# The bibliometric journey towards technological and social change: A review of current challenges and issues

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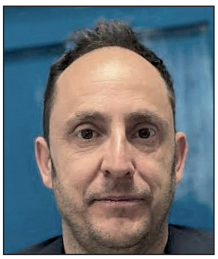

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## Abstract

The current trends and challenges in the field of bibliometrics are reviewed. To do so, we take the reader along a bibliometric route with six stations: the explosion of databases, the inflation of metrics, its relationship to Data Science, searching for meaning, evaluative bibliometrics, and diversity and profession. This evaluation encompasses three dimensions of the bibliometrics field regarding research evaluation: the technological, the theoretical, and the social. Finally, we advocate for the principles of an evaluative bibliometrics, balancing the power of metrics with expert judgment and science policy.

## Keywords

Evaluative bibliometrics; Research evaluation; Peer review; Trends; Metrics; Scientific databases; Bibliometric indicators; Evolution.

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## 1. Introduction

90 years ago now, Ortega y Gasset proposed the creation of a "Statistics of Ideas" (**Ortega y Gasset**, 2005) in order to

> "determine strictly the chronological moment at which an idea sprouted, the process of its expansion, its exact duration as a collective belief and then the hour of its decline".[1]

In doing so, he foresaw the governing principles of bibliometrics, which is nowadays defined as

> "the quantitative analysis of published [scholarly] literature, notably journal articles and the network of their bibliographic connections" (**De-Bellis**, 2009).

By specifying "published literature" the definition covers all types of documents (present and future, digital or printed) and does not renounce its essential object: despite the views of its most voracious critics, bibliometrics largely continues to be the art of counting articles in journals.

Due to its definitions and the nature of its very history, bibliometrics has been shaped by the evolution of technology and scientific communication habits, with its past being characterized by the monopoly of a single citation index dating back to the 1950s, *Web of Science*. From the 1990s onwards, the irruption of the internet marked the beginning of the search for new horizons, with new alternative proposals to the use of papers and their citations such as webometrics (**Björneborn**; **Ingwersen**, 2001) and usage metrics (**Bollen** *et al.*, 2005). This movement gained pace in 2004 and 2005 with the emergence of *Google Scholar* and *Scopus* and subscription-based document citation services such as the *Book Citation Index* (**Torres-Salinas** *et al.*, 2012) and the *Data Citation Index* (**Robinson-García**; **Jiménez-Contreras**; **Torres-Salinas**, 2016). Around the same time, the concept of altmetrics was developed, which introduced the possibility of analyzing all kinds of digital artifacts through the most singular indicators (**Priem** *et al.*, 2010).

In view of the above, it is undeniably an area in expansion and it is therefore not surprising that some of its leading figures such as **Cronin** (2013) and **Moed** (2017) have advocated broadening its epistemological domains. In a previous paper (**Robinson-García**; **Repiso**; **Torres-Salinas**, 2018) we already pointed out some of the changes that needed to be addressed in the world of scientific assessment, including the explosion in the number of information sources and metrics and the current process of complete immersion in the data science paradigm. Five years on, this proposal has fallen short due to the demands and social sensitivities arisen and accelerated in the aftermath of the pandemic. Terms such as diversity or equity are now included in the policy discourse along with open science or responsible research. Hence, it is time to for an update which reflects current trends and aligns with this post-pandemic reality. It is now a good time to draw up a new map of the bibliometric territory with all its highways and byways. Accordingly, the aim of this paper is to present an overview of our current personal vision of the major issues and challenges facing the world of metrics.

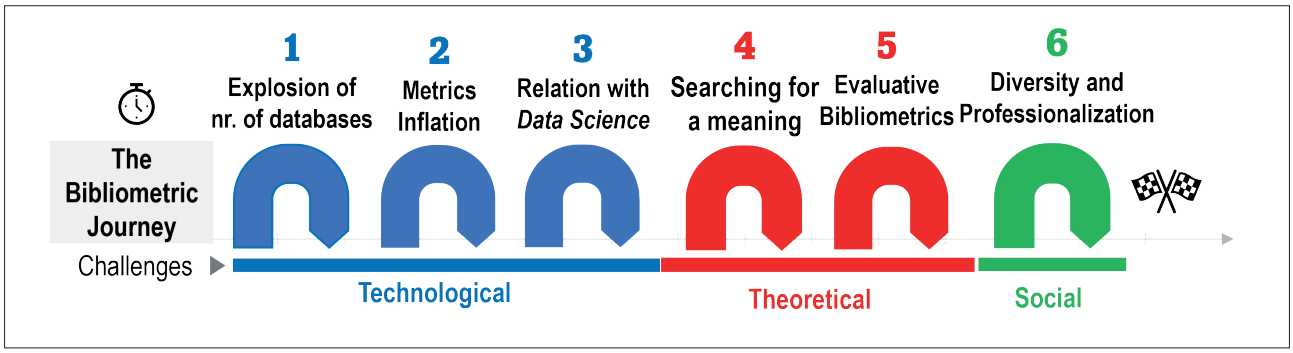


Figure 1. The bibliometric route towards technological and social change

The resulting "Bibliometric route towards technological and social change" is made up of six-way stations grouped into three different dimensions (Figure 1). The review undertaken is also structured along these same lines. Firstly, we deal with the technological dimension by focusing on the explosion of information sources (Fig. 1, 1) and indicators (Fig.1, 2) a situation that is leading to increasing reliance upon data science (Fig.1, 3). Secondly, in the theoretical dimension we consider the need to agree on an interpretative framework regarding the meaning of indicators (Fig.1, 4) and the unquestionable importance of evaluative bibliometrics (Fig.1, 5). Finally, we conclude by pointing to the need for awareness of current social challenges, including a greater focus on diversity and higher levels of professionalization (Fig. 1, 6). Let the journey begin!

## 2. The bibliometric route

### 2.1. The explosion of databases

Until recently, databases for bibliometric purposes were rare and the scientific community had very precise knowledge of their limitations and uses. Today, the situation is quite the opposite. The massive creation of digital resources has generated endless options and we have neither the time nor the resources to characterize them in depth (for a more

detailed account, see **Visser**; **Van-Eck**; **Waltman**, 2021). There is also much greater diversity: from a global perspective we have the ever-expanding bibliographic universes of Web of Science and Scopus focusing on scientific journals, along with their respective suites *In-Cites* and *Scival*. On the other hand, there are also academic search engines such as the now-defunct *Microsoft Academic Search* (*MAS*) and *Google Scholar*, which while touted as revolutionary (**Orduña-Malea** *et al.*, 2016), has not made such an major impact.

In addition to these 'classic' products, national solutions also exist such as *Dialnet* (**Mateo**, 2015) or Latin American alternative such as *Scielo* and *Redalyc*. These initiatives with a strong geographic-linguistic component have helped to ensure coverage of local research, as well as doing so in an open and altruistic manner. Despite the dominance of the main corporate databases, more and more open sources are emerging in the Global North as well. Examples of this trend include *CrossRef*, preprint repositories such as *PubMedCentral* and *arXiv*, scientific data sources such as *FigShare* and *Datacite* and digital library catalogues such as *WorldCat*. Mention should also be made of products focusing on identifiers such as *ORCID* at an individual level, (**Costas**; **Corona**; **Robinson-García**, 2022) the *Research Organization Registry* (*ROR*) at an institutional level (**Lammey**, 2020) and, of course, the typical networks that can also offer information on scientific publications (*Twitter*, *Wikipedia*, *F1000*...).

Alongside this phenomenon of balkanization of information, a further trend is the emergence of third-generation citation indexes, first and foremost among them being *Dimensions* by *Digital Science* (**Herzog**; **Hook**; **Konkiel**, 2020). These new indexes are characterized by a single interface for indexing of resources of different natures. Including not only journals, but all kinds of publications: from repositories, patent databases, to more specialized information such as clinical trials and research projects. Within this group, we also include social media data aggregators such as *Altmetric.com*, *PlumX* and, although more specialized, *Overton* (**Szomszor**; **Adie**, 2022). The current trend is to centralize, combine and integrate data of all kinds. Other examples of metadata aggregators include *OpenAlex* (**Priem**; **Piwowar**; **Orr**, 2022), which describes itself as

> "[a]n open and comprehensive catalog of scholarly papers, authors, institutions, and more"

and Lens (**Jefferson** *et al.*, 2019) which compiles records retrieved from *MAS*, *PubMed*, *CrossRef*, *OpenAlex*, *UnPaywall*, and *ORCID*, among others. Table 1 offers an overview of the content and size of these third-generation bibliometric sources.

Now we have more sources and more ways of accessing them, which has led to a radical change in the formula for retrieving and downloading entries. Together with these traditional interfaces, consultation via APIs has become widespread and is forcing a rethinking of data flows and life cycles (**Torres-Salinas**; **Arroyo-Machado**, 2022a). APIs open up major possibilities for interconnection and interoperability and are already a tangible reality, as is demonstrated by the fact that there are 49 APIs currently available for bibliometric purposes (**Torres-Salinas**; **Arroyo-Machado**, 2022b). The massive opening up of data will allow the creation of *ad hoc* solutions and different interpretations of scientific activity beyond the globalized and Anglo-Saxon mold of mainstream citation indexes, with identifiers (DOIs, PubMedIDs, handles, arXivID, etc.) assuming an essential role.

Table 1. Basic characteristics of third-generation bibliometric databases: *Dimensions*, *OpenAlex*, and *Lens*

| ***Dimensions*** | ***Open Alex*** | ***Lens.org*** |
|---|---|---|
| **Content and scope** | | |
| Publications<br>Authors<br>Organizations<br>Grants | Publications<br>Authors<br>Instructions<br>Concepts | Patents<br>Publications<br>Profiles<br>Biological sequences |
| **Sources indexed** | | |
| *CrossRef*, *PubMed*, thematic and institutional repositories, publishers, *ORCID*, clinical trials registries, *DataCite*, *Figshare*, government guidelines and reports, *ROR ID* and patents offices. | *CrossRef*, *PubMed*, thematic and institutional repositories, *Microsoft Academic Search*, *ORCID*, *ROR ID*, *ISSN Network* and *Wikidata* | *CrossRef*, *PubMed*, thematic and institutional repositories, *Microsoft Academic Search*, *ORCID*, *OpenAlex*, *UnPaywall*, *CORE full text* and patents from various jurisdictions |
| **Number of entries** | | |
| 134 million papers<br>6 million grants<br>12 million datasets<br>239 million online mentions<br>933,000 policy mentions | 239 million papers<br>50,000 papers added daily<br>213 million authors<br>109,000 institutions<br>65,000 concepts | 200 million papers<br>36 million authors<br>141.9 million patents<br>429,092,477 biological sequences |

Finally, one of the features of many of the products mentioned is their fluid nature. Many will disappear, become obsolete or have a short life span, which also has its implications. Given their mortality and mutability and in some cases poor metadata quality (as in the case of *OpenAlex*), a certain degree of uncertainty must be assumed in terms of their coverage, especially when working with them. This scenario presents new challenges such as the mapping of sources of bibliometric interest; indicating their validity, coverage and possible applications, a task addressed by initiatives

such as the *Registry of Scientometric Data Sources*, and the use of ontology-based systems (**Daraio** *et al.*, 2016). Despite this landscape, it is undeniable that traditional databases such as *WoS* and *Scopus* continue to dominate scientific assessment tasks (**Jappe**, 2020). Factors such as better journal coverage, cover-to-cover indexing, greater accuracy of metadata, more reliable normalization algorithms and thematic classifications make them unbeatable products for the time being.

> APIs open up major possibilities for interconnection and interoperability and are already a tangible reality, as is demonstrated by the fact that there are 49 APIs currently available for bibliometric purposes

### 2.2. Inflation of indicators and metrics

A direct consequence of this explosion of databases is a comparable explosion in the number of indicators. It is difficult to determine how many currently exist. To give an idea of their variety, **Moed** (2017) established ten families of indicators (publications, webometrics, altmetrics, patents, collaboration, etc.) that can be used to characterize research in a multidimensional way (**Bu**; **Waltman**; **Huang**, 2021). A review of the literature almost a decade ago found 108 bibliometric indicators at author level (**Wildgaard**; **Schneider**; **Larsen**, 2014), while a more recent review found up to 32 variations in publication counting methods alone. This abundance is reflected in the metrics of the two main bibliometric suites, *InCites* and *Scival.* The former has a total of 56 indicators (*Clarivate Analytics*, 2018), while the latter has 54 (*Elsevier*, 2019). To these we should also add all the indicators that are being added to journal platforms such as the *Journal Citation Impact - JCI* in the *JCR* (**Torres-Salinas**; **Valderrama-Baca**; **Arroyo-Machado**, 2022), along with the modifications of traditional indicators as in the case of the Crown-Normalized Impact (**Torres-Salinas** *et al.*, 2018) and the never-ending adjustments and improvements to the Hirsch Index (**Alonso** *et al.*, 2009).

In addition, each new database is accompanied by its corresponding metric proposals. Some of the countless examples include *Dialnet Metrics* with its *Journal Dissemination Index* (*IDR*) (**Gregorio-Chaviano** *et al.*, 2021), *Influscience* with its *InfluRatio* (**Torres-Salinas**, 2022a) and *PubMed* with its normalized citation. It seems that no one can resist the urge to create new indicators. This inflation has been further accentuated by altmetrics, as each digital interaction in the scientific context (tweets, likes, replies...) produces a new set of metrics. Many of these are incorporated into aggregators, with recent studies showing that many of them are far from useful. For example, *Altmetric.com* incorporates 19 indicators, however some of them are dispensable because they either have a large regional bias, the original source has disappeared or the values are simply very low (**Robinson-García** *et al.*, 2014). Faced with so many indicators, it is only logical to seek to achieve unification. In this respect, composite indicators now exist such as the *Altmetric Attention Score*, the limitations of which are glaring (**Gumpenberger**; **Glänzel**; **Gorraiz**, 2016).

Table 2. Illustrative example of the calculation of altmetric indicators in two sources: *Altmetric.com* and *CrossRef Event Data*

| Doi de la publicación | *Altmetric.com* | | *CrossRef Event Data* | |
|---|---|---|---|---|
| | **Total tweets** | **Original tweets** | **Total tweets** | **Original tweets** |
| *10.1186/1743-422x-2-69* | 78,610 | 30,449 | 235 | 135 |
| *10.1097/mjt.0000000000001402* | 77,136 | 27,342 | 68,838 | 21,568 |
| *10.1016/s0140-6736(21)02243-1* | 54,628 | 17,805 | 910 | 223 |
| *10.1016/s0140-6736(21)00234-8* | 53,943 | 8,477 | 67 | 61 |
| *10.1016/s0140-6736(20)31142-9* | 36,332 | 13,876 | 1,116 | 509 |
| *10.1038/s41550-020-01222-x* | 793 | 266 | 739 | 251 |
| *10.1080/03075079.2020.1712693* | 1,311 | 417 | 1,007 | 335 |
| *10.1056/nejme2029812* | 44,338 | 17,850 | 46,649 | 18,131 |

Inflation leads to the existence of metrics of which we have limited knowledge regarding their application and limitations. Accordingly, while aggregators facilitate data collection, they also require super-users with in-depth knowledge of their metrics and data. A clear reflection of the need to better understand the origin and calculation of indicators is the lack of concordance when calculating the same indicator for a scientific article on different platforms (**Zahedi**; **Costas**, 2018). Table 2 gives some examples of the divergences that can occur. For the different dois, we have compiled the number of mentions on Twitter with *Altmetric.com* and *CrossRef Event Data*. As can be seen, the differences can be extreme. These problems are one of the major challenges we face, raising the question as to how we can efficiently manage the proposals made by these so-called social media metrics (**Wouters**; **Zahedi**; **Costas**, 2019) in a contextualized manner without reverting to "bean counting" (**Ràfols** *et al.*, 2016). Having many indicators does not necessarily mean they are better if our methodological approach remains the same (**Barré**, 2019).

### 2.3. Bibliometrics and its link with data science

Any specialist in our field should not be too surprised by the growing influence of data science in the different branches of knowledge. Ever since its origins, bibliometrics has had a close relationship with computational methods and data

management (**Egghe**; **Rousseau**, 1990). The use of different sources, massive processing of records, calculation and selection of indicators and their visualization are issues that bring us ever closer to data science and, more specifically, to Big Scholarly Data (**Xia** *et al.*, 2017). This latter concept is defined as the application of Big Data and machine learning techniques (acquisition, storage, processing, analytics and visualization) to support the management and analysis of scientific data and information (**Khan** *et al.*, 2017). Bibliometrics falls within this scientific corpus since its content and praxis are perfectly adapted to the 5Vs (Volume, Variety, Velocity, Veracity and Value) that theoretically characterize data science as shown in Figure 2, which is based on the proposal by **Xia** *et al.* (2017).

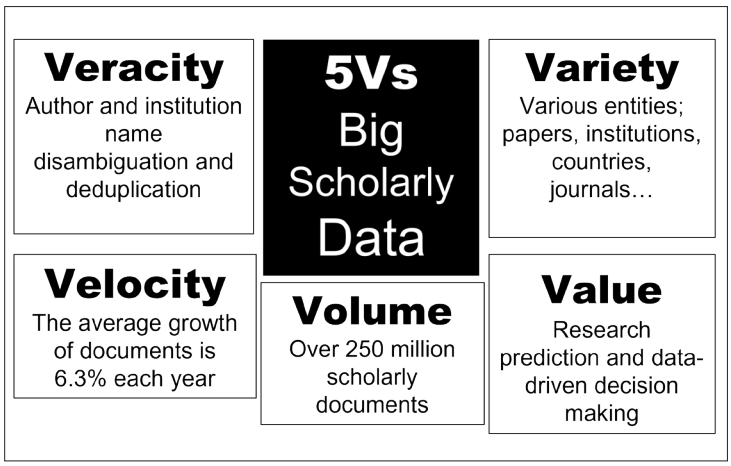


Figure 2. The five Vs defining data science applied to the world of academic and scientific data

The link to data science existed before this new field was reformulated. Data mining techniques, clustering algorithms and information representation have a long and proven tradition in the fields of bibliometrics and information retrieval. A clear example is the work by Henry Small and his proposals for science mapping (**Small**; **Sweeney**; **Greenlee**, 1985; **Small**, 2006), along with the close conceptual link to *Google's PageRank* design (**Leydesdorff**, 2009). One of the aspects that most strongly links us with data science is the ultimate aspiration of synthesizing and making sense of information, which in our case manifests itself in the development of visualization software. This trend ranging from *HistCite* (**Garfield**, 2004) through to *VOSviewer* (**Van-Eck**; **Waltman**, 2017) now appears to be leaning towards languages such as *R* and *Python* based on collective package development. Other noteworthy examples include the *Pybliometrics* package (**Rose**; **Kitchin**, 2019) and, above all, *Bibliometrix* (**Aria**; **Cuccurullo**, 2017). This latter *R*-tool offers the possibility of an interface (*Biblioshiny*) which combines a large number of indicators and graphical representations.

However, apart from the visualizations the size of the studies is also increasing, with samples totaling millions and millions of publications. This is evidenced by papers which include 'large scale' in their title, for example to analyze the coverage of databases (**Visser**; **Van-Eck**; **Waltman**, 2021) or the linguistic analysis of publications (**Saier**; **Färber**; **Tsereteli**, 2022). Indeed, the availability of bibliometric data means that certain topics can be tackled globally, such as scientific mobility between countries and continents (**Robinson-García** *et al.*, 2019), the cognitive structure of social platforms such as *Wikipedia* (**Arroyo-Machado** *et al.*, 2020) and the characteristics of researchers via their *ORCID* codes (**Costas**; **Corona**; **Robinson-García**, 2022). Data science also contributes to the improvement of author disambiguation algorithms (**Tekles**; **Bornmann**, 2020), entity identification (**Wang**; **Zhang**; **Li**, 2022), automatic genre classification (**Bérubé** *et al.*, 2020) and sentiment analysis of citation mechanisms (**Athar**, 2014).

Among the countless other examples of Big Data techniques, a further highlight is the application of machine learning to collaborative networks to determine the future impact of an author (**Grodzinski**; **Grodzinski**; **Davies**, 2021) or to predict the type of contributions made by authors in their work (**Robinson-García** *et al.*, 2020). Deep learning has also been applied to predict citations from metadata (**Ma** *et al.*, 2021) and for the recommendation of scientific articles (**Yang**; **Xu**; **Chen**, 2021). Finally, another symptom of our datification is the fact that more and more bibliometric datasets are being shared openly, whether COVID-19 conversations on *Twitter* (**Banda** *et al.*, 2022) or complete databases based on *Wikipedia* for informetric purposes (**Arroyo-Machado**; **Torres-Salinas**; **Costas**, 2022). To sum up, data science is a multidisciplinary field with contributions that are likely to have direct applications in the field of bibliometrics. While this was already the case, now this process is becoming accentuated. The development and influence of data science has enabled a qualitative leap in both the technical and conceptual development of the discipline and this link is bound to become closer over time.

### 2.4. The search for meaning and interpretation

A traditional criticism of bibliometrics in other related disciplines (e.g., sociology of science, economics of science), is its eminently empirical basis and its theoretical gaps (**Leydesdorff**, 1998). Bibliometrics has endeavored to deploy a striking array of techniques but at the cost of failing to articulate a sustainable theoretical corpus, with the exception of isolated efforts such as *Citation Theory* (**Cronin**, 1984) and the *Triple Helix* (**Leydesdorff**; **Etzkowitz**, 1998). As seen in the previous section, like computational disciplines it has become a data-driven science (**Bell**; **Hey**; **Szalay**, 2009), i.e., an area driven by data and not proof of preconceived, theory-based hypotheses (**Anderson**, 2008).

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This process of extreme datification should be viewed with caution and prompt reflection on essential aspects such as the validity of the sources, the data they contain, the indicators designed using them and, ultimately, the evaluative frameworks. Numerous voices warn of the harmful effects of quantification (**Benedictus**; **Miedema**; **Ferguson**, 2016; **Pardo-Guerra**, 2022), especially when it is accompanied by the unreflective use of information, as is often the case when using rankings and their indicators in decision-making (**Bastedo**; **Bowman**, 2010). This raises the relatively urgent need for bibliometrics to join the movement towards what has been dubbed "numeroethics" (**Saltelli** *et al.*, 2021) as a means of establishing a critical viewpoint and a more ordered space for reception, assimilation and interpretation of the avalanche of metrics we are immersed in.

This is another of the major challenges we face: bibliometrics is an area that generates large amounts of data, and so we must take steps to ensure its veracity and validity. In this sense, important work is being done in the area known as Responsible Research Metrics (**Wilsdon**, 2018). A good example of its application is the promotion and encouragement of best practices to be applied in our work as consultants in assessment centers and units (**Cabezas-Clavijo**; **Torres-Salinas**, 2021). This is a good start, fostering a global praxis that considers numeroethics together with responsible metrics. Once this is achieved, all that remains is to agree on a framework for the meanings of the different indicators. **Sugimoto** and **Larivière** (2018) point out that for an indicator to be useful, i.e., to be interpreted appropriately, it must be explicitly linked to a concept and the indicator must be a valid representation of that concept. One of the current problems with metric inflation is that it is not always possible to bridge the gap between measure and concept and desire and reality.

We currently seem to have overcome the notion of equating any particular indicator to quality, peer recognition or scientific impact according to Garfield's classic vision. A clear indication of their limitations is that they are not even applicable as an interpretative framework for social metrics, since a scientific journal has little or nothing at all to do with Twitter, and yet no one disputes the idea that both channels should form part of a unified theory of scientific communication. In order to take the first steps, this context requires us to apply more flexible categories and more inclusive concepts such as audiences (**Robinson-García**; **Ráfols**, 2020). Some attempts have been made by expanding on different social theories (**Haustein**; **Bowman**; **Costas**, 2016; **Tahamtan**; **Bornmann**, 2022). Based on the communication paradigm, the key factor would be an assessment of the effectiveness of the issuer's communication of the results in different scientific or social contexts. Indicators, whether bibliometric or altmetric, would be a measure of researchers' success in getting their message to the right audience (**Moed**, 2017) which, as Sugimoto and Larivière point out, is a good way to link indicators to tangible concepts and realities.

Table 3. The three pillars of Evaluative Bibliometrics

| Against magical thinking in Informetrics | Combination of indicators and peer review | The indicators depend on the context of the application |
|---|---|---|
| Magical thinking substitutes reality with symbols; by modifying these symbols we can modify reality. The magical view leads us to think that citations reflect the quality and contribution of a researcher and that as citations increase so does the quality and contribution. This reasoning is common among researchers and policy makers. | The future of our field involves working together with experts. Bibliometrics is a tool which, when intelligently combined with peer review, aids decision-making processes. Indicators are decision-making tools (monitoring devices) and neither a substitute nor an enemy of peer review. | It is important to understand the context of the indicators in order to select the most appropriate ones. Before carrying out any study and in order to respect scientific uniqueness, the following should be considered as a minimum: (a) the type of assessment unit (b) the dimension to be assessed (c) the objectives of the assessment and (d) the characteristics of the unit (local vs national, areas of specialization). |

## 2.5. Commitment to Evaluative Bibliometrics

Although there is a pressing need to search for an interpretative framework, we should not deceive ourselves; we are still governed by a conservative and descriptive praxis, as revealed by the global and indiscriminate use of the impact factor in the assessment process (**Delgado-López-Cózar**; **Ràfols**; **Abadal**, 2021). This has led to another phenomenon in contemporary bibliometrics: the proliferation of manifestos advocating more transparent, multidimensional and respectful practices, aspects initially identified in the *Metric Tide* report (**Wilsdon** *et al.*, 2015). Among these manifestos, three have prevailed: the *Leiden Manifesto* (**Hicks** *et al.*, 2015), statements such as *DORA* (*https://sfdora.org*) and more recently the *Hong Kong Manifesto* (**Moher** *et al.*, 2020). Their overall effect has been of great value to generate a process of reflection focusing on how to approach assessment processes in a fairer and more inclusive manner. This is reflected in the recent "Agreement on Reforming Research Assessment" (*European Commission*, 2022) reached in the EU framework and implemented through the *Coalition for Advancing Research Assessment* (*https://coara.eu*), which is destined to guide the member states' assessment policies in the coming years.

This agreement states that the core element for decision-making in scientific assessments should be the qualitative judgments of experts. Consequently, this 'new' proposal repeats the idea that peer review is the central mechanism and

that quantitative indicators (at no stage is bibliometrics mentioned) should only be used to support the experts. However, this proposal is not as new as it claims, given that its postulates are highly reminiscent of the basic principles of Evaluative Bibliometrics (EB) as conceived by the Leiden School in the 1980s (**Moed** *et al.*, 1985; **Torres-Salinas**, 2022b). Table 3 recalls the principles of EB (**Moed**, 2017), which should ultimately constitute the working approach to be taken when carrying out our activity and are also compatible with the EU policies. EB takes into account constant qualitative developments and more modern and relatively original perspectives (**Rafols**; **Stirling**, 2021) advocating a commitment to experts and respect for context. However, in light of Table 3 it is obvious that both the EU and the qualitative wave have taken the principles of EB and disseminated them as an original approach.

> There is a relatively urgent need for bibliometrics to join the movement towards what has been dubbed "numeroethics" (**Saltelli** *et al.*, 2021) as a means of establishing a critical viewpoint and a more ordered space for reception, assimilation and interpretation of the avalanche of metrics we are immersed in

This scientific appropriation obliges us to place the postulates of EB at the core of our discipline, a constructive way of countering a trend that views bibliometrics with suspicion and fosters a new breed of bibliometric denialism. This denialism, like others, is based on the denial of empirical evidence regarding the benefits of EB for decision-making. It is also the result of a Manichean interpretation of the manifestos and declarations, extending criticism of the impact factor to the rest of the indicators and practices. An example of this negationist trend would be the extreme application of narrative curricula, forbidding the use of metrics to validate arguments given. The typology of national assessment systems has diversified in the last few years (**Zacharewicz** *et al.*, 2019), going from systems which deny the informative power of bibliometric indicators for decision making (e.g., UK's *REF*) to others which rely on somewhat arbitrary metrics, ignoring experts' warnings and recommendations (e.g., Spain, see **Torres-Salinas** *et al.*, 2018; **Robinson-García**; **Amat**, 2018). It is clear that EB must remain equidistant from both, this culture of metric cancellation and metric worship, and work to create a vision that unites and integrates the different evaluative perspectives.

### 2.6. Social challenges

Within this integration process, bibliometrics is also beginning to incorporate changes and new social sensitivities. Our publications are increasingly aware of issues relating to inclusion and diversity. Matters such as gender and language have always been part of our agendas, but it is only recently that other more specific variables (race, age, gender identity, etc.) are being systematically incorporated. For example, recent works have quantitatively addressed complex issues such as the influence of race on the choice of research topics (**Kozlowski** *et al.*, 2022) and the global professional status of women scientists (**Boekhout**; **Van-der-Weijden**; **Waltman**, 2021). These are examples of a new vision that highlights situations of inequality.

The bibliometric community has therefore shifted its focus from a perspective that is more concerned with technical and documentary issues (e.g., algorithms, data management and standardization) to one that is more sensitive and attentive to the use made of bibliometric data and its consequences. It should be remembered that indicators, like any social construct, can become tainted with ideological or commercial interests or, even worse, it can perpetuate situations of social-scientific inequality (**Sugimoto**; **Larivière**, 2018). The challenge consists of promoting a more committed bibliometric approach which seeks to reveal the metrics of inequality and moves without hesitation towards a more neutral and less conditioned approach to metrics. It is fundamental to address the diversity of research and different local approaches in a process that incorporates multiple contexts.

In this scenario, scientific assessment services play an essential role, providing the means for correct application of bibliometrics. These services link academics with the real-life scenarios of assessments, which is where our knowledge becomes effective. These services also have other positive functions. According to **Gorraiz** *et al.* (2020), they allow us to forge a positive attitude among stakeholders, preventing misuse of indicators by managers and stimulating informed peer reviews. This expansion through institutional structures appears to be the way forward. Indeed, in Spain these institutional structures have become commonplace since we proposed a systematization of them in 2007 (**Torres-Salinas**; **Jiménez-Contreras**, 2012; **Cabezas-Clavijo**; **Torres-Salinas**, 2021).

## 3. Concluding remarks

Bibliometric practitioners need to prepare themselves for the issues raised above. At a technical level, we will need classical training relating to databases and indicators. However, above all we will be required to upgrade our technological skills and update our IT and statistical competencies on an almost daily basis.

> To place the postulates of EB at the core of our discipline can be a constructive way of countering a trend that views bibliometrics with suspicion and fosters a new breed of bibliometric denialism

In addition, we need to take a professional approach to an issue which is yet to be resolved: the transition towards a peaceful coexistence with peer review. This means going beyond our usual boundaries, which are

closely linked to the content of the degree and work typical of library services, to a scenario of scientific assessment in a more general sense involving collaboration with reviewers, managers and researchers, which requires other types of methodological and administrative skills. Although the pandemic interrupted the efforts to create a professional community to face these challenges (**Torres-Salinas**; **González-Molina**, 2019), there is still time to create an associative structure and a mechanism that allows us to share experiences, make joint decisions and advocate jointly and unequivocally for our profession.

> The challenge consists of promoting a more committed bibliometric approach which seeks to reveal the metrics of inequality and moves without hesitation towards a more neutral and less conditioned approach to metrics

## 4. Note

1. Translator's note: The original text in Spanish reads "precisar con todo rigor el instante cronológico en que una idea brota, el proceso de su expansión, el periodo exacto que dura como vigencia colectiva y luego la hora de su declinación".

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