

In addition, it is possible that the primary users of Altmetric, who are mainly in the Global North, are the ones recommending news sources for inclusion for tracking on Altmetric, which may

also be the reason for the geographic and English-language bias (i.e., the news sources reflect the customer base).

Finally, news media is a crucial part of science communication, but news media and/or journalists do not always accurately report the results of scientific studies, and in *some* cases, news media sources can indulge in or promote conspiracy theories, depending on the reliability and credibility of the news source (see the interactive news media bias chart and AllSides for resources on media bias and reliability). Therefore, it is crucial to investigate the news source itself for credibility, the accuracy of the claims made by the news article as it relates to the research output, and the research output itself for credibility.

During the COVID-19 pandemic, conspiracy theories ran rampant, especially on social media, which could be started by prominent figures and regurgitated by far-right talk show hosts and alternative health gurus on social media. News media usually fact checks such conspiracy theories, but unfortunately, such fact checking often acts like an echo chamber for those consuming conspiracy theories online (Shahsavari et al., 2020), in which conspiracy theorists will use fact checking articles as "proof" that the "fake news" is deep at work to maintain control over the masses (Baker, 2022). Users of the AE database will notice that the platform tracks news media sources from multiple political points of view, and thus, it is up to the user to investigate and evaluate each source. For example, the research outputs with the highest AAS in AE are listed as the "Top Outputs" in the Highlights tab, all of which, as of the time of this writing, are about or related to the COVID-19 pandemic. For example, "Chloroquine is a potent inhibitor of SARS coronavirus infection and spread" has an AAS of 36178, and many of its news media mentions are from far-right news media sources, such as The Epoch Times, in which one of its articles claims that hydroxychloroquine is an effective treatment for reducing COVID-19 deaths, a claim that was debunked a year previously. These news sources are more "fringe," but they are tracked by Altmetric and do not include any ratings or reviews.

Mainstream news media can also sensationalize research results, especially those that make lofty claims *and* have little to no scientific reliability, especially in health and diet research; for example, in 2015, science journalist John Bohannon exposed how reporters treat health science "like lifestyle material rather than real science" with a sting operations on health reporters themselves. Bohannon published a "junk science" study on the weight loss effect of including chocolate in your diet, which was widely and immediately publicized and sensationalized by the mainstream news media.

Overall, mainstream and fringe news media sources can both publish erroneous or misleading information, which can be intentional (disinformation) or not (misinformation). Mainstream media, however, is typically more trustworthy, credible, and reliable than fringe news sources. Researchers who want to take a more active role in communication of their research results can do so by talking directly to journalists, fact checking articles already published, and/or playing an active role on social media. Users interpreting the Altmetric news media data should take care to evaluate the source, the news article, and the research output itself for reliability, credibility, and consistency across the academic literature.

Practical insight and tips for use

Research and scholarly studies and topics with clear interest from the public will always get more attention in the media (e.g., healthcare, climate change, astronomical discoveries), but blogs and local news outlets may give attention to less generalist areas. It does not mean that one topic is more important or impactful than another; rather, the media and the general public's levels of interest in these topics are different, and assessing such societal or social impact should be nuanced and carefully interpreted. Broad conclusions should not be made about news media attention, which could be hype or interest in research that shows real-world or societal impact. Attention in local news outlets (which tend to cite locally relevant research) or blogs (which are usually more focused on special interest research topics) could represent a different *type* of engagement or impact compared to attention in global news outlets.

Keep in mind: a study with considerable citation impact in academia could have little engagement with the media or public sources, and vice versa. Studies that receive considerable attention in the media may be poor quality and have titles that are "click bait." The media can also misrepresent the research outputs they cite. That doesn't mean every study mentioned in the media is overhyped and/or poor quality. Compare the attention across news media mentions and blog mentions; compare it with its citation impact as well (if applicable), and of course, assess its quality with critical appraisal and expert evaluation.

Social Media

Definition of Source

Altmetric identifies and tracks mentions to research outputs on social media on Facebook (public posts only), X (formerly Twitter), and Reddit, as well as historical data from Google+, Pinterest, LinkedIn, and Sina Weibo. (The latter three no longer supply an open feed, and Google+ retired in 2019). For details about the contribution of individual mentions to the Altmetric Attention Score, see the Altmetric Attention Score section.

Related indicators

Social media platforms are largely used to share information, interactions, and news in real time. Thus, many of these platforms are often regarded as "just buzz" or "gossip," especially by academics (see the X (formerly Twitter) Bias subsection). Therefore, related sources of attention to social media mentions are *to each other,* e.g., X mentions are similar to Facebook mentions. Of course, read more about each platforms' demographics, interpretation, limitations, bias, and practical implications to understand how they differentiate as well.

X (formerly known as Twitter)

Notes

The platform is now referred to as X, as of July 2023; thus, 'tweets,' 'retweets,' 'quoted tweets,' and 'Tweeters' are now referred to as 'posts,' 'reposts,' 'quoted posts,' and 'Posters,' respectively.

This section is quite extensive and comprehensive. X makes up the bulk of attention from Altmetric sources. Therefore, the academic literature on X altmetrics is also quite extensive. Although this is a huge source of attention, it does not necessarily mean it is the most important source of attention from Altmetric. For example, a mention in a public policy document may have more influence on the public or society than a hundred posts from X.

Demographics

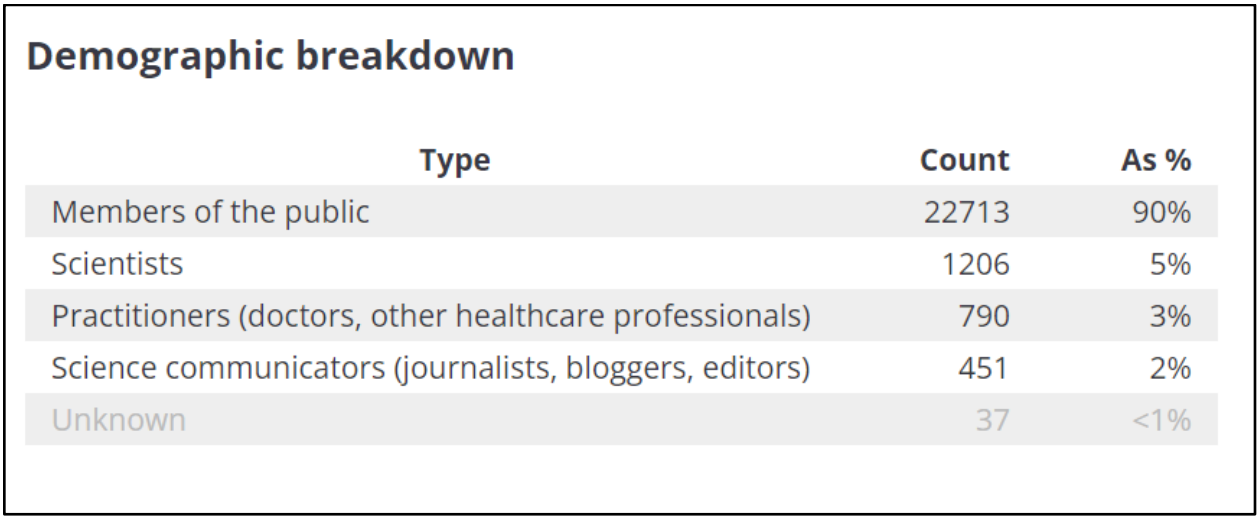
Altmetric automatically tracks mentions to research outputs on X in real-time via an API. They automatically collect posts, reposts, and quoted posts that contain a *direct link* (e.g., the URL or the DOI) to a scholarly output. Without the direct link to an output, the system is not able to match the post with the output. It does not track secondary citations to outputs, such as posts or reposts about news articles that mention research outputs (Altmetric, 2020).

According to Altmetric, demographics are collected (in addition to demographics from Mendeley) based on X posting history, profile information (e.g., keywords in profile descriptions), user category and geolocation (when made publicly available), the types of journals users link to, and followers of accounts. These are the four categories they assign:

- **Member of the public**

    - Somebody who doesn't typically link to scholarly literature and;
    - *Doesn't fit the categories below.*
        - This is a crucial caveat, since Altmetric uses a keyword-based approach to categorize its users. This category includes all users who cannot be classified as belonging to the other three groups below and therefore is not a good indicator of how much an article has been posted by members of the public. Therefore, many Altmetric Attention X demographics seemingly suggest that the majority of research is posted by members of the public due to this large, ill-defined category. However, studies on the altmetrics of X contradict this and actually suggest that the majority of research posted on X is posted by other academics (Haustein, 2019).
- **Researcher**
    - Somebody familiar with the literature (i.e., links frequently to it)
- **Practitioner**
    - A clinician, or researcher who is working in clinical science (based on keywords in their 160 character bio)
- **Science communicator**
    - Somebody who links frequently to scientific articles from a variety of different journals / publishers

(Altmetric, 2020e).



Demographic breakdown

Type	Count	As %
Members of the public	22713	90%
Scientists	1206	5%
Practitioners (doctors, other healthcare professionals)	790	3%
Science communicators (journalists, bloggers, editors)	451	2%
Unknown	37	<1%

Figure 10. Example of demographic breakdown from an Altmetric Details Page. Screenshot taken from an Altmetrics Details Page on Altmetric Explorer on October 9, 2023.

Altmetric demographics for the category or type of individual who posts are only available on the Altmetrics Details Page for individual outputs and not in an analytics view for a set of outputs (or the entirety of Altmetric data) on its database Altmetric Explorer.

Altmetric Explorer X Demographics

(All research outputs tracked by Altmetric, 2012-2021)		
Country	**Total posts**	**Unique Posters****
Country not specified*	56,503,483 (42.5%)	4,705,892 (49.1%)
United States	24,628,249 (18.5%)	1,530,386 (16%)
United Kingdom	12,777,599 (9.6%)	581,123 (6.1%)
Australia	4,029,361 (3%)	139,988 (1.5%)
Spain	3,988,147 (3%)	208,266 (2.2%)
Canada	3,848,775 (2.9%)	215,280 (2.2%)
France	2,676,237 (2%)	162,517 (1.7%)
Japan	2,541,521 (1.9%)	216,216 (2.3%)
Germany	1,998,868 (1.5%)	98,318 (1%)
India	1,326,710 (1%)	153,266 (1.6%)
Netherlands	1,235,976 (0.9%)	61,608 (0.6%)

Table 10. X demographics by country, according to Altmetric

*Altmetric provides location information for 58% of posts (as well as 57% of users and 71% of documents, not represented in this table) based on location information provided in the X bio.
**Unique Posters represent the number of Posters who post research outputs whereas number of posts is the actual number of posts; there are typically multiple posts that mention or repost a unique research output from the same user, which is why the number of posts is so inflated.

Literature review

Out of all attention sources tracked via Altmetric, X has by far been the second most popular attention source after Mendeley, the reference manager, but understanding the caveats and complex uses of X in a scholarly context is paramount to understanding the meaning behind such mentions. For example, a significant percentage of posts to research outputs are reposts and automated accounts, which is more representative of information dissemination and academic publication alerts than public engagement or impact (Haustein, 2019).

Only so much can be inferred from academic X studies, which usually pull data from users' bios and posts. However, a group of researchers decided to ask X users engaged with academic posts directly; in their study, an international survey was distributed (1,912 respondents; 4%

response rate) to determine characteristics of those who post academic papers and those who use X to find scholarly information (Mohammadi et al., 2018). Prior to this study, little was known about how non-academics use X to seek and communicate such information; therefore, this study provides early evidence for non-academics using X to disseminate academic information to the wider public.

Important results in this survey study provide evidence behind reasons that academics and non-academics use X and the types of content they share on the popular platform. With respect to disciplinary differences among academics and non-academics regarding their ***reasons for using X***:

- **Humanities scholars** are more likely to use X to contribute to larger conversations.
- **Social scientists** are more likely to use X for teaching purposes.
- **Engineering and technology scholars** are least likely to use X for everything, particularly for communicating research and for academic events.
- **Natural scientists** are least likely to use X to contribute to wider conversations (opposite to Humanities scholars).
- **Medical and health scientists** are likely to use it for most things *except* teaching; they are especially likely to use it for communicating results to peers and the public and for communicating about academic events.
- **Non-researchers** are more likely to use X to promote their organization, especially among industry/professionals; government workers are most likely to post to contribute to wider conversations.
  (Mohammadi et al., 2018)
  See this table for more details.

With respect to the ***types of scholarly content*** shared through X:

- **Social scientists** share the most, including publications, research news, and policy announcements.
- **Humanities** scholars share scholarly content the least.
- **Engineering and Technology scholars** share slides the most.
  - Perhaps reflects the importance of conferences in their fields.
- **Medical and health scientists** frequently shared policy announcements
- **Non-researchers** (e.g., professionals, government workers, and industry/corporate workers) were *least likely* to share publications and research-related news but *most likely* to share videos, images, blog posts, and lay summaries of research.
  - This suggests an intermediary role for non-researchers to communicate research to the public.
  - It's important to note that this type of "second-order citation" to research is not and cannot currently be tracked by Altmetric (Altmetric, 2020e); therefore, such research communication metrics do not yet exist, though they are important to demonstrating potential societal impact. Manual tracking, such as searching on X for the specific blog post, news media story, or hashtag associated with the research output(s), is a potential solution for finding such public posts.

Another survey result from the same study demonstrated that most respondents (81%) believe that “posting academic articles disseminates scholarly information to the public” (p. 10); however, with the exception of health and astronomy research, there is little evidence to suggest that members of the public link directly to scholarly outputs (through posts or reposts) (Haustein, 2019); most X users linking directly to scholarly outputs work in academic institutions or directly represent the institution or organization; however, this type of posting behavior is a minor one compared to the majority of academics’ X behavior, suggesting an overlap of professional and personal interest in academics’ X usage (Ke et al., 2017).

Despite previous contradicting results that non-researchers rarely link directly to research outputs on X, the Mohammedi et al. (2018) survey respondents, which included non-researchers, agreed that X helps to disseminate scholarly information to the public; this suggests that both researchers and non-researchers participate in research dissemination on X, whether it is *directly with the research output* or the *secondary source* (e.g., a video, blog post, or news story that mentions the research output).

In addition, previous studies show that social circles on X are crucial to finding information (e.g., following accounts and hashtags), but this is more of a reflection of how most users find information on X rather than a unique characteristic of how users find *academic* information on X (Efron, 2011; Mohammadi et al., 2018).

The Mohammadi et al. (2018) survey study is the first large-scale evidence to show that X contributes to cross-disciplinary academic information spread, which is a significant finding in research communication and altmetrics research; although it might be difficult to demonstrate such cross-disciplinary communications through X data analyses and systematic linking analyses, the survey results indicate that users’ X experiences lead to more discovery of more diverse academic information (e.g., outside their field or profession). Furthermore, this survey research shows that it is *possible* that posts reflect non-academic or societal impact, especially given the weak correlations between X mentions of research outputs and future citations to those same outputs (de Winter, 2015; Haustein, Peters, et al., 2014; Shuai et al., 2012); however, a systematic review found that fields in the health sciences have found positive correlations between X mentions and future citations, such as medical education, urology, surgery, Parkinson disease, psychiatry (Bardus et al., 2020), and COVID-19 research (Kousha & Thelwall, 2020). There is some evidence to suggest that *active participation* on X can influence the dissemination of a scholar’s academic outputs, potentially and indirectly influencing future citations (Ortega, 2016). However, posts that contain links to secondary sources are not and cannot be tracked by Altmetric or other altmetrics data providers due to the inherent problem that secondary sources do not contain unique identifiers and structured meta tags on their webpages. Please see the Practical applications section for use for more information on how to track and use X metrics more broadly.

In more recent observations and studies, thousands of academics are either cutting back or completely abandoning the platform following its takeover by Elon Musk and rebranding it as X. Most of these academics question the value of X as a platform for reliable science communication and fact checking in light of its many changes (e.g., abandoning the ‘blue check’

verification in favor of granting paying members the check mark in addition to other privileges, charging money for access to X data for research, and cutting back drastically on content moderation, to name a few). According to one study, more than half of X users have cut down on their use of the platform, seven percent have abandoned it altogether, and almost half have begun using other platforms, such as Mastodon, Bluesky, Threads, and TikTok (Vidal Valero, 2023).

Limitations

- **Reposts:** Reposts that circulate among the academic community are more common than original posts, and reposts that link directly to a research output are less likely to occur than reposts of other information (e.g., conference chatter, information diffusion among the academic community). Arguably, **reposts represent a rather passive act of information sharing**, even when the repost contains a direct link to a scholarly output (Haustein, 2019). Altmetric counts posts and reposts the same (i.e, each post or repost from a unique Poster typically equals one point to the AAS). However, original posts and reposts do not have the same implication, especially since reposting requires so little effort. Reposts lead to more visibility but do not necessarily indicate impact or research communication beyond the academic community.
- **Date coverage:** X coverage, as with other altmetrics, increases with more recent papers for two reasons: the majority of these posts occur immediately after publication, and Altmetric began collection of X data in 2012. Older papers are less likely to be posted, and in general, they're less likely to receive online attention from other sources, due to the nature of digital scholarly communication rapidly evolving in the past decade.
- **Data sources:** Generally speaking, unless an institution, organization, or publisher sets up customized tracking to URLs, Altmetric tracks mentions to research outputs that have identifiers, such as DOIs, PubMed IDs, clinical trial IDs, and arXiv IDs. This limits the types of research outputs that are posted, in particular for scholarship in the arts and humanities, which do not always assign identifiers, such as DOIs, to their outputs.
- **Accuracy of data:** X users' accounts sometimes get suspended, accounts get deleted, and individual posts get deleted; these posts still appear in the Altmetric Attention Details page and contribute towards the AAS. Altmetric also has some errors regarding the X post date of publication, the DOI, the article date of publication; one study found the overall error rate for X altmetrics data was 17% (Yu et al., 2021).
- **Potentially unsustainable environment**: Since billionaire Elon Musk bought the social media platform in October 2022, he has made a number of unpopular decisions that have led many to abandon the platform or reduce their usage on it. Many advertisers have also pulled their ads, hurting the company's revenue. The ad revenue for the platform has plummeted at least 55% year-over-year each month since the billionaire bought the company (Dang, 2023), though some disagree that X is losing any momentum (Coyne, 2023). Musk also tends to make impulsive decisions, which leads many to question the sustainability of the platform over the long-term.

Bias

- **Geographic**: according to one analysis, a large majority of X users mentioning research outputs are overrepresented by the US and to an extent the UK (20% and 8%, respectively), with less than three percent X mentions coming from each of the next top eight countries (Canada, 3%, Japan, Australia, and Spain, 2% each; France, 1.4%; India, the Netherlands, and Denmark, 1% each) (Haustein, 2019). Altmetric Explorer's current (2021) data shows similar geographic demographics (see X - Demographics). In addition, X is blocked in countries such as Iran and China, which limits those scholars' online visibility through Western communication channels like X.
- **Demographics:** According to two studies that examined X bios to identify types of accounts (organizations, academics, researchers, professionals, science communicators, and members of the public), approximately 25% of Posters sharing direct links to research outputs are accounts maintained by an organization, such as non-profits, corporations, universities, news, and media and outreach institutions; individual accounts make up roughly the other three-quarters of accounts; however, 50% or more of individual accounts identified as having a PhD, as researchers, or as students, which differs greatly with the demographics of 1% of the public holding PhDs. A small percentage (5%) were identified as professionals and science communicators. This suggests that most posts to scholarly outputs represent scholarly communication activities rather than public engagement or impact, but the lines are blurry on deciphering the reason for mentioning and linking to an output (e.g., public or personal interest in research from an academic) and the challenges of identifying members of the public via X bios (Haustein, Tsou, et al., 2016; Tsou et al., 2015).

    Some side notes:

    - There is a hesitation among the academic community to take to X (23% of US adults in the public versus around 15% among academics) for one or both reasons: academics' perception of X as a shallow or hype medium of communication, and the backlash of using X in an academic profession, which can lead to violation of academic norms in public spaces and negative consequences of posts (e.g., in extreme examples: loss of position or withdrawal of a job offer) (Haustein, 2019).
    - In addition, most academics on X have been found to have passive interaction with research outputs and use X almost like a publication alert system, following links to articles rather than actually disseminating the links themselves (Letierce et al., 2010; Priem & Costello, 2010).
    - Members of the public are least likely to be engaged in posting direct links to research outputs, but when they do, they are more likely to engage with articles from journals in professional fields and the social sciences and least likely to post directly to chemistry papers.
- **Discipline:** Multidisciplinary, biomedical, and social science publications tend to have the most visibility on X, partially because of the relevance to everyday life among the

public and partially due to the marketing and promotional efforts of the journals and publishers on X. For example, the mean number of posts per publication across all disciplines was 7.2 while the mean number was highest in general & internal medicine at 13.5 (Haustein, 2019). The arts and humanities received the least attention on X, but this cannot be generalized, since these disciplines do not typically use DOIs for their scholarly outputs. Furthermore, X attention to the so-called "hard sciences" is low, particularly in mathematics, computer science, natural sciences, technology, and engineering (Haustein, 2019; Haustein et al., 2015)**.**

    - X participation among academics also differs by discipline, with one study finding that 13% of science and engineering researchers regularly used X while almost 25% of social science, humanities and arts scholars used it (Van Noorden, 2014). Another study found similar results, with social scientists particularly overrepresented on X and mathematicians the least represented (Ke et al., 2017)

- **Bots:** A significant but unknown percentage of posts to academic papers are bots, many of which are self-identified as such (i.e., automated accounts, such as @oceanologia, @blackphysicists, @PhysicsPapers, many of which link to arxiv.org preprints). In one study, posts from bot accounts to arxiv preprints accounted for 9% of these posts; in another study, between 5% to 8% were identified as bots in a random sample of 800 posts captured by Altmetric (Haustein, Tsou, et al., 2016). In one general X study, 16% of all X accounts were identified as automated (Zhang & Paxson, 2011). This presence seems to have increased since the company was bought by Elon Musk (Arroyo-Machado et al., 2023).
    - It's important to note that not all bots are malicious or spam; many are automated accounts designed as a publication alert system similar to RSS feeds. Many of the posts to chemistry and physics papers come from such automated accounts, such as @blackphysicists and @MathPaper.
- **Publication characteristics:** papers with more intriguing, humorous, or "sexy" titles are more likely to be posted; systematic reviews and meta-analyses are also more likely to be posted (and cited). In addition, X attention was also higher for news items and editorials (which include DOIs, such as those published in *Nature News* and *The Conversation*) but which do not typically receive citations, which suggests that the public is more likely to post and discuss nontechnical papers and opinion pieces. In addition, publications with shorter titles and fewer pages tend to receive more posts while the opposite is usually true for receiving citations (Haustein et al., 2015)**.**

Practical applications

Overall, X is a complex social networking site that can *potentially* show the societal impact of research, though more evidence is needed to prove that such mentions on the social media platform demonstrate any type of specific *impact*.

A key component of online research communication on X involves non-academics posting academic information, which is often linked to secondary sources, such as videos, blog posts, or research-related news. Altmetric (as well as other altmetrics data providers) can only track

direct links to research outputs on X, which leaves a huge gap in tracking research communication efforts by intermediary players (mainly non-academics, such as professionals, industry workers, and journalists). Therefore, the current X metrics available through Altmetric mostly demonstrate dissemination of academic literature among academics. In addition, Altmetric counts posts the same as it counts reposts, which are also more representative of research dissemination and publication alerts than research communication to the public.

Those using Altmetric to track X mentions of research outputs should interpret such mentions cautiously and understand their limitations. posts should be separated from reposts, and unique posts should be carefully examined to determine the context surrounding the mention, especially since many posts often copy/paste the titles of the papers and post them, which is not representative of impact but rather dissemination.

In addition, there are stark disciplinary differences among X users, with social scientists being most active on X than other disciplines. Researchers in these fields may benefit from engaging and networking on X, especially since such participation can increase their visibility, the sharing of their work on various social networks, and potentially, their citations. Proportionally, there are more social scientists than engineering, technology, and mathematician researchers. Therefore, researchers and evaluators in the latter fields should not interpret fewer overall X mentions to their research as an indication of 'lower impact' or even as a failure to disseminate research results. For example, engineering researchers tend to post presentation slides more than other disciplines, but these types of outputs are not usually as trackable by Altmetric.

Overall, there are many disciplinary differences for why academics post and what types of content they post. In addition, non-academics rarely link directly to research outputs and are more likely to disseminate research information through secondary sources. Therefore, X may reveal a wider impact of research, but it must be interpreted cautiously, and it is still not recommended for formal evaluations. Furthermore, more complex analyses of X activity around an individual's research portfolio can be conducted, such as through manually finding mentions of their research on X to secondary sources. For instance, a researcher can find the news articles, blog posts, and videos that mention their research outputs via Altmetric; then, they can perform simple searches to the titles and/or URLs of those articles, posts, and videos on X and sift through them to determine if their research is explicitly mentioned in the post by non-academics and members of the public.

Finally, since X represents a complex social network, more advanced mapping methods can be used to extrapolate X users' networks and find engagements and interactions among researchers and key stakeholders (e.g., the public, organizations, government entities, etc.). Such an approach is more appropriate for assessing societal impact of social media interactions (Robinson-Garcia et al., 2017).

There is mixed research on the correlation between X posts and future citations; the most notable studies show no direct correlations (de Winter, 2015; Haustein, Peters, et al., 2014; Shuai et al., 2012) while others find a correlation (Bardus et al., 2020; Kousha & Thelwall, 2020); however, one study showed that a scholar's *active participation* on X can increase the posting of their articles on X and, by extension, the likelihood of those articles being cited

(Ortega, 2016). Such X chatter surrounding links directly to research outputs likely has different implications, namely research dissemination among academic networks, but it could be indicative of more societal impact; at this point, it is too early to make such firm conclusions, and therefore, Altmetric X mentions should only be used in formal evaluations with the context described above and/or to describe science communication efforts made on X. At the very least, previous research demonstrates that non-academics are interested in finding scholarly information via social media, which means that academics should improve their written communication skills for the lay audience and communicate more directly with research communicators, journalists, and news media outlets, which have bigger platforms in which to communicate broad messages to the public. Academics who increase their online visibility have the potential to make an impact in public as well as academic spheres.

Facebook

Altmetric tracks public Facebook pages; due to data access restrictions, Altmetric cannot track activity on private, personal, and Group pages. They do not count mentions on private pages, because they cannot link directly back to the mention, which they deem as essential context. Altmetric curates a list of public Facebook pages, and anyone can suggest a Page be indexed in their database for tracking. Posts made on public pages that link directly to a research output receive a weight of 0.25 to the total Altmetric Attention Score (AAS). Altmetric does not track likes, shares, or comments to Facebook posts that mention research outputs. (Altmetric, 2020a)

Demographics

Altmetric attempts to collect information on the geographical demographics of posts that mention research outputs on public Facebook pages (curated list). Altmetric differentiates between unique Facebook *pages* and Facebook *posts.* Posts to public pages can come from anyone and not necessarily the owner or moderator of the page, which means that it is more difficult to accurately track the geographical origin of the post; thus, there are more posts classified as “country not specified” (70.9%) compared to the geographical origins of the Facebook pages themselves (“country not specified” is 60.4%).

Altmetric Explorer Facebook Demographics (All research outputs tracked by Altmetric, 2012-2022)		
COUNTRY	**TOTAL FACEBOOK POSTS**	**UNIQUE FACEBOOK PAGES**
Country not specified	4,266,138(70.9%)	179,352(60.4%)
United States	831,318(13.8%)	59,743(20.1%)

United Kingdom	201,149(3.3%)	8,418(2.8%)
Canada	83,180(1.4%)	6,597(2.2%)
Australia	79,716(1.3%)	5,828(2%)
Brazil	47,729(0.8%)	3,256(1.1%)
Spain	43,380(0.7%)	2,495(0.8%)
Italy	38,043(0.6%)	2,439(0.8%)
Mexico	34,063(0.6%)	1,807(0.6%)
Germany	29,978(0.5%)	2,014(0.7%)
India	25,304(0.4%)	1,541(0.5%)
France	17,164(0.3%)	1,391(0.5%)

Literature review

Facebook has the largest population of active users (more than two billion) than any other social media platform. However, the majority of its activity is on private pages, posts, or groups' pages, which Altmetric does not track for the reasons listed in the introductory paragraph of this section. Therefore, it may appear that Facebook users have little engagement with research papers, especially compared to X, but a broader understanding of Facebook users' engagement with research outputs is relatively unknown due to data restrictions. However, a recent study found that almost two-thirds of PLOS ONE papers shared on Facebook happened outside public Facebook pages (Enkhbayar et al., 2020). Thus, the level of engagement with academic papers on Facebook is likely underestimated, especially when only looking at Altmetric data on Facebook shares. However, this study also showed that X users share academic articles from *PLOS ONE* more than Facebook users on public or private posts.

Publications from certain fields receive more attention on Facebook than others; in the biomedical fields, the following fields, based on Medical Subject Headings (MeSH) subfields,

receive more attention than all other MeSH subfields: General & Internal Medicine, General Science & Technology, Sports Sciences, and Complementary & Alternative Medicine (Mohammadi, Gregory, et al., 2020). Across broader fields, similar patterns can be observed for Facebook posts as for X, except that they are less common; Facebook posts are more likely to mention research articles across the biomedical and health sciences, social sciences, and life and earth sciences.

Another study indicates that Facebook shares of health and medical research may be an indicator of both academic and non-academic engagement, especially among health care professionals, who have previously been shown to use Facebook to communicate health care information with peers and patients (Bosslet et al., 2011). Over half of Facebook users sharing articles are non-academics and around a third of users represented health care professionals and communities; these results suggest that Facebook can act as a science communication tool between academics, professionals, and the public. In addition and in contrast to X, the majority of users posting links to academic papers were group accounts rather than individuals (Mohammadi, Barahmand, et al., 2020).

While some studies find a correlation between posts and future citation counts, one study found that Facebook *likes,* which are not tracked by altmetrics, can help predict future citations for psychology articles but not other fields (Ringelhan et al., 2015). In addition, in the biomedical sciences, the most popular articles shared on Facebook are either easier to understand for the lay audience or of more interest to the public (e.g., alternative medicine articles are more likely to be shared on Facebook but their mentions do not predict future citations), and in some cases, both are true (e.g., fields associated with chemicals and drugs) (Mohammadi, Gregory, et al., 2020). In other words, predicting future citation counts based on Facebook mentions is field-dependent, at least in the medical and health sciences.

Limitations

- **Errors & inaccuracies:** Facebook users' accounts sometimes get suspended, accounts get deleted, and individual posts get deleted; these posts still appear in the Altmetric Attention Details page and contribute towards the AAS. Altmetric also has some errors regarding the Facebook post date of publication, the DOI, the article date of publication; one study found the overall error rate for Facebook altmetrics data was 32% (Yu et al., 2021).
- **Coverage:** Altmetric can only track public posts on Facebook, which likely represent a tiny fraction of Facebook posts; in addition, most of the public pages are likely from organizational accounts rather than individual users (Mohammadi, Gregory, et al., 2020).
- **Demographics by location**: The majority of Facebook users are in India, followed by the United States, Indonesia, Brazil, and Mexico; Altmetric cannot identify the geographic location of a large majority of Facebook posts, and for those it can track, it finds that the majority of identifiable posts are from the United States. The data is inconclusive but also suggests that there is a Western bias towards sharing research articles on Facebook compared to other countries. In addition, Facebook is banned in China, North Korea, Iran, and Russia.

- **Current research:** There is considerably more research on X altmetrics than Facebook altmetrics, largely due to the data restrictions of Facebook user data. In addition, most of the Facebook altmetrics research tends to focus on health and medical research sharing.

Bias

Similar to X, there is a Western bias towards the use of Facebook, especially for users sharing academic articles. Facebook is also banned or restricted in a number of countries (Wikipedia, 2022).

Certain fields of research are of more interest to Facebook users than others, particularly the social sciences and the biomedical and health sciences, suggesting that users on this platform are more focused on social and health-related topics while technical, mathematical, or physical/chemistry topics are less relevant or appealing to Facebook users (Haustein et al., 2015).

Practical applications

Public Facebook shares can be used as a rough proxy for scholarly engagement with professionals and the public; Facebook is more likely to be used as a means to communicate research, especially health information, from professionals, practitioners, and communities to the general public (e.g., patients). However, even when studying the differences in engagement with research between X and Facebook, Facebook still has less direct engagement with research outputs. It's quite likely that Facebook users are more likely to interact with secondary sources of information, such as news articles and blog posts, on research-related topics. Therefore, direct sharing of research outputs on Facebook may represent non-academics in professional fields sharing information with the lay audience and using direct links to research articles to provide evidence of the information they share in their post.

If practical, researchers who find Facebook attention to their articles should investigate the context of the posts that link to their articles, such as the text of the post itself and the demographics of the poster. Such context can help reveal the reach and dissemination of their research, and potentially a science communication impact of their research. Similar to X, it is probably even more likely that Facebook users are sharing secondary sources of research, and therefore, it may be useful to search for news articles and blogs on Facebook that mention their research article; however, Facebook has a large number of private accounts and groups, which means it would be difficult for an individual to get an accurate count of mentions by simply doing a search.

In general, social media mentions tend to focus on research that directly affects human health and well-being, such as medical and health sciences, climate science, social sciences, and humanities; thus, researchers from more technical fields should not be discouraged by low numbers of social media mentions.

Facebook mentions to research articles, at an aggregate level, have a weak correlation with future citation counts, if any correlation, depending on the field. Thus, Facebook mentions are

likely an indicator of a different type of engagement or impact outside academia. In particular, articles shared on Facebook may be more translatable to the lay audience and serve as crucial indicators of science communication. Often, the public shares links to news articles and blog posts (secondary sources) about research, so finding Facebook shares of research articles, especially among professionals and practitioners, is encouraging of the dissemination of scientific knowledge to broader audiences. As always, investigating the context of such shares is important to discerning the meaning behind such mentions.

Reddit

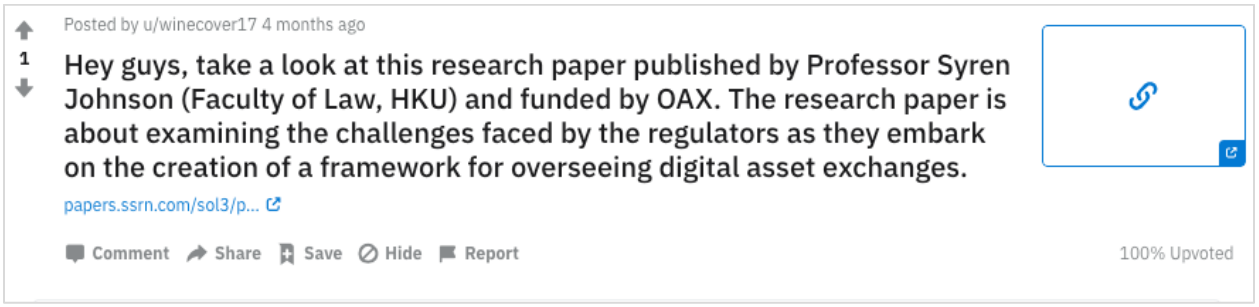
Reddit is a community and discussion social media platform. Reddit is organized into different sub-forums or communities called *subreddits* (e.g., https://www.reddit.com/r/science/), which act as individual boards for anyone to begin discussions about broader or more narrow topics.

Altmetric tracks Reddit attention via their API and the data is updated on a daily basis. They track all subreddits but cannot track comments or posts on user pages; for example, if a comment on a post links to a research output, Altmetric cannot track at that particular level of engagement on Reddit.

Altmetric automatically collects attention from *subreddits* if they contain a *direct link* to a scholarly output within the *header*. If the link to the research output is now in the header, then it cannot be tracked by Altmetric.

For example, the format of this post cannot be tracked:

while this format can be tracked:



This is an unfortunate limitation given that Reddit users who organize their posts more formally cannot be tracked by Altmetric.

Demographics

According to one report, only about four percent of U.S. adults report using Reddit, but of those users, 70 percent of them report using Reddit as a news source, but not their sole news source; two percent of all U.S. adults report getting their news from Reddit. In addition, 62 percent of posts link to an outside source. Reddit users tend to be balanced in terms of gender (49% men, 51% women), but 71 percent of Reddit *news users* are men. A large majority of Reddit users are under the age of 50 (93%) (Barthel, 2016). Not surprisingly, the majority of researchers who host Ask Me Anything sessions on r/science are also young (62% under the age of 40). The majority of these researchers were white (90%) (Hara et al., 2019).

Reddit users tend to be heavy Internet users, but they make up a relatively small percentage of the general population, which may be why Reddit is not as studied as other social media platforms in the altmetrics literature, such as X, which has the highest number of mentions to research outputs (nearly 190 million mentions on X versus approximately a half million mentions on Reddit, according to Altmetric, April 2023).

The table below shows the top ten subreddits by Altmetric events (i.e., the subreddits with the highest number of posts that link directly to research outputs in the header). The table demonstrates the topics in which users engage most with research outputs on Reddit; these are broad categories on Reddit (known as subreddits) (Donathan, 2023; Donathan & Bowman, 2022).

Subreddit	Members	Altmetric Events
science	22394701	23626
todayilearned	3116920	5262
drugnerds	81826	3322
nootropics	17478	3295
machinelearning	14511	2842
psychology	527900	1887
futurology	13968603	1812
australia	40465	1726
environment	95778	1651
physics	68663	1510

Table 11. Top 10 subreddits based on number of mentions (Altmetric.com data dump (2019)) (Donathan, 2023)

Reddit is a relatively under-studied source of attention in the altmetrics literature, but it does show promising potential as a source of direct science communication between researchers and the lay audience, especially when researchers host Ask Me Anything (AMA) sessions on subreddit channels (Hara et al., 2019). In another study examining AMA sessions hosted by scientists, Edwards and Ziegler (2022) found that there are several mediators in the science communication process on social media and that it is less likely to occur directly between scientists and the public; such mediators include forum rules, human moderators, Reddit's voting system, and automated software bots, which can have negative and positive consequences, e.g., Reddit's AutoModerator (AutoMod) engages in rule enforcement while automated bots on Facebook and X sometimes contribute to the rapid spread of misinformation.

While X may have the highest number of mentions, the majority of those mentions tend to act as publication alerts or sharing of research papers among academic communities; whereas there are approximately 400 times fewer Reddit mentions to research outputs compared to X, the interaction with those mentions tends to be richer, more contextual, and often represents a more direct engagement between researchers and the lay audience or general public, though moderators often contribute to such communication. In addition, the researchers who host AMA sessions reported positively on their experiences; the researchers also reported positive experiences in collaborating with colleagues on the AMA sessions, a surprising finding given that most science communication efforts are done individually, especially in the more traditional method with news media and journalists.

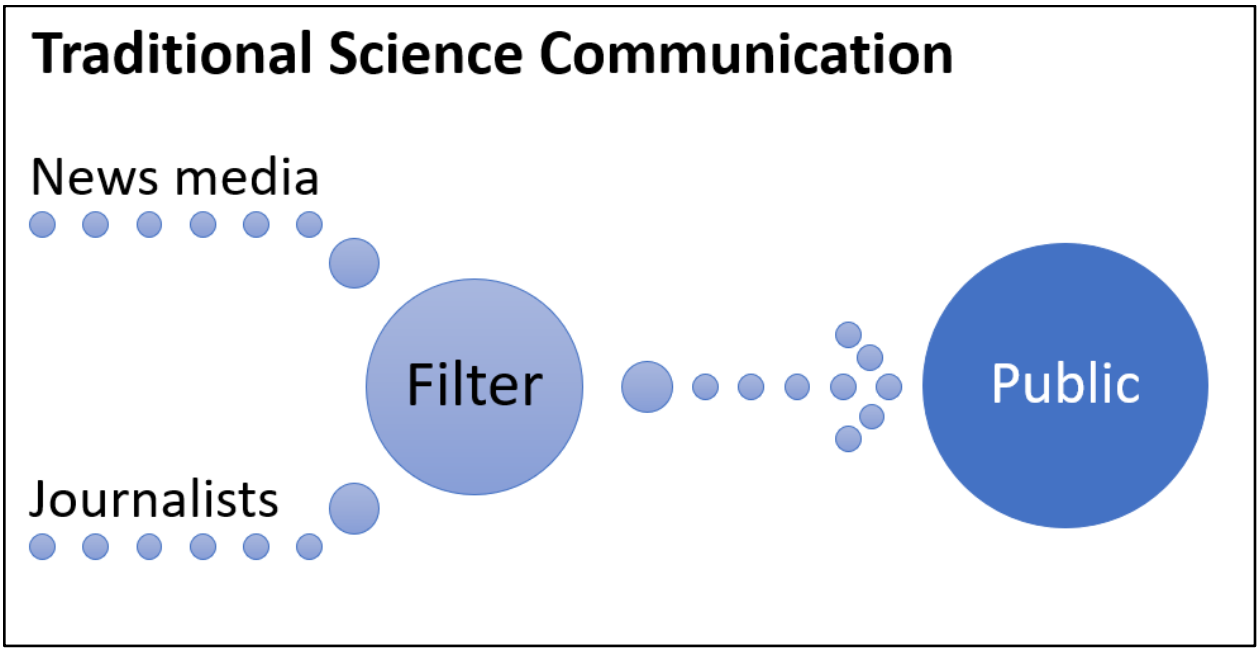


Figure 11. Traditional science communication is one directional, typically with journalists conducting interviews with individual researchers, writing their news article, editorial work, and then publication and promotion of the article.

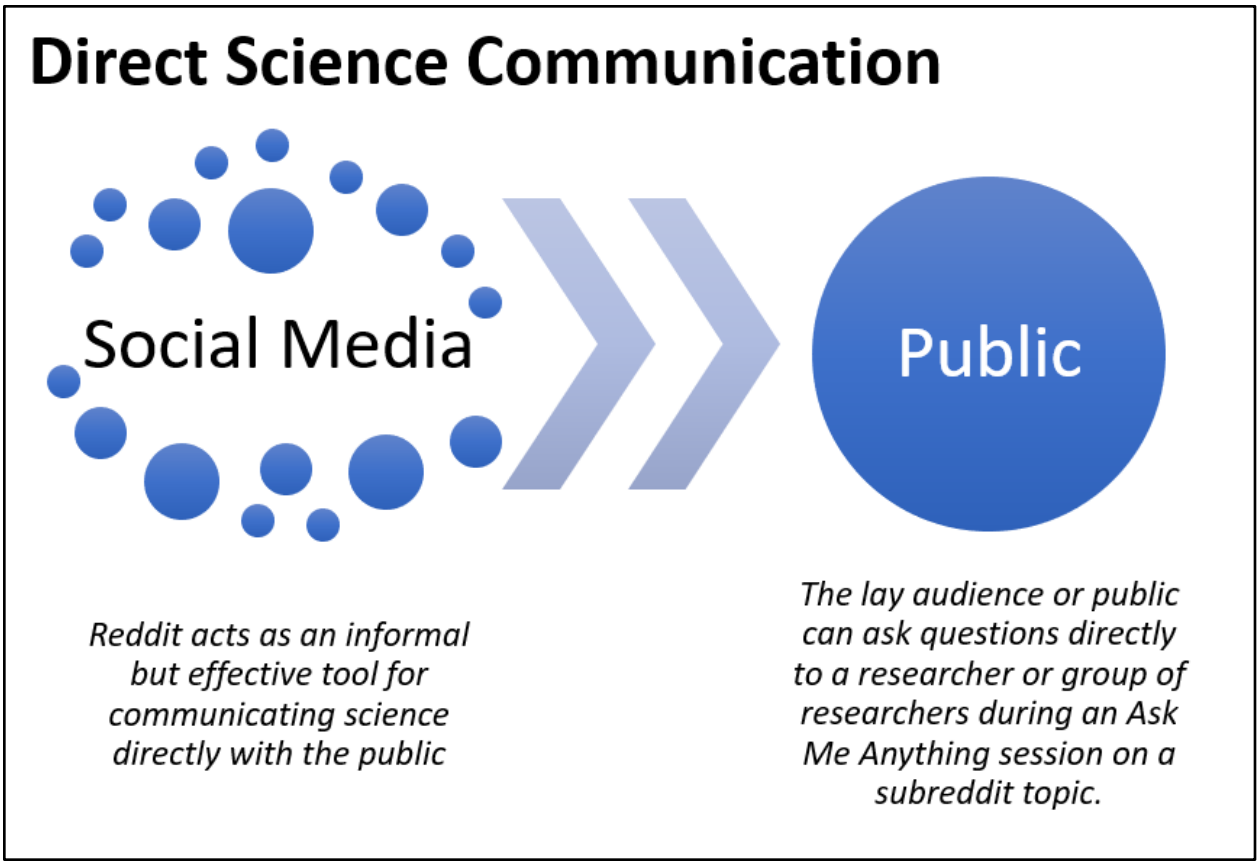


Figure 12. Direct science communication can now exist with the Internet and social media, and Reddit provides a unique opportunity for engaging discussions between researchers and the public, such as during an Ask Me Anything session on Reddit. However, moderators often exist during these efforts, such as human and non-human moderators, forum rules, and voting/rating.

Limitations & bias

The majority of users on Reddit tend to be white, educated, and liberal, which is not entirely representative of the demographics of the U.S. population. In addition, Altmetric can only track links to research outputs in the header of a subreddit post, which means there is probably much more engagement with research outputs than what Altmetric reports (e.g., the link section, comments).

Reddit is also primarily an English-language site (as of 2021 it has begun supporting French, German, Portuguese, Spanish and Italian in product). Statista estimated Reddit visits by region in 2020 (Degenhard, 2021). This estimate placed visitors from the United States (222 million visits in 2020), followed by Australia (17 million visits) and India (14 million visits) amongst others. Reddit has not published demographic user data.

The quality of engagement with the mention is not accounted for by Altmetric, e.g. a research output on a subreddit post with hundreds of comments would be awarded the same Attention Score as a subreddit post with no comments (0.25 points contribution per post).

Practical applications

There is limited altmetrics research on Reddit, mainly because it is a tiny fraction of all mentions on Altmetric, making up only about 0.2% of all mentions. However, if a research output is mentioned and discussed on Reddit, the depth of that discussion can make up for the lack of mentions. In addition, researchers interested in science communication efforts can be encouraged by the previous research on Reddit engagement with research. For example, researchers who host an Ask Me Anything session on a subreddit topic may receive valuable feedback from the general public on how they communicate, what they communicate, and how they can improve their communication overall. Furthermore, such engagement with the public can demonstrate diligent outreach. If a researcher finds Reddit engagement with their research which they did not contribute to, the context is crucial. The researcher should go to the subreddit thread and sift through the discussions to determine how their research is being discussed and interpreted by the layperson. Such context could be informative to the researcher and/or help to assess their own science communication efforts as well as understanding how readable their research article is to the general public.

Historic Data: Google+, Pinterest, LinkedIn, and Sina Weibo

There are few altmetrics studies on Google+, Pinterest, LinkedIn, and Sina Weibo, mainly because each of them had short windows in which Altmetric could or did track their activity due to each platform's updated data restrictions between 2013 and 2015. In the case of Sina Weibo, the "cost became unaffordable when they stopped distributing data to external companies and ever since started up using Socialgist as their sole non-Chinese data broker" (based on the author's personal communication with Euan Adie) (Yu et al., 2017, pp. 3).

Google+ had a longer window of activity to study (from 2011-2019), and it officially retired in 2019; however, Google+ as a social media platform never really "took off." Thus, its engagement with research was also relatively low. Here are the Altmetric date coverages of these social media platforms:

Social Media Platform	Coverage began	Coverage ended
Google+	Oct 2011	January 2019
Sina Weibo	Mid-March 2014	July 2015
LinkedIn	Early 2013	March 2014
Pinterest	Oct 2011	June 2013

Source: Altmetric Sources Coverage Dates, Altmetric, 2022

Sina Weibo is the most widely used microblogging platform in China; most of its users are Chinese (97.2% for the period of 2014-2015). There are a handful of Sina Weibo altmetrics studies, and most focus on how it is a unique and geographically local area of study, especially because China restricts the use of other social media platforms, such as Facebook, X, and YouTube.

There are no known studies that focus solely on LinkedIn or Pinterest altmetrics, and overall, there appears to be very little data available to make firm conclusions about these two platforms' engagement with research outputs. According to Altmetric, for LinkedIn, there were 1,876 mentions (from 1,571 individual posts); these mentions were shared between 2011 and 2014.

Demographics

Historic data from Sina Weibo, Google+, LinkedIn, and Pinterest shows very little activity and engagement with research outputs on these social media platforms, each with less than 1% of coverage on Altmetric compared to other attention sources (e.g., X, Facebook, news media, etc.).The only three sources having lower coverage than these are Peer Review (PubPeer and Publons), Video (YouTube), and Q&A. Policy, Reddit, and F1000 (now known as Faculty Opinions) are of similar coverage level (<1%).

Platform specific demographics:

- **Sina Weibo:** most users are Chinese (97.2%).
- **Google+:**
- **LinkedIn:**
- **Pinterest:**

Literature Review

Google+: Although dated, one significant study found that **Google+ had the least presence of research articles** (0.7%) compared to X (21.5%), Facebook (4.7%), and blogs (0.8%). While Google+ posts mention research articles rarely, there was a slightly higher prevalence of posts to articles from the social sciences and humanities (1.1%). Google+ posters were slightly more likely to share links to article document types than Facebook and X posters (Haustein et al., 2015). Interestingly, this study also showed the strongest correlation, though still weak, between Google+ shares and future citation counts (0.209; n = 10,082), with news, blogs, Facebook, and X mentions having lower Spearman values.

Weibo: In a study comparing Weibo altmetrics to X altmetrics (Yu et al., 2017), researchers found that Weibo users pay more attention to higher impact journals than X users, likely because Chinese universities have direct financial incentives for publishing in high impact journals. X users discuss more diverse sources, including research outputs on Figshare, which includes non-peer reviewed content, such as presentation slides. Both social media platforms pay equal attention to medical sources, indicating equal interest to such research across the globe. Interestingly, while X users are more likely to reflect the text of the title of the article, the conclusion of the article is more likely to be discussed or reiterated in weibos. Weibo users tend

to have similar motivations for sharing research outputs to X users, with the majority of highly weiboed articles being shared to disseminate and introduce users to the content. Other motivations are to “to highlight or elaborate the academic usage, practical usage, interesting parts or surprising parts” (pp. 14), which is in accordance with previous X altmetrics studies.

Pinterest: Most studies eliminate Pinterest from their analyses, because there is insufficient data available to make firm conclusions. Data was pulled from Altmetric Explorer to determine the most popular fields of research shared on Pinterest (Table 12).

Subject	Percentage of Pinterest Mentions (N=3,998)
Medical and Health Sciences	57%
Biological Sciences	39%
Biomedical and Clinical Sciences	39%
Psychology and Cognitive Sciences	16%
Earth Sciences	10%
Human Society	8%
Engineering	7%

Table 12. Percentage of Pinterest mentions by Field of Research

LinkedIn: Most studies eliminate LinkedIn from their analyses, because there is insufficient data available to make firm conclusions. Data was pulled from Altmetric Explorer to determine the most popular fields of research shared on LinkedIn (Table 13).

Field	Percentage of LinkedIn Mentions (N=1,673)
Medical and Health Sciences	60%
Biomedical and Clinical Sciences	37%
Biological Sciences	24%
Engineering	21%
Commerce, Management, Tourism and Services	19%

Information and Computing Sciences	14%
Chemical Sciences	13%
Psychology and Cognitive Sciences	11%

Table 13. Percentage of LinkedIn mentions by Field of Research

Limitations

Few studies have investigated the altmetrics activity of Google+, Sina Weibo, Pinterest, and LinkedIn, mainly because Altmetric only had a short window of time in which they were able to track user activity with research outputs on these social media platforms. Therefore, little is known about how users interact with research outputs on these social media platforms. What is known is that these platforms have little activity with research outputs compared to other sources, such as X, with each platform accounting for less than one percent of the Altmetric coverage during the periods in which Altmetric was tracking the activity.

Bias

Google+, LinkedIn, and Pinterest are primarily used in Western countries. Sina Weibo is primarily used in China. Therefore, there are obvious geographic differences in their uses. Weibo users also tend to be more likely to mention articles from prestigious journals compared to X users. Weibo users make for an interesting study of local altmetrics data, which represent a very small percentage of altmetrics research, mainly because most studies use data from large commercial databases, such as Scopus and Web of Science, which are reflective of the Global North and English-language literature.

Practical applications

There are not many practical applications of altmetrics data from the four social media platforms where only historic data exists, because the time frames in which data was collected were short and their users had little interactions with research outputs. Therefore, there was typically not enough data for researchers to include these platforms in their altmetrics studies. There are a few studies in which Google+ was included in researchers' analyses, and there are a handful of studies that focus on altmetrics data from Chinese users, which includes Sina Weibo.

Most of the activity from the historic data for these platforms occurred between 2013 and 2015, with Google+ being the exception. Therefore, there will not be current or recent data on interaction with research outputs on these platforms. Interested users can do searches for article titles and DOIs on these platforms to attempt to find more recent activity around a specific research output for their own purposes. The context of the mentions to individual research outputs is important for interpretation (e.g., purpose and motivation of the mention).

Patents

Definition

A patent is the granting of intellectual property rights by an authority to an inventor to their invention or discovery, and the rights are usually in reference to the process, design or innovation for a period of time. Patents can cite other documents including other patent documents and research publications. There is no limit to how many research publications a patent might cite. Altmetric tracks citations from patents *to* articles/publications and not the reverse or patent-to-patent citations. For the Altmetric Attention Score, patent citations are scored per jurisdiction not per patent, so two patent citations from the same jurisdiction will contribute 3 points to the score while two patent citations from two jurisdictions will contribute 6 points.

Data Source and Coverage

Altmetric collects patent data via Dimensions from the aggregator IFI Claims, which was acquired by Digital Science (Altmetric's parent company) in 2021.

The coverage is from patents filed from 1994 onwards and refreshes from Dimensions on a fortnightly basis. It is not clear how frequently Dimensions updates from its source. Many countries/legal jurisdictions are included in the IFI Claims aggregator and can be found in the 'Country' column of this table. Because of the inclusion of the World Intellectual Property Organization as a source, it seems like many Global South national patent offices may also be covered. IFI Claims states on its website that its bibliographic data covers 100 countries.

Literature review

Patents often cite other patents, because they are building on previous inventions and discoveries or renewing or modifying an existing patent. They sometimes cite academic research, though, which can be an indicator of a relationship of commercial or economic value. Patent citations to academic articles are rare, with less than one percent of journal articles receiving a patent citation in most fields, but this proportion is larger for biomedical engineering, biotechnology, and pharmacology & pharmaceutics (7-10%) (Kousha & Thelwall, 2017; Thelwall, 2020).

Limitations

It seems reasonable that in many, but not all cases, that patents will generally be indicators of impact for research with science and technology applications, and so likely to be less relevant for arts and humanities research.

It also should not be assumed that patent citations are conclusive indicators of impact; with research suggesting that they do not capture "private and contract-based knowledge flows… (and) that firms' patent and citing strategies affect patent citation… can lead to substantial underestimation of the effect of public research on firms' innovative performance" (Roach &

Cohen, 2013, pp. 1). There are many ways that research and researchers can interact with industry and innovation, and patent citations must never be relied on as a sole indicator to assess this.

Practical applications

Using patent activity to demonstrate knowledge exchange or economic impact is widely accepted, but it should be remembered that:

- Researchers who file patents are likely to cite their own research in the application, known as ‘inventor-author self citation’. Although this is perfectly legitimate, it should be considered.
- Some research suggests that many ‘Sleeping Beauty’ publications, that is publication that goes unnoticed for a long time before suddenly attracting attention, are application-orientated and go on to be heavily cited by patents (van Raan, 2017). This could suggest a longer citation lifespan for outputs cited by patents, and so analysis based on patent citation might benefit from being inclusive of longer citation windows.
- Patent citations can be studied like scholarly citations in many ways, such as evaluating their geographical, authors’ demographic, and subject category data.

Related sources of attention

Patent citations are quite unique and can be studied similar to how scholarly citations are studied. They could be used in network visualization software tools to visualize connections and influences of research on patents / industry.

Peer Review

Definition

Altmetric tracks two post-publication peer review websites: PubPeer and Publons (PubPeer is no longer tracked but historic activity is archived). For the Altmetric Attention Score, each public review (not a comment on a review) contributes 1 point towards the score.

Data source and coverage

PubPeer is a public comment forum for articles published in journals. PubPeer encourages constructive discussion of the scientific content of published research including research integrity and conduct (Callaway, 2015). The organization is a non-profit US-based foundation. Altmetric stopped tracking new PubPeer comments in 2019 but prior activity is maintained.

Publons operates both pre-publication and post-publication peer review commentary, but Altmetric only reports post-publication peer review. Publons is a commercial product owned by Clarivate Analytics, also the owner of the Journal Citation Reports and the proprietary Journal Impact Factor and is integrated into their Web of Science platform. It is also a major part of Publons profiles, which is the only scholarly profile system in which users can list the journals in which they have completed peer reviews as well as their post-publication Publons peer reviews.

As of May 2021, Altmetric tracks more than 147,000 unique outputs with post publication peer reviews from both sites. Activity dated from 2019 onwards is exclusively Publons. This is likely a minority representation of the global post-publication peer review corpus as the two largest by number of users academic networking sites that permit Comments, Academia.edu and ResearchGate (71 million users and 17 millions users respectively claimed), are not Altmetric sources. However, ResearchGate and Academia.edu act more as scholarly networking sites and sites for sharing or claiming publications.

Literature review

Any instance of a public post-publication peer review comment on PubPeer (to 2019) or Publons to an output contributes one point to the Altmetric Attention Score. The maximum that any quantity of comment on either site can contribute to the Altmetric Attention Score is one, so a single comment or multiple are all valued the same by Altmetric.

It is not clear how, without further investigation and context, post-publication peer review should be used as evidence of alternative impact. PubPeer is a forum for mostly anonymous discussion of research integrity with some notable cases of the PubPeer forum assisting identification of misconduct sometimes resulting in journal correction or retraction. Publons reviews can be left by any internet user and credentials are not verified.

Limitations

Research indicates disciplinary biases in Publons, identifying an overrepresentation of Life Sciences research (comprising 40.2% of the database in comparison to 18.3% of outputs in Scopus) and an underrepresentation of Physical Sciences and Engineering (comprising 18.3% in Publons compared to 43.2% in Scopus). Article coverage also varies by publisher and depends on whether or not the publisher has contractual arrangements with Publons or not (e.g., Frontiers Media is overrepresented at 44%) (Ortega, 2018).

No data on the language or regional usage of Publons and PubPeer could be found. Although both sites can be integrated with non-English language journals, it seems that the online communities and commenting/reviewing is mainly in English-language.

Correlations between Publons metrics and citation counts are weak and statistically insignificant. However, Ortega points out that the design of Publons, which allows anyone to post, does not allow the platform to properly or accurately capture the academic views of its users. For example, only one user is responsible for scoring 92 percent of articles reviewed on Publons, which presents huge limitations and biases. In addition, there are two components to scoring a Publons article: scientific or methodological rigor and influence or importance of the article; however, the lack of difference in these scores suggests that users treat them the same.

Practical applications

Mentions to research outputs on Publons or PubPeer should be carefully evaluated and interpreted. Anyone can post a comment or review on these sites, and for any reason. For example, academic conflicts could lead to negative reviews on Publons. Such post-publication peer reviews can also signify, at least in theory, academic impact or influence after publication. In addition, some of the comments or responses could be evaluated to discern if non-academics are involved in the discussions to evaluate their perspectives as well. Context of the reviews is crucial; however, it is not possible to verify the user or their credentials or credibility.

Related sources

There is similarity between Peer Review and Faculty Opinions, which is also an online post-publication peer review community. The two differ because Faculty Opinions is post-publication review by invite-only named academics; whereas Publons and PubPeer have different levels of anonymity and are open to all web users.

Syllabi (Historical data only)

Definition of indicator

Mention of an output on a syllabus found on Open Syllabus. Any output identified by Altmetric as existing in the Open Syllabus data is awarded one point, regardless of the number of times mentioned or the context. An output mentioned once on a single syllabus would receive the same 1 point to the score as an output found on thousands of syllabi.

Data source and coverage

Altmetric's syllabus content is exclusively derived from Open Syllabus data. Open Syllabus is a non-profit research organization that provides citation information for and analyzes over 18 million English-language syllabi from 140 countries by crawling publicly-available university websites. It uses machine learning and other techniques to extract the citations and metadata. It has four online tools, one of which is free to use, the Syllabus Explorer; users can explore course syllabi based on the title, author, school, field, country, and publisher of the textbooks, books, book chapters, and journal articles listed on syllabi. It also receives some content through contributions of syllabi from course leaders, instructors, and students. Open Syllabus describes their data corpus as comprising majority textbooks versus other output types.

Altmetric stopped receiving data from Open Syllabus in 2015, so their data coverage is from 1996 to 2015. However, Altmetric only tracked books, not book chapters or journal articles or other output types. The book would have to be added to a syllabus before 2015 to be tracked by Altmetric, regardless of its publication date.

When Open Syllabus data is displayed in Altmetric Explorer, users are prompted "*This data is correct as of December of 2015 - for more up to date information, please visit https://opensyllabus.org*."

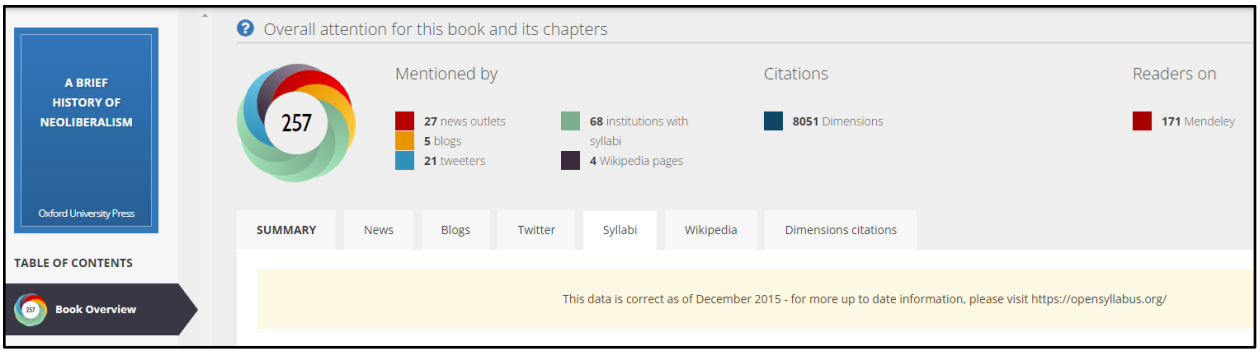


Figure 13. Altmetric Explorer users are prompted that Syllabi data is correct as of December 2015 and to visit Open Syllabus for more up-to-date data. Screenshot taken May 25, 2023.

Literature review

This source requires careful interpretation. The capping of any volume of mentions at 1 point towards the Altmetric Attention Score, combined with the way that some highly influential sources, e.g., some of the outputs shown in Figure 14 (below), are recorded by Altmetric mean that this source is limited in usability. This, combined with Altmetric's warning about data correct to December 2015 means that those interested in syllabi data are probably better, to at minimum, check all data taken from Altmetric on this source, and possibly instead use the free Open Syllabus Explorer rather than Altmetric to explore this data.

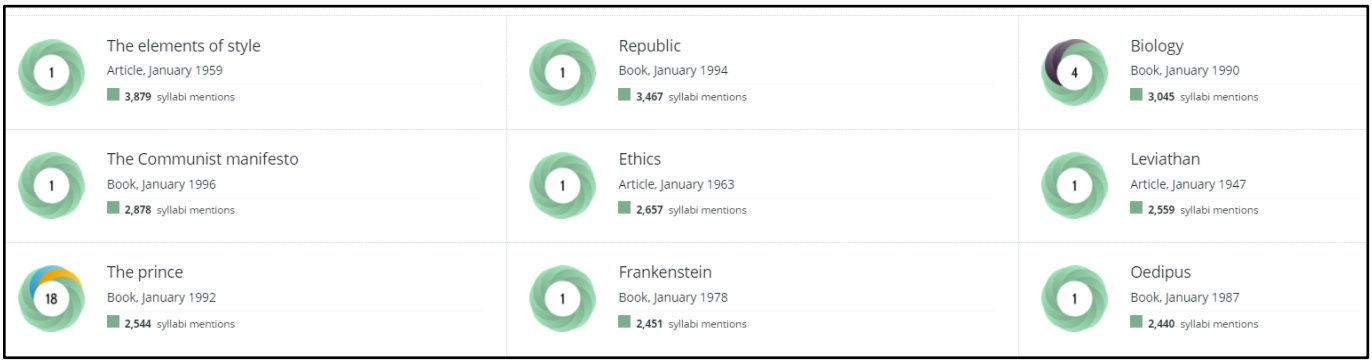


Figure 14. Examples of highly impactful outputs that, due to Altmetric indexing and capping of Syllabi data to value of 1 point in the Altmetric Attention Score, do not appear to be meaningfully captured by Altmetric using Syllabi data. Screenshot taken May 27, 2023.

Limitations and Bias

Although the syllabi collected represents around 140 countries, it is limited to English-language syllabi only. As of 2019, over half of the syllabi covered are from US-based institutions (Harzing, 2019). This is a severe limitation to understanding impact in both non-English language teaching institutions and of non-English language sources. The Open Syllabus project also excludes approximately 70 countries for inclusion due to concerns for academic freedom and teaching choices for those faculty and instructors living in those countries (Open Syllabus, 2023). It also shows only the underlying metadata of syllabi, such as the description and learning outcomes, and it does not identify individuals.

Open Syllabus does not index or share the digital identifiers (e.g., DOI) for the underlying research outputs and educational resources mentioned in syllabi. Therefore, it was too difficult for Altmetric to track, and even before they stopped tracking it. In addition, the platform launched its own analytics tools which likely made them hesitant to share their data with a potentially competing product.

Practical applications

On account of Altmetric no longer tracking Open Syllabus, it is recommended that users do a Title or Author search on the Open Syllabus Explorer directly to find mentions of research outputs. Research managers and administrators interested in analyses of their units can also do a School search, which will allow them to filter by their institution or school; it can further be filtered by field after selecting an institution, though not by college or department.

Usually, books and journal articles mentioned in syllabi tend to be more readable, digestible, and accessible for a larger audience, such as undergraduate students. They can be interpreted as providing educational value or impact, and more generally as a broader dissemination of knowledge to those studying in universities.

Related indicators

Reference Managers and Research Highlights might be used in combination with Syllabi to demonstrate impact on teaching and faculty use of an output.

Multimedia

Definition of indicator

Altmetric tracks video content and Q&A posts. Any output identified by Altmetric as mentioned by YouTube or StackExchange is awarded one point, regardless of the number of times mentioned or the context.

Data source and coverage

YouTube: a link to a research output is included in the video description. Most of the research outputs cited in videos are related to medicine and biochemistry, while the videos mentioning these outputs are typically in either the Science & Technology or Education category on YouTube (Shaikh et al., 2023). As of May 2023, there are 470,687 mentions from 156,343 videos on YouTube (data from Altmetric Explorer).

StackExchange: StackExchange is a free Question & Answer forum and a privately held business headquartered in the United States. Amongst the communities in StackExchange, the largest is Stack Overflow, the largest online computer programming network. To be tracked, a link to a research output must be included in a Question or Answer post. If there is attention to a research output, it will be included on the Q&A tab of an Altmetric Details Page. As of May 2023, there are 66,634 mentions from 36,026 posts on StackExchange (data from Altmetric Explorer).

While some Altmetric attention sources rapidly accumulate data within days of publication, others do not, which includes both YouTube and StackExchange/Q&A. Others with slower data accumulation include policy, peer review, and Wikipedia; therefore, older documents are more likely to have attention from these sources.

Literature review

YouTube has over 2.5 billion active users, as of January 2023, making it the second most used social media platform, after Facebook. (Dixon, 2023). YouTube is often a part of people's daily lives and has changed how information is shared worldwide. Several studies have found that YouTube has acted as an important learning tool, such as for sharing health information (Madathil et al., 2015) or learning anatomy in medical school (Jaffar, 2012). It is difficult, however, for YouTubers (or those who create and distribute content on YouTube) to reach large audiences, because of the massive quantity of content available on YouTube; therefore, it can be difficult to gauge the impact of a research output mentioned on YouTube. Interestingly, previous research has found that user-created content is more popular than professionally generated content (Welbourne & Grant, 2016), locally relevant videos gain more traction from users in their own regions (Brodersen et al., 2012), and offline social capital contributes strongly to virality (Feroz Khan & Vong, 2014). One recent study found that research outputs first mentioned in the news or on X helped predict their mentions on YouTube as well as the subscriber count of the channel; furthermore, this study found that YouTube mentions helped

increase popularity of the research outputs in the research community and eventually increase their citations. The researchers also found that the comment section did not correlate highly with views of videos mentioning research outputs, which might suggest a hesitancy to comment publicly on research articles (Shaikh et al., 2023).

StackExchange: unfortunately, due to insufficient data available from Altmetric on mentions to research outputs on this platform, Q&A is often removed from analyses and published altmetrics studies.

Limitations

Similar to Reddit needing to have a link to the output in the header, YouTube is limited by the need for the link to the research output in the description, so any references to the research output in other parts of the source, e.g., in a comment or as the actual topic of the video, without correct linking will be missed.

The quality of engagement with the mention is not accounted for by Altmetric, e.g. a research output linked to by a YouTube video with millions of views would be awarded the same Attention Score of one as a video with no views. This is the same for StackExchange where the source activity could have been highly engaged with or not at all.

YouTube is available in over 80 languages and localized to over 100 countries, with the four of the top five countries by number of monthly users outside of first-language English regions (India, Brazil, Japan and Russia) (Dean, 2023).

Practical applications

YouTube: a mention on YouTube can indicate consumption of research in a secondary source by the general public. The research on this topic demonstrates that YouTube content with mentions to research outputs is usually consumed for educational purposes, and sometimes entertainment purposes. Interestingly, YouTube mentions tend to be preceded by X and news media mentions; the view count of the video mentioning the research output then helps to predict future citation counts. Therefore, science communication efforts on social media and in

the news can help lead to future citation impact.

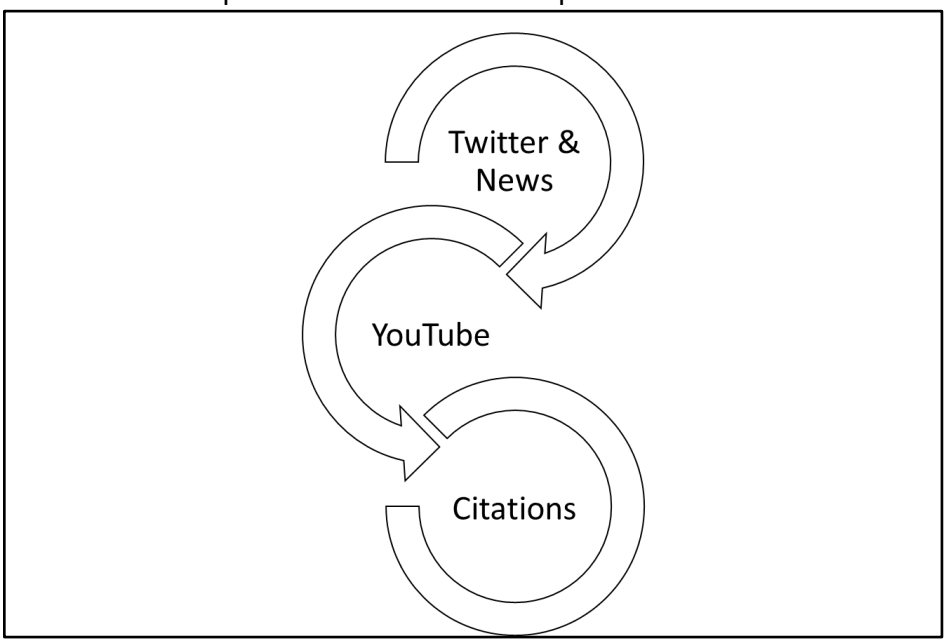


Figure 15. Flow of research mentions from X and news media to YouTube to scholarly citations.

StackExchange: a mention on StackExchange may indicate engagement with a research output from the general public and/or direct or indirect science communication, similar to how users interact with research outputs on Reddit. However, there is insufficient evidence in the literature to make a firm conclusion. Those evaluating mentions on StackExchange/Q&A should investigate the context of the post and any comments or discussion.

Related indicators

Reddit and other social media mentions can indicate similar engagements with research outputs, but context is important for understanding a mention across multiple social media platforms.

Public Policy Documents

Definition of indicator

Altmetric tracks citations in policy documents, such as government guidelines, reports, white papers, independent policy institute and research institute publications, advisory committees on specific topics, and international development organization publications. Mentions in policy documents are scored 3 points per source, regardless of the number of documents from that source that mention the resource output.

Data source and coverage

As of May 2023, Altmetric has tracked 3,358,151 mentions to research outputs in 529 unique policy sources from 63 countries; Altmetric does not report on the number of policy documents, only the number of policy sources and mentions. Altmetric reports that growing its policy sources is an ongoing priority (Broadberry, 2023). They reported that from 2020 to January 2023, the Altmetric policy database has grown from 83 policy sources and 23 countries to 514 sources and 60 countries; it has clearly grown in the past five months as well.

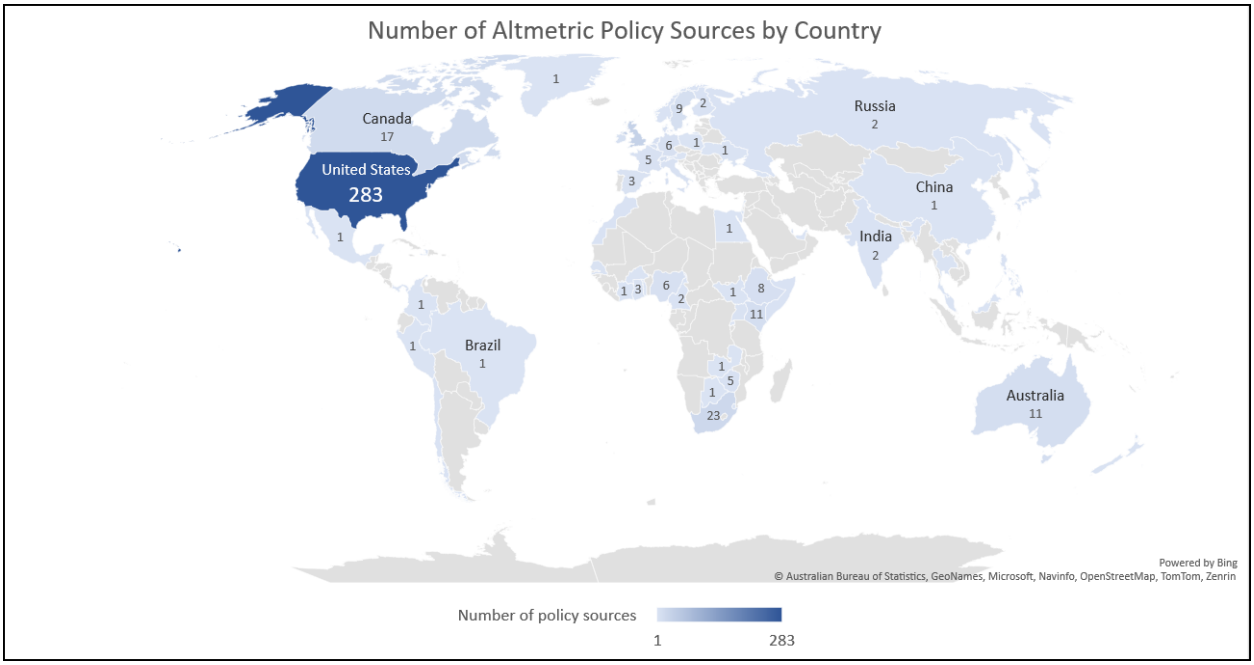


Figure 16. Number of Altmetric Policy Sources by Country. Data retrieved from Altmetric Explorer on May 30, 2023 and visualized using Excel.

Interestingly, the countries with the highest number of policy sources are not necessarily the countries with the highest number of mentions. For example, South Africa has the third highest number of policy sources (23) but is in 19th place in terms of number of mentions (8,612). See Table 14 for the top ten countries in terms of the number of mentions.

Country	Number of mentions
United States	1,149,850
Switzerland	659,846
United Kingdom	485,588
Italy	186,678
Netherlands	131,799
Luxembourg	114,481
Canada	105,141
Germany	97,801
Sweden	76,851
Denmark	68,275

Table 14. Top 10 countries with the highest number of policy mentions

Literature review

Evidence of mentions in policy documents may help scholars describe the impact of their scholarship on populations outside of academia. In particular, policy mentions can help provide evidence of societal impact; however, such mentions should be contextualized to determine why it was cited and if it was taken out of context, such as cherry-picking research to move political agendas forward. Unlike scholarly publications, there are no standards or protocols for citing sources in policy documents, which leads to difficulties in tracking citations. Western countries appear to provide more formal citations than Eastern and Global South countries.

The definition of a policy document varies, depending on the source of the information, but in general, these include documents written for or by policy or law makers. Such documents *can*

lead to meaningful policy change, but not always; for example, a policy document may eventually lead to a meaningful government strategy that improves lives, or the policy document could be more of an idea-generating proposal that eventually gets thrown out, or it could get filed away and ignored.

Limitations

Because Altmetric is using text mining and fuzzy searching to find mentions of outputs, as opposed to matching directly on a link, they are more limited to English-language sources that are susceptible to this methodology. While Altmetric welcomes suggestions of new policy sources to add, whether or not those sources will actually be added depends mainly on whether Altmetric has the technological capability to identify mentions in policy documents from that source.

A 2017 study found that fewer than 0.5% of papers indexed in Web of Science are cited by policy documents in Altmetric (Haunschild & Bornmann, 2017). There are a few possible explanations for this:

- Few to no standards for proper citations and linking to them in policy documents, likely because policy authors are not researchers themselves
- Coverage of policy documents is quite low
- A small part of the literature is relevant to policy
- Low interaction between researchers and policy makers

Altmetric does not index the full-text of policy documents. However, users can access the link to the policy document directly from the Altmetric Details Page and find the context of the citation through a CTRL+F if they wish.

Altmetric does not provide a list of their policy *documents*. Subscribers of Altmetric Explorer can access the names of the policy *sources* and their countries by exporting a CSV file or via an API, or Altmetric will provide a list of the policy sources via a PDF if requested.
Some countries do not have functioning governments and/or central banking systems, which means they typically do not have policy documents available from these sources. In many cases, countries with low transparency and/or highly secretive governments do not make many documents publicly available, such as China and Russia.

Altmetric data on policy document mentions are not entirely accurate; however, the majority of the errors are a result of the policy website or the third-party bibliographic data provider (Yu et al., 2020).

Overton is a newer altmetrics data provider specifically focused on policy documents, and it is competing with the policy source side of Altmetric. Overton tracks citations from policy documents to research outputs as well as policy-to-policy citations. It also provides more context to the citations themselves, i.e., the snippet of text where the in-text citation occurs. Overton also indexes the full-text of policy documents, and it indexes many more policy sources (as of May 2023, eight million policy documents from over 1,600 policy sites from over 29,000 organizations across 188 countries) (Overton, 2023). Overton is an alternative or complementary source of altmetrics data; Overton may introduce more noise to their policy data due the automation of adding and contextualizing policy documents and citations; however, it has a greater size, depth, and breadth compared to Altmetric. However, Altmetric is still a valuable source of data for policy mentions to research outputs, especially if individuals only

have access to free sources, such as the Altmetric Bookmarklet, or their institution cannot afford to subscribe to other altmetrics data providers, especially one as specific as Overton.

Practical Applications

Policy citations can indicate an important and impactful type of societal and public engagement, especially because a research output used to support policy can indicate an influence on crucial changes in governance, laws, regulations, systems, and more. Research managers and administrators are taking more interest in societal impact, and this specific type of data may be of more interest to them in the near future.

Individuals should be careful in their interpretations of policy mentions to research outputs. Context is key. The type of administration, association, organization, or council should be taken into consideration as well as the country or region where the policy originated. If possible, the context of the citation itself should also be investigated to determine how the research supported the policy change or proposal. The type of policy document should also be investigated; certain publications are merely reports while others are actual federal agency policy documents codifying a new law or regulation. Some documents lead to meaningful change in people's lives, often referred to as 'real world impact,' while other policy documents may act more as reports that do not ultimately have any real world impact.

Evaluating context when exporting policy data on groups of researchers, such as colleges and departments, is more challenging. Experts in altmetrics and bibliometrics should be consulted to contextualize the data and show impact more broadly, such as by country, organization, and even text-mining the titles of the policy documents. In addition, more investigation should be undertaken to determine if the policy document(s) lead to real world impact; impact stories can be told about policy and/or real world impact, but it takes time and initiative to investigate. However, policy citations alone cannot be taken at face value as 'impactful.'

Related indicators

Public policy mentions to research outputs are quite unique, especially since they indicate a stronger societal impact. Mentions in patents are somewhat comparable in their academic impacts, though their type of impacts are quite different.

Wikipedia

Definition of indicator

Wikipedia includes many references on its free, online encyclopedia, many of which reference and link directly to research outputs, both in-text and in the reference list. However, Altmetric only tracks mentions with properly-formatted Wikipedia citation tags in the reference section; simply linking to a research article is not sufficient. If you need to fix or add a citation on Wikipedia, instructions on how to properly do so can be found on Altmetric's Wikipedia support web page (Altmetric, 2022a).

One or more mentions receives a contribution of three points to the Altmetric Attention Score (AAS), regardless of how many mentions received or the number of Wikipedia pages mentioning the output; Altmetric explains that this is because Wikipedia attention is not comparable to a news media mention, in terms of its reach and attention. It is also a static scoring to avoid manipulation of the AAS, because Wikipedia pages can be edited by anyone, including researchers themselves (Altmetric, 2021a); though Wikipedia pages are moderated, in part, by Wikipedia Administrators.

Data source and coverage

Altmetric tracks mentions to research outputs on Wikipedia in 34 languages:

- English
- French
- German
- Japanese
- Spanish
- Portuguese
- Chinese
- Italian
- Persian
- Arabic
- Polish
- Dutch
- Ukrainian
- Indonesian
- Turkish
- Hebrew
- Czech
- Swedish
- Vietnamese
- Finnish
- Korean
- Hungarian

- Catalan
- Norwegian
- Hindi
- Thai
- Bangla
- Greek
- Romanian
- Serbian
- Swahili
- Afrikaans
- Egyptian Arabic
- Uzbek

Altmetric does not track mentions on non-encyclopedic pages, such as user pages,Wiktionary, Wikimedia Commons, Wikibooks, and Meta-Wiki.

Literature review

In a 2022 study, researchers analyzed Wikipedia references over time in order to determine the characterization of Wikipedia editors; they found that the quality of Wikipedia references has slowly but steadily been improving. Therefore, they authors suggested that this opens a new opportunity for altmetrics data providers to create more contextual and meaningful analytics from such data to show the dynamics in references, the difference in fields on Wikipedia citing research, the demographics of the Wikipedia editors, and the context of the pages and citations mentioning the research outputs. For now, references in Wikipedia to research outputs show promising engagement with research with a valuable resource written for the lay audience. Overall, there is citation volatility on Wikipedia, because references often get permanently deleted from pages, something that is a rare occurrence in academic literature. For example, from 2007 to 2019, between 19.4% and 31.8% of total references were deleted every year. We further find evidence that there is a continuous effort to increase the quality of Wikipedia references, expressed in the constant rise of references added to Wikipedia and the increase of the ratio of modifications to creations, with the peak in the last three years, where there were 20–40% more modifications than creations.

In contrast to X, Wikipedia references are mostly created, modified, and maintained by registered editors (87.6%), with bots only making up around 1.6% of all references. Thus, most of the references curated on Wikipedia are human-created with bots mainly used to modify and update references throughout most of Wikipedia's history (Zagorova et al., 2022).

Research on Wikipedia, as well as international initiatives to improve it, has shown that Wikipedia is not only a popular source of information but also a reliable and credible source for gleaning basic information about a topic, particularly for medical information and the dissemination of medical research for the layperson. For example, Wikipedia emerged as a reliable and critical medical information source during the 2014 ebola outbreak (Cohen, 2014). It is also one of the most if not the most viewed medical resource globally, with over half of medical page Wikipedia editors being health care providers and 85 percent having a university

education (Heilman & West, 2015). In contrast to social media, especially during the COVID-19 pandemic, Wikipedia has acted as a reliable, current, and consistent source of medical information (Cohen, 2020; World Health Organization, 2020).

However, while Wikipedia can often be a credible source of information, it is not entirely accurate and should be treated with a healthy degree of skepticism with further evaluation of its content and cited sources (Chesney, 2006). Wikipedia is also often accused of being politically biased from both the right and left, but more often of being liberally biased. However, research has shown that the more a page is edited, especially by diverse and even polarized teams of Wikipedia editors on politically divisive topics, the more it becomes balanced over time (Shi et al., 2019), which is usually quite the opposite result of such interactions on social media platforms. However, other research shows a pro-Western bias, especially on the English Wikipedia (Hube, 2017; Morris-O'Connor et al., 2022; Nemoto, 2017).

Open Access content is more likely to be referenced in Wikipedia than paywalled content (Teplitskiy et al., 2017), which is not surprising, considering that Wikipedia editors and contributors are typically dedicated to the dissemination and communication of research, especially medical research.

Limitations

Proper citations are required for Altmetric to track the output on Wikipedia. Simply creating an in-text link in the text of the Wikipedia article is not sufficient. Therefore, there may be more citations to a research output than what Altmetric tracks.

References constantly get updated, added, and deleted on Wikipedia. If a reference is deleted, Altmetric will update its attention page details to reflect this. Therefore, a research output with attention on Wikipedia may not have that same attention next week or next year. However, it is worth noting that Wikipedia references have greatly improved and are continuing to improve.

Not all languages are tracked on Wikipedia, which limits the ability to track the reach of research outputs on Wikipedia, especially on a global scale.

There may be more gray literature cited on Wikipedia than traditional academic outputs (i.e., those tracked by Altmetric), but this is difficult to track; it seems likely, since many types of gray literature, such as reports, fact sheets, policy documents, and health information on websites, are more accessible and readable to the layperson than literature produced by academics (Thelwall, 2020).

Practical Applications

Mentions of research outputs on Wikipedia can be an indicator of the dissemination of knowledge to the lay audience or general public. Wikipedia is the most widely used encyclopedia in the world, and it is also crowd-sourced knowledge by experts and Wikipedia administrators and editors. Wikipedia can also act as a reliable source of information in times of crisis, such as during the ebola epidemic and the COVID-19 pandemic. It has been described as the "last best place on the Internet," because it takes more time and effort to disrupt the

information and its organizational structure than it does to correct it; the opposite is true of social media (Cohen, 2020). Therefore, a mention on one or more Wikipedia articles, even and especially if it is added by the author themself, can demonstrate the grassroots efforts of percolating scientific and scholarly information to the general public.

Because Wikipedia is one of the most viewed and used information resources in the world, a mention to a research output on a Wikipedia page can also indicate public digestion of snippets of scholarly information by the public, but it cannot truly be interpreted as a direct digestion of the research output itself, because there is no easy way to track the clicks on the links from the Wikipedia page to the research output. Instead, individuals should track usage statistics, when available, for view and download counts.

A lack of attention on Wikipedia, especially for non-English and/or Global South scholarship, should not be interpreted as an indicator of poor engagement with the public. Wikipedia, even on non-English Wikipedias, is often dominated by Western, particularly U.S., politics and culture (Nemoto, 2017).

Related indicators

YouTube is somewhat comparable to Wikipedia, because it represents a more direct engagement with the layperson or public, especially for general educational purposes, but their audiences can be quite different.

Research Highlights

Definition of indicator

Currently the only research highlight platform tracked by Altmetric is Faculty Opinions, formerly F1000Prime. This service was formerly a part of a suite of services under F1000, a publisher of research services; however, in January 2020, Taylor & Francis acquired F1000Research, the scientific publishing platform, but not F1000Prime or F1000Workspace. To rebrand themselves after the acquisition, the company changed the name F1000Prime to Faculty Opinions.

Faculty Opinions publishes article recommendations in the fields of medicine and biology. If a subscribed member of the website recommends an article, it is rated as “good” and will display as a recommendation under the ‘Research highlights’ tab on the Altmetric Details page. Each recommendation on FO contributes one point to the Altmetric Attention Score (AAS). Altmetric cannot display information about the member who made the recommendation, because a subscription is required on FO to view that information.

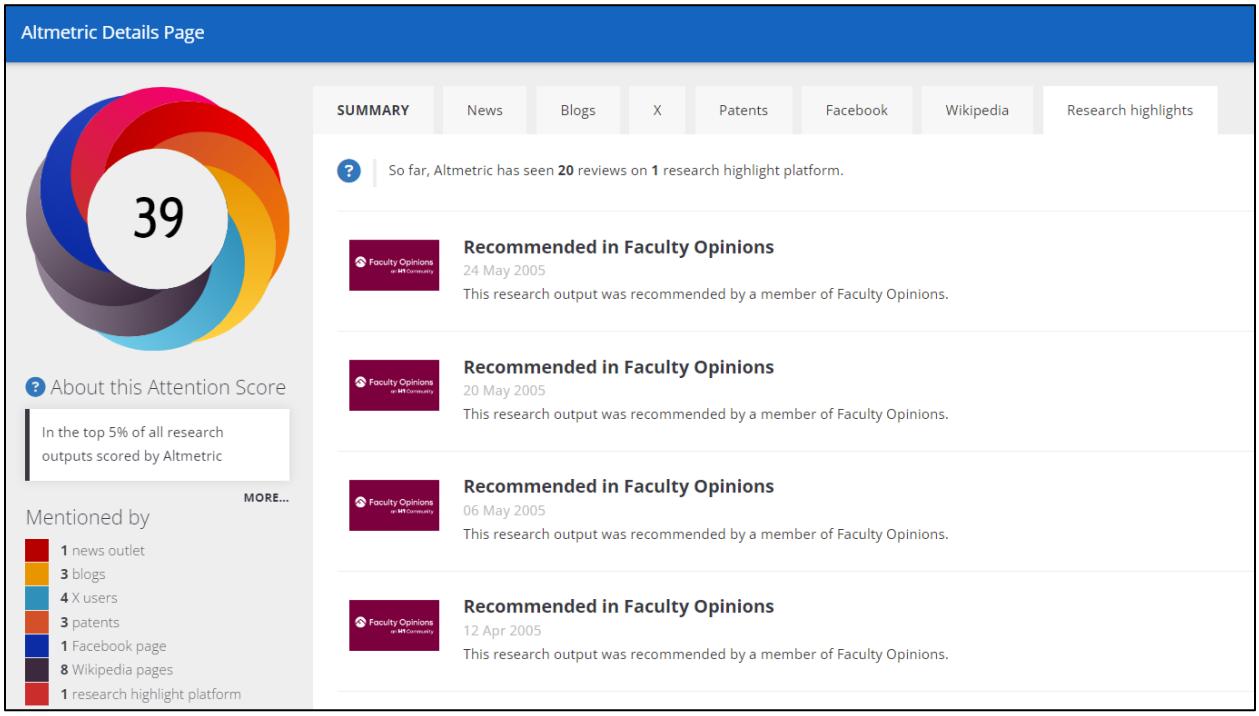


Figure 17. Screenshot of an Altmetrics Details Page on the Research highlights tab captured October 11, 2023.

Data source and coverage

Altmetric sources its data directly from Faculty Opinions on a daily basis through XML feed. When an output is recommended on Faculty Opinions, Altmetric automatically picks it up. Altmetric lists the Faculty Opinion recommendations in descending order, with the most recent listed first. Users who find research highlights on the Altmetric Details Page will not be able to

see who made the recommendation or the full text of the detailed recommendation, which is only available to subscribers of Faculty Opinions. However, Faculty Opinions was recently acquired by H1, which announced it is making all its recommendations free-to-access to current and new users of its platform; users must register for an account to view and read the recommendations. Users on the Altmetric Details Page can click on recommendation from the Research highlights tab and will be taken to the recommendation; however, they must register for an account to read and view the content.

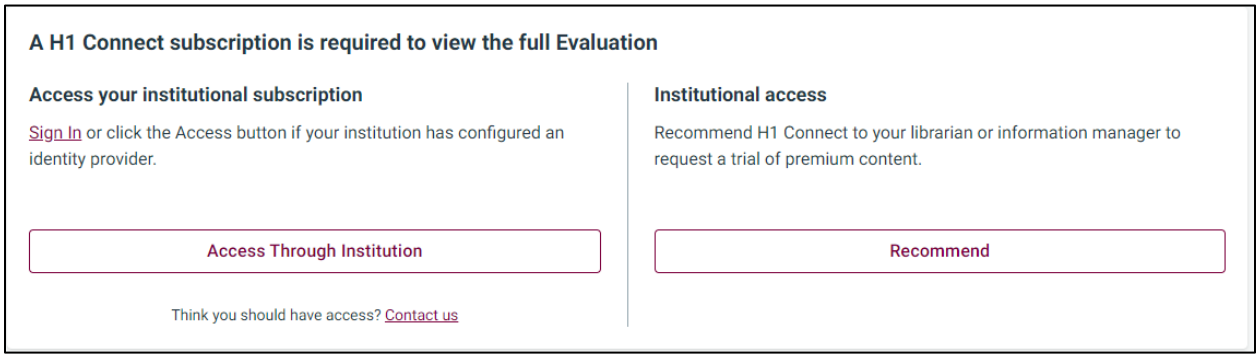


Figure 18. Screenshot of sign-in options.

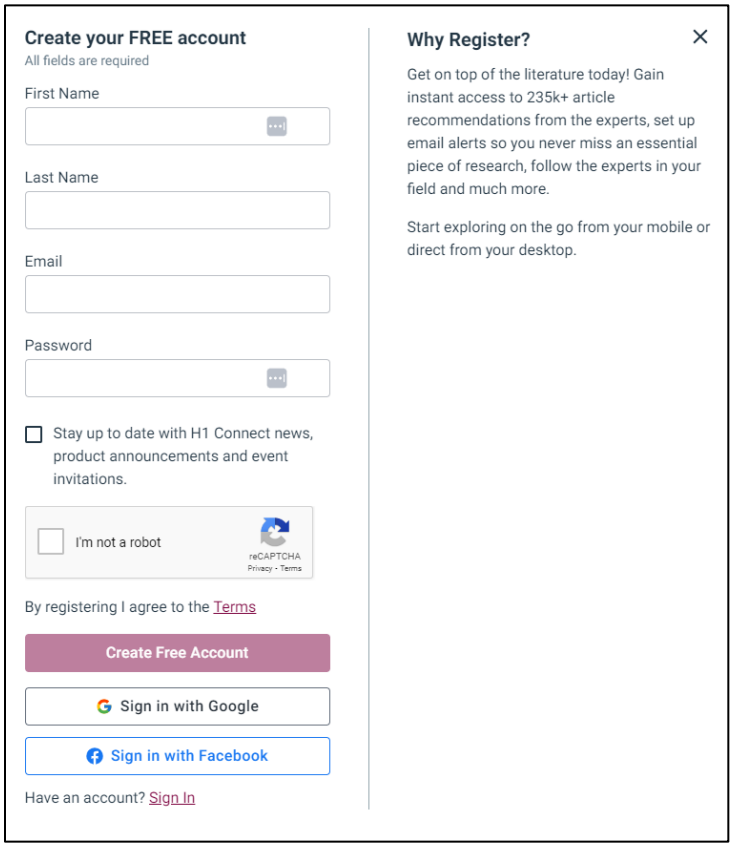


Figure 19. Screenshot of the form to create a free account. Note: users must select the sign in button in the top-right corner and then the 'Register' link to create an account.

As of May 2023, there are 245,395 mentions from 243,733 individual posts on FO, making up a fraction of the mentions on Altmetric (<1%). Coverage of FO mentions is from 2000 to the present.

Literature review

According to their website, Faculty Opinions is a "literature discovery tool for the qualitative assessment of published research." Over 8,000 experts in biology and medicine, referred to as "The Faculty" in Faculty Opinions, review scientific papers, called "evaluations," and either recommend the paper or not; Recommendations must also be accompanied by a rating, with one (Good), two (Very Good) or three (Exceptional) stars. Users of Altmetric data, such as those who find research highlights on an Altmetric Details Page, will only be able to see how many Recommendations the paper has received. Registered users of FO can also view the Faculty Opinion Score for an article, which is calculated using the Recommendation star rating and bibliometric indicators (Barros & Rodriguez, 2021).

Although not visible via Altmetric, Faculty can also tag their Recommendations with specific uses, such as "good for teaching," "new finding," "confirmation," "technical advice," and "interesting hypothesis." According to a paper that examined the relationship between Mendeley users and F1000Prime recommendation tags, there is considerable interest in papers with the "new finding" tag among the researcher community while the opposite is true among those from the teaching community; unsurprisingly, the teaching/lecturer community is much more likely to save papers with the tag "good for teaching," though students are not any more interested in papers with this tag compared to other papers despite being the target readership (Bornmann & Haunschild, 2015).

Recommendations on FO are slightly different from post publication peer review platforms such as Publons, which allow any Internet user on their platform to review papers. 'The Faculty' on FO are all credentialed, established experts in the field who must be appointed through a peer-nomination process. In addition, if a paper is not recommended on Faculty Opinions, it will not be included in the feed on the Research Highlights tab on the Altmetric Details Page. Although users must register for a free account on FO to read Recommendations and see details about the Faculty Opinion Scores, the individual tags, and the star ratings, Altmetric users can at least assume that if a paper has one or more FO Recommendations, it has been qualitatively assessed and recommended for reading by biomedical experts.

Several studies investigate relationships between research quality and other research impact indicators by relying on FO for peer assessment data to indicate the quality of papers. For example, two studies have found a strong relationship between peer assessments (using FO data) and citations as well as between peer assessments and Mendeley readership (Bornmann, 2014; Bornmann & Haunschild, 2018b).

Limitations

There are a limited number of experts on Faculty Opinions. As of August 2022, there are over 8,000 Faculty Members and almost 200,000 article recommendations, which represents a small

subset of the biomedical literature; compare this subset, for example, to the PubMed database, which comprises over 34 million research outputs in the biomedical literature. Furthermore, currently FO only covers biomedical literature and experts, so other fields do not get any coverage on this platform. Finally, qualitative assessment is multidimensional and the experts on FO may only assess the research from one or two dimensions; therefore, FO Recommendations should be interpreted with care.

Practical applications

Faculty Opinions is a unique type of altmetric and can demonstrate significant academic impact as well as potential for future citations. An absence of a recommendation on FO should not be taken as an indicator of poor performance though, since this platform is not widely adopted or used by academics. Experts on FO are credentialed and vetted, and if a research output has a recommendation, anyone can set up a free account with FO to read the review and identify the expert who made the recommendation; this will help with doing a qualitative analysis of the research output as well.

Related indicators

Post-publication peer review platforms, such as PubPeer and Publons, are related sources of attention. However, those platforms allow anyone to review and comment on a research output. Faculty Opinions is a more reliable indicator of academic impact and potentially quality.

Reference Managers

Definition of indicator

Number of users who have saved the output to their Mendeley reference management library. This is the only mention source that does not contribute towards the Altmetric Attention Score. The data can only be seen as a breakdown of demographics (geographic region, discipline and 'professional status' (e.g. student, researcher).

Data source and coverage

Altmetric uses one reference management software to provide this data- Mendeley (owned since 2012 by Elsevier). The Mendeley demographic data is provided by users.

Literature review

It is likely that reference management tools will be heavily used by students, and also used by researchers. Some studies have found positive correlation between Mendeley readership and future citation counts (Didegah et al., 2018; Haustein, Larivière, et al., 2014; Ruan et al., 2018).

It might be possible to demonstrate impact amongst readership that is not usually accessible through citations, particularly students. However the limitations of this using a single reference manager software.

Due to the impossibility of expecting all research outputs to receive evaluation by appropriate experts via a forum such as Mendeley, "while a recommendation is a positive measure, a lack of recommendation is not significant" (Bornmann & Haunschild, 2018a).

Limitations and bias

This data should be used with the understanding that there is only one reference manager tool providing the data, and so this is extremely narrow and not representative of the users of many other popular reference management tools.

Previous studies have found that the decision for Altmetric to aggregate Mendeley readership from different versions of the same paper (e.g., the version in a repository, the publisher's version) likely leads to erroneous and inflationary counting of the readership. Therefore, users should be wary of the numbers reported by Altmetric (Zahedi & Costas, 2018a, 2018b).

It is difficult to find up-to-date data on Mendeley users, but the software is available in eight languages. A 2013 estimate proposes its largest 10 users at the time to be the United States (16.1%), India (13.2%), Belgium (9.9%), Germany (6.2%), United Kingdom (5.9%), Japan (4.6%), France (2.8%), Brazil (2.8%), Australia (2.3%), and Spain (2.1%) (Thelwall & Maflahi, 2015).

It is also worth noting that what is being reported here is the number of users who have added the paper to their ‘list’, which indicates an interest in the paper or intention to read it, rather than numbers of users who have downloaded, accessed, or cited the paper.

Practical applications

Saves on reference managers are more passive engagements with research outputs and should not be interpreted as impactful or meaningful indicators. While there is a correlation with future citation counts, users have many reasons for saving works in their reference managers, such as for saving for reading later on or potentially saving for citing. Mendeley saves can help to indicate future citation impact but should not be interpreted as impactful on their own.

Related indicators

May be used in combination with Research Highlights and Syllabi to demonstrate impact in teaching and post-publication academic recommendations.

Blogs

Definition of indicator

Altmetric tracks mentions or citations to scientific literature coming from a manually curated list of more than 9,000 blogs. For the Altmetric Attention Score, a mention on a blog contributes 5 points to the score; however, it is not clear if there are modifiers to the score, such as limiting the score by blog source or increasing the score based on the reach of the blog.

Blog	URL	Number of mentions
arXiver	http://arxiver.moonhats.com/	62,156
Balkinization	https://balkin.blogspot.in/	44,254
Physician's Weekly	http://www.physiciansweekly.com/	33,044
Microbiome Digest - Bik's Picks	http://www.microbiomedigest.com/	32,882
Authority Nutrition (Healthline)	http://authoritynutrition.com/	29,256
Information for practice	http://ifp.nyu.edu/	29,112
N+1: научные статьи, новости, открытия	https://nplus1.ru/	26,809
Skeptical Science	http://www.skepticalscience.com/	26,726
Forum:Blog	https://agenda.weforum.org/podcast/feed/	25,145
Computational Chemistry Daily	https://paper.li/janhjensen/1416314690#/	22,668

Table 15. Top 10 blogs with the highest number of mentions up to July 2022

Data source and coverage + literature review

The blogs selected for coverage are 'curated' by Altmetric. Altmetric states that they "are primarily looking for scholarly blogs that discuss research" (Altmetric, 2020d). Other than this, it is not clear what criteria are used to find and assess blogs for inclusion.

This becomes a bit confusing when looking at the diversity of the types of blogs tracked by Altmetric. One type of blog, such as those that post primarily original content with an editorial style similar to online magazines or news sites, like Healthline, often 'digest' or copy text verbatim from research articles. The most-mentioned blog source (as of July 2022) on Altmetric is, arXiver, which has almost double the number of mentions of the third most mentioned blog source, is essentially a port of new preprints uploaded to arXiv/astro-ph (astrophysics arXiv).

According to a 2020 study (Ortega), blogs have more special interest, academic topics than news sources, which tend to focus more on global, general-interest topics; Altmetric primarily indexes blogs in the physical sciences, social sciences, humanities, and life sciences (Table 16).

Number and Percentage of News Outlets by Science Journal Classification Code (ASJC) Fields		
Subject	**Number of Sources**	**Percentage of Sources**
Science and Technology	339	13.1%
Medicine	256	9.9%
Agricultural and Biological Sciences	152	5.9%
Physics and Astronomy	121	4.7%
Neuroscience	113	4.4%
Environmental Science	94	3.6%
Library and Information Sciences	91	3.5%
Genetics	89	3.4%
Economics, Econometrics and Finance	87	3.4%
Not assigned	76	2.9%
Total	*2582*	*100%*

Table 16. Number and percentage of blogs by subject (Ortega, 2020, pp. 566).

Limitations and bias

The only limitation declared by Altmetric for a blog source is that it must have an RSS feed. Non-English language blogs are tracked, but only one non-English language blog comprising the top 10 most mentioned blogs (a Russian language science blog) adds uncertainty as to whether there is equal attention or capacity to track non-English language blogs. According to Ortega (2020), the vast majority of blogs covered by Altmetric are in the English language (84.7%) but only 77.4% are in English-speaking countries, which may demonstrate English as the language for science communication, both formally and informally. Regardless, such poor coverage of non-English speaking media can have unfortunate consequences on local communities, such as lack of attention and representation of local communities, history, species, and policies.

Altmetric have previously commented to the authors of this document that they do not accept blogs owned by universities or research-performing organizations for coverage, possibly because of the likelihood that university blogs would be biased towards coverage of their own research. However, it is interesting that they do not exclude university-owned social media channels, e.g., university X or Facebook accounts. They also state that they primarily measure *attention* to research outputs rather than attempting to differentiate between 'good' and 'bad' research outputs (Altmetric, 2023). In general, it is up to the user to assess the article's quality, significance, and impact.

Ultimately, the lack of transparency over their indexing policy, such as how they define a blog as suitable for indexing as a source, makes it difficult to estimate the limitations, e.g., what potential blogs in the world have been excluded.

Practical applications

The blogs tracked by Altmetric are academic or scientific in nature, and thus, attention from blogs can indicate an alternative type of academic engagement with research outputs. However, some of the blogs tracked by Altmetric are regurgitation of academic articles on their sites, such as Healthline. Therefore, the user should investigate the blogs where there is attention, if practical to do so, to determine the type of attention. Verbatim text on Healthline may be unoriginal, but Healthline does still have a greater reach to the general public than an academic journal does. Such attention could indicate a greater influence on the public and their health decisions, for example.

Related attention sources

Blogs tracked on Altmetric are primarily authored, managed, and edited by academics. However, **social media** attention to research outputs, particularly on X, often represents academic attention to articles and can be seen as a related attention source. In addition, **multimedia** attention, such as YouTube, is often academic attention and/or science communication, and can also be a related attention source, depending on the context.

Conclusion

Users of Altmetric data, or any source of altmetrics data, whether they are researchers, faculty members, librarians, bibliometric practitioners, university administrators, grant funders, or research managers, should approach the incorporation of such data in their work as carefully and pragmatically as they would any type of data and metrics. With the rise and availability of bibliometrics, altmetrics, and research analytic tools and databases, anyone can easily find such data and include it in their individual, group, and institutional reports and evaluations. While this helps with the democratization and widespread availability of such data, it also invites anyone to be an 'expert,' especially when companies offer training. Such training and support is valuable and important, but experts should always be included in conversations, decision-making, strategic planning, and other purposes when such data (altmetrics, bibliometrics, etc.) are used, especially for guidance in the realm of evaluations, reviews, funding, and hiring decisions.

This guide provides users, whether experts or novices, with direction on:

- Demographics of the users and/or consumers of the individual attention sources
- Coverage of the attention sources
- Altmetric's breakdown of the data and how it compares to the academic literature
- Limitations and biases of each attention source
- Practical applications of Altmetric attention sources

For example, the demographic breakdown of X/Twitter users on Altmetric are categorized as: Member of the public, "Doesn't fit the categories below" or Unknown, Researcher, Practitioner, and Science communicator, with the majority of users usually categorized as Members of the public on the Altmetric Details Page; however, the literature shows that the majority of X users who post or repost direct links to research outputs are likely academics.

With a better understanding of the data, researchers and practitioners should feel compelled to investigate the context of online mentions to determine the type of attention and its context, whether it is X, Facebook, blogs, Wikipedia, public policy, patents, post-publication peer review, or news media. They may find that their research is being shared broadly amongst a special subset of academics in their field, outside their field, or among non-academic users on social media. For example, the limited research on Reddit has found that Reddit can be an effective tool for communicating research, and thus, while there may be fewer posts on such a platform, there may also be more meaningful and contextual discussions surrounding the research on such a platform. Such evaluations of the data may also guide researchers on assessing how their research is being communicated within their fields, outside their fields, and outside academia, though Altmetric data and/or altmetrics should not be relied upon exclusively for this purpose. For instance, researchers who work more closely with local communities may never see their research picked up by news media or social media, but their research can still be communicated effectively with local or regional communities, governments, and industry partners. Altmetric data is a tool among many tools.

As with the use of any data or metric, it is always important to use multiple measures when evaluating, reviewing, or making decisions. No measure should be used in isolation or taken at

face value. For example, if a university administrator found a considerable amount of research from their unit mentioned in the news, they should investigate the news sources, the context of the mentions, and evaluate the research outputs themselves rather than making sweeping statements, e.g., their unit's research is "highly influential" in the news or in the public. Certain research outputs may be more broadly publicized than others; some research may be more easily turned into clickbait while other research may be appropriately used by news organizations to fact check claims and boost their credibility. Experts in the fields of bibliometrics and altmetrics should be relied upon to make more nuanced interpretations and even provide advanced analytics, such as network analysis, text mining, and/or term co-occurrence of titles and/or posts of mentions to research outputs, if and when the data and expertise are available.

Related Resources & Readings

- The Responsible Use Guides
    - Using InCites responsibly: a guide to interpretation and good practice
    - Using SciVal responsibly: a guide to interpretation and good practice
- 2021 Competency Model for Bibliometric Work
- Statements of Responsible Metrics
- Declaration on Research Assessment
- Bibliometrics: The Leiden Manifesto for research metrics
- Responsible metrics: the state of the art
- The Metric Tide, revisited
- HuMetricsHSS
- The Hong Kong Principles for assessing researchers: Fostering research integrity
- To what extent does the Leiden Manifesto also apply to altmetrics? A discussion of the manifesto against the background of research into altmetrics
- INORMS Research Evaluation Group
    - Rethinking Global University Rankings
    - SCOPE Framework for Research Evaluation
    - Outputs and Outreach
- Altmetric Solutions

Appendix A: Fields of Research in Dimensions

Fields of Research in Dimensions

Sorted in descending order by number of publications

Exported from Dimensions on October 4, 2023

Name	Fields of Research (ANZSRC 2020) code	Publications	Citations	Citations (mean)
Biomedical and Clinical Sciences	32	31436778	579794379	18.44
Engineering	40	18160335	283877291	15.63
Clinical Sciences	3202	13367599	219921916	16.45
Biological Sciences	31	10849677	311696794	28.73
Chemical Sciences	34	9114892	205084885	22.5
Health Sciences	42	8713690	102765103	11.79
Physical Sciences	51	8183879	135963014	16.61
Information and Computing Sciences	46	7804944	87559518	11.22
Mathematical Sciences	49	5024790	59861977	11.91
Human Society	44	5007046	43249374	8.64
Agricultural, Veterinary and Food Sciences	30	4200351	61656304	14.68
Psychology	52	4132492	90589389	21.92

Commerce, Management, Tourism and Services	35	3724170	51088600	13.72
Biochemistry and Cell Biology	3101	3425149	130043111	37.97
Earth Sciences	37	3391637	65095758	19.19
Language, Communication and Culture	47	3355487	13075182	3.9
Oncology and Carcinogenesis	3211	3211540	70368161	21.91
Philosophy and Religious Studies	50	2842332	10509898	3.7
Materials Engineering	4016	2606091	58113199	22.3
History, Heritage and Archaeology	43	2366702	7655393	3.23
Education	39	2359632	17111897	7.25
Inorganic Chemistry	3402	2342050	46519082	19.86
Health Services and Systems	4203	2333552	29565667	12.67
Cardiovascular Medicine and Haematology	3201	2255804	35833121	15.88
Physical Chemistry	3406	2161799	59246013	27.41
Applied Mathematics	4901	2015373	22355680	11.09
Environmental Sciences	41	1992508	42030041	21.09
Reproductive Medicine	3215	1959254	32169744	16.42

Communications Engineering	4006	1953457	18997587	9.73
Economics	38	1916622	28782913	15.02
Pharmacology and Pharmaceutical Sciences	3214	1915501	40937786	21.37
Pure Mathematics	4904	1894637	15520983	8.19
Electronics, Sensors and Digital Hardware	4009	1885415	20146690	10.69
Ecology	3103	1872714	43890838	23.44
Historical Studies	4303	1835768	4258360	2.32
Electrical Engineering	4008	1649935	18744859	11.36
Law and Legal Studies	48	1595835	5580886	3.5
Creative Arts and Writing	36	1545731	3948752	2.55
Literary Studies	4705	1478218	1662603	1.12
Data Management and Data Science	4605	1478121	16975796	11.48
Immunology	3204	1463034	40629848	27.77
Civil Engineering	4005	1446467	17288031	11.95
Nuclear and Plasma Physics	5106	1440619	20544367	14.26
Applied Economics	3801	1430448	21412033	14.97
Public Health	4206	1425631	24442716	17.15

Organic Chemistry	3405	1406949	28044883	19.93
Neurosciences	3209	1383858	37953487	27.43
Built Environment and Design	33	1364240	13186553	9.67
Biological Psychology	5202	1359875	39618037	29.13
Geology	3705	1312493	27695573	21.1
Chemical Engineering	4004	1309640	26045763	19.89
Genetics	3105	1288470	45140576	35.03
Strategy, Management and Organisational Behaviour	3507	1279988	21454310	16.76
Macromolecular and Materials Chemistry	3403	1272111	30246422	23.78
Dentistry	3203	1264872	13811355	10.92
Microbiology	3107	1246715	33680301	27.02
Condensed Matter Physics	5104	1211330	24085966	19.88
Curriculum and Pedagogy	3901	1196837	8855005	7.4
Clinical and Health Psychology	5203	1180656	22817872	19.33
Political Science	4408	1167458	9416795	8.07
Atomic, Molecular and Optical Physics	5102	1121862	16830764	15
Medical Physiology	3208	1096987	31409283	28.63

Medical Microbiology	3207	1091951	28859608	26.43
Nursing	4205	1057907	6968689	6.59
Plant Biology	3108	1007985	23086903	22.9
Ophthalmology and Optometry	3212	990587	15275800	15.42
Control Engineering, Mechatronics and Robotics	4007	985298	12547693	12.73
Particle and High Energy Physics	5107	969928	16265458	16.77
Zoology	3109	940005	16188572	17.22
Nanotechnology	4018	934808	24664684	26.38
Allied Health and Rehabilitation Science	4201	914044	11012557	12.05
Mathematical Physics	4902	913168	11089487	12.14
Education Systems	3903	905174	6315743	6.98
Artificial Intelligence	4602	881478	11176149	12.68
Analytical Chemistry	3401	840123	17381326	20.69
Astronomical Sciences	5101	829085	15188126	18.32
Religious Studies	5004	828651	1044614	1.26
Computer Vision and Multimedia Computation	4603	827366	12360465	14.94

Manufacturing Engineering	4014	819589	8668638	10.58
Linguistics	4704	816620	5863591	7.18
Paediatrics	3213	813536	11876158	14.6
Biomedical Engineering	4003	803430	17032289	21.2
Fluid Mechanics and Thermal Engineering	4012	801577	13723454	17.12
Policy and Administration	4407	801251	7638420	9.53
Veterinary Sciences	3009	789817	8562868	10.84
Machine Learning	4611	751677	11979691	15.94
Food Sciences	3006	741962	13772264	18.56
Banking, Finance and Investment	3502	741730	10620145	14.32
Distributed Computing and Systems Software	4606	738490	9279353	12.57
Philosophy	5003	730562	3614839	4.95
Medicinal and Biomolecular Chemistry	3404	710102	14752893	20.78
Quantum Physics	5108	706783	13148578	18.6
Crop and Pasture Production	3004	706681	10580386	14.97
Mechanical Engineering	4017	690254	10806021	15.66

Resources Engineering and Extractive Metallurgy	4019	674449	7782549	11.54
History and Philosophy Of Specific Fields	5002	662700	3305404	4.99
Statistics	4905	658420	12303622	18.69
Atmospheric Sciences	3701	643849	15898634	24.69
Nutrition and Dietetics	3210	643734	14035481	21.8
Applied and Developmental Psychology	5201	616120	13539968	21.98
Aerospace Engineering	4001	615285	8344284	13.56
Development Studies	4404	604933	4034176	6.67
Engineering Practice and Education	4010	589101	5796274	9.84
Theology	5005	582851	563469	0.97
Language Studies	4703	563825	2432101	4.31
Sports Science and Exercise	4207	562476	8282784	14.73
Evolutionary Biology	3104	560501	10422555	18.6
Sociology	4410	560408	7083603	12.64
Bioinformatics and Computational Biology	3102	550694	24858797	45.14
Econometrics	3802	549482	10249543	18.65

Theoretical and Computational Chemistry	3407	543149	12520750	23.05
Human-Centred Computing	4608	524825	5991121	11.42
Physical Geography and Environmental Geoscience	3709	500874	11056439	22.07
Synchrotrons and Accelerators	5110	497712	6663822	13.39
Medical Biotechnology	3206	497094	14241792	28.65
Environmental Management	4104	491751	8792024	17.88
Classical Physics	5103	491714	8821320	17.94
Social and Personality Psychology	5205	483663	14159679	29.28
Animal Production	3003	480111	6855205	14.28
Epidemiology	4202	471779	11105693	23.54
Library and Information Studies	4610	470891	2128761	4.52
Cognitive and Computational Psychology	5204	470004	14435281	30.71
Pollution and Contamination	4105	460195	11272208	24.49
Transportation, Logistics and Supply Chains	3509	458489	5974520	13.03
Human Geography	4406	454916	5405490	11.88
Information Systems	4609	454017	5455470	12.02

Numerical and Computational Mathematics	4903	452479	5896017	13.03
Marketing	3506	451036	8008191	17.76
Human Resources and Industrial Relations	3505	447258	5138183	11.49
Space Sciences	5109	439235	9007876	20.51
Geophysics	3706	436550	12192632	27.93
Cybersecurity and Privacy	4604	431085	4732924	10.98
Theory Of Computation	4613	428732	5281456	12.32
Midwifery	4204	417568	2290329	5.48
Specialist Studies In Education	3904	411263	4542108	11.04
Industrial Biotechnology	3106	402637	10120989	25.14
Cultural Studies	4702	394400	1663761	4.22
Architecture	3301	390965	2702681	6.91
Building	3302	379449	4438559	11.7
Economic Theory	3803	375481	6633650	17.67
Archaeology	4301	375066	3168663	8.45
Maritime Engineering	4015	359308	3839943	10.69
Software Engineering	4612	359197	3930012	10.94

Education Policy, Sociology and Philosophy	3902	355322	2310139	6.5
Horticultural Production	3008	354822	4876013	13.74
Communication and Media Studies	4701	353115	2989594	8.47
Public Law	4807	337401	786686	2.33
Medical Biochemistry and Metabolomics	3205	337225	6622479	19.64
Screen and Digital Media	3605	328203	1183136	3.6
Geochemistry	3703	326994	10566941	32.32
Criminology	4402	317801	3434076	10.81
Law In Context	4804	316878	1145827	3.62
Environmental Engineering	4011	316542	7087633	22.39
Business Systems In Context	3503	314432	6506936	20.69
Art History, Theory and Criticism	3601	301941	593695	1.97
Commercial Services	3504	292686	3541262	12.1
Agriculture, Land and Farm Management	3002	291333	4390974	15.07
Fisheries Sciences	3005	289110	4877411	16.87
International and Comparative Law	4803	288727	916114	3.17

Geoinformatics	3704	286328	2448037	8.55
Anthropology	4401	284694	2595066	9.12
Gender Studies	4405	282773	2633460	9.31
Automotive Engineering	4002	278475	4223338	15.17
Music	3603	277889	746975	2.69
Hydrology	3707	262326	5525597	21.06
Urban and Regional Planning	3304	262288	3082290	11.75
Performing Arts	3604	260128	421224	1.62
Applied Computing	4601	256014	3129730	12.22
Social Work	4409	254313	1843317	7.25
Geomatic Engineering	4013	251333	3564013	14.18
Graphics, Augmented Reality and Games	4607	246783	4075163	16.51
Commercial Law	4801	245764	420659	1.71
Applied Ethics	5001	244707	2095593	8.56
Oceanography	3708	241842	7083905	29.29
Demography	4403	239988	2618111	10.91
Ecological Applications	4102	224923	6653523	29.58

Design	3303	219879	1331907	6.06
Forestry Sciences	3007	216757	3147899	14.52
Medical and Biological Physics	5105	211129	2078739	9.85
Private Law and Civil Obligations	4806	204196	437595	2.14
Accounting, Auditing and Accountability	3501	201869	3281344	16.25
Soil Sciences	4106	196967	3889166	19.75
Creative and Professional Writing	3602	195405	474510	2.43
Traditional, Complementary and Integrative Medicine	4208	191730	2309500	12.05
Tourism	3508	191622	2263319	11.81
Agricultural Biotechnology	3001	176705	3567628	20.19
Climate Change Science	3702	157571	4356870	27.65
Heritage, Archive and Museum Studies	4302	150507	580334	3.86
Legal Systems	4805	137544	904539	6.58
Environmental and Resources Law	4802	125821	963228	7.66
Climate Change Impacts and Adaptation	4101	102911	3379644	32.84
Environmental Biotechnology	4103	96236	1776573	18.46

Visual Arts	3606	23375	67043	2.87

Appendix B: Peer Review

This guide was reviewed by three experts in the field of altmetrics: Drs. Kim Holmberg, Timothy Bowman, and Nicolas Robinson-Garcia. Dr. Holmberg provided a full report on his peer review (below) while Drs. Bowman and Robinson-Garcia provided minor comments and recommendations for further citations and readings. All comments were addressed and revisions were made based on their recommendations; therefore, the comments from Dr. Holmberg may seem irrelevant given the revisions made before this guide was deposited to an institutional repository.

Peer review report from Dr. Kim Holmberg, University of Turku

Who is the intended target audience? Who is the guide for? Information professionals? Researchers? Funders? All the above?

Page 4. Altmetric Attention Score

- You mention normalization in table 2, which is good, but normalization might deserve a bit more discussion, as it's really important and there's plenty of evidence of for instance disciplinary differences. In addition, in altmetrics differences over time are also usual. Partly perhaps due to increasing usage of social media in general (although that may be leveling out?).

Discussing the problems or challenges with a composite indicator, such as AAS, might also deserve a bit more discussion. Particularly in altmetrics, as the platforms used, the data sources, are very different. One mention in Twitter/X is created for totally different reasons/motivations than a Wikipedia citation or a mention in news or policy documents. Even if the mentions are weighted there are problems with the AAS because of the differences in how and why the platforms are used.

At least in the beginning, the guide focuses very much on Altmetric.com. Perhaps this is intentional (?), but I thoughts this would be a guide to altmetrics, not just the product of Altmetric.com.

It is perhaps not always clear if you mean Altmetric.com or altmetrics as a research field. Perhaps make this clear in the beginning.

I wonder how much the activity from "representatives" from certain countries influence the list of news sources that Altmetric.com maintains? I mean, if a researcher from Finland for instance, who has good knowledge about news sources in Finland, contacts Altmetric.com and asks them to add Finnish news sources to their list, then Finland would be quite well covered, while some other country might not be, because the people at Altmetric.com may not have as extensive knowledge about national news sources in all countries. So the list might be biased in this way too.

In the part where you write about news sources you could also include a section about public understanding of science. Perhaps it's beyond the scope of the guide, but it would be fitting and important. For instance, misinterpretations of research results that were widely covered during the pandemic and that even lead to conspiracy theories. This highlights the media's responsibility in reporting science, and not just trying to get clicks/hits. Just an idea.

Page 20 and 21. Consider moving these to the beginning. You discuss the platforms and the weights earlier already, and this might fit to that part better.

You spend quite a lot of space to discuss X, which is understandable as most of altmetrics research has done so too. We know quite a lot about X. But X, although the biggest source of altmetrics, may not be the most important, if we consider how different platforms are able to reflect impact or attention. Hence, the weights.

You may want to mention that Twitter is no longer Twitter. You might also mention that a lot of researchers have left X, some moving to Mastodon, others taking up blogging again. With the recent changes on Twitter/X, introduced by Musk, we can't really be sure whether X will exist next year, or next week.

Overall, I think the structure with which you present the different platforms is good: short presentation, followed by what research tells us about that platform (you call this "Interpretation", I'm not sure if that's accurate, maybe consider changing it), then limitations, and practical applications.

You might want to consider ending the guide with some conclusions, perhaps a more general discussion about the usefulness of altmetrics or what one should keep in mind when using them responsibly. You have "responsibly" in the title of the guide, so it would be fitting to emphasize this in the closing of the guide (in the beginning too). This responsibility-aspect appears now only in the part where you analyze altmetrics against the Metric Tide, even the word "responsible / responsibly" do not appear more than a couple of times in the guide. This is probably what you should focus more on, or change the title a bit

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