TUM

Personal Scientific Impact:
Methods to Determine the Scientific Impact of Authors

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Abstract

Initial situation: Bibliometric indicators are used to assess the scientific relevance of researchers' publications and to compare their performance. In some cases, procedures are used at TUM that do not comply with the rules of good scientific practice and lead to misleading or false statements.

Proposal for the determination of the personal scientific impact: The assessment of the scientific relevance of the publications of researchers as well as a comparison of performance can be usefully supported by bibliometric evaluations. However, the indicators must be appropriate to the intended purpose, significant, easy to determine, and transparent.

The following procedure is proposed for assessing the scientific relevance of researchers' publications and for comparing their performance:

1. Synopsis: for the quantitative assessment of the publications of researchers and performance comparisons, several indicators are determined and considered in their entirety (four basic indicators, and seven subject-weighted indicators; see below for a table of suitable indicators).

2. Benchmarking: for the quantitative evaluation of the publications of individuals for qualification steps (e.g. habilitation), the following is additionally proposed

- demand a Field-Weighted Citation Impact of > 1 as a threshold for a predefined selection or a number of publications,

- demand a Field-Weighted View Impact of > 1 as a threshold for a predefined selection or a number of publications.

Introduction: Quantitative Performance Measurement of an Individual Author

Measuring the performance of a scientist needs a detailed understanding of the research field. It can only be done on the basis of a qualitative evaluation of the research results by experts in the field.

In many assessment situations, however, quantitative methods are also used to measure performance, such as the evaluation of citation counts of individual publications or all publications of an individual person, or bibliometric indicators for journals in which an author has published.

When using quantitative methods, it is necessary to include the indicators in the evaluation according to their actual significance and in relation to their actual area of application. Otherwise, quantitative indicators suggest significance, precision, and comparability that is not given in many cases. Statements that are carelessly or exclusively based on such quantitative indicators are often misleading or false.

Provided that quantitative methods are used with care and in consideration of their actual informative value, they can usefully complement a qualitative assessment approach. For example, quantitative methods can clarify how visible a scientist is in the respective subject context or how influential an author's publications are in research.

This recommendation explains the situation and proposes a procedure for the quantitative evaluation of personal scientific impact.

Indicators for the Assessment of an Individual Author

Requirements for Bibliometric Indicators

- **Transparency:** The indicators used must be calculated according to a standardized and transparent procedure, i.e. they must be available as standard bibliometric indicators in the literature databases used. In the case of self-calculated or defined indicators (e.g., cumulative impact factor), it is often not clear which data bases and which methods were used to calculate the indicators. Such data calculations are not transparent, often not reproducible, and therefore unusable.

- **Significance and relevance for the bibliometric analysis of the person in question**: The indicators used must allow an accurate statement about the person to be evaluated, i.e. the indicators must be meaningful and relevant. Statements about a person must be based on indicators that are author-related (e.g. median of citation percentiles or h-index).

- **Use of several criteria:** Bibliometric indicators only measure certain aspects of the publication process, and their significance is selective. Only the combination of several indicators allows a broader and more appropriate picture. For example, in order to make a statement about the impact of a publication over time, indicators can be used to measure how often a particular publication is searched for or viewed (views).

- **Compliance with the rules of good scientific practice:** Classical and alternative metrics should not be influenceable by the candidate. Otherwise, the achievement of certain indicators becomes the goal of the publication process. This contradicts the rules of good scientific practice. If, for example, a certain value for the so-called cumulative impact factor is required, the choice of the publication channel and the publication organ is no longer made in a way that is sensible from a scientific point of view but follows the goal of maximizing the candidate's own metrics.

In some cases, the informative value of classical, bibliometric methods for the quantitative evaluation of the publications of individuals is fundamentally limited. This applies, for example, to

- young scientists, who principally show lower citation numbers,

- scientists whose publications are not, or only to a small extent, recorded in large interdisciplinary literature databases such as the Web of Science and Scopus,

- scientists in research areas with a high percentage of monographs and/or printed publications,

- scientists in research areas in which scientific impact is not achieved through publications (e.g. planning subjects of architecture).

Comparison of Authors

For the comparison of the scientific relevance of the publications of persons from different disciplines, an additional criterion has to be considered.

- **Subject normalization**: For the comparability of citation figures (related to individual articles or individual persons), it is necessary that indicators are weighted according to the subject. Subject-normalized indicators determine, for example, how often a particular article is cited in the context of the citation frequency that can be expected in the field.

  In some cases, the informative value of bibliometric methods for the comparative evaluation of individuals is fundamentally limited. This applies, for example, to

- Authors in interdisciplinary research networks: In this case, it should be noted that the different publication and citation cultures of the different disciplines of the researchers have to be considered in a publication analysis if all publications of the persons concerned are included. In such analyses, only publications relevant to the research field under investigation may be included.

- Individuals who differ greatly in their field and/or in the number of years they have published (academic age) or in their career paths (e.g., family times, non-university phases).

- Individuals who have been publishing in very different time periods, as there has been a steady increase in citations over time. The reasons for this are the constantly increasing number of publications worldwide as well as the increasing number of citations per publication.

- Persons with very few publications, provided that the number of respective citations is very diverging (problem of normal distribution if a mean value is used).

- Very new publications that have not been published long enough to be cited.

- Publications with very many authors. If each of these authors cites this publication only once, the total number of citations will be excessive.

Appropriate Indicators

1. Synopsis: In order to evaluate the research performance of individuals, it is suggested that all the indicators listed in the table below be identified and considered in their entirety.

2. Benchmarking: When evaluating the research performance of individuals for qualification steps (e.g. habilitation), it is additionally proposed to require:

   - a Field-Weighted **Citation** Impact of > 1 as a concrete threshold value for a selection or number of publications to be defined,

   - a Field-Weighted **View** Impact of > 1 as a concrete threshold value for a selection or number of publications to be defined.

Publications to be included in the evaluation may be, for example:

- the full list of publications,

- publications of certain years (at least three years old),

- five publications selected by the author, or

- publications of a specific discipline. It has to be clarified whether the subject area is defined journal-based (e.g. Categories in WoS) or article-based (e.g. Topic or Topic Cluster in Scopus).

Indicators of Limited Suitability

The more individuals differ with regard to their field of expertise and their academic age or career path, the less suitable size-dependent indicators (SDI) such as the number of publications or the h-index are for comparisons.

In some situations, for example in job applications, in evaluation procedures or in applications for external funding, the provision of certain indicators for individuals is expected. Therefore, these are listed in the following table, even though they are only of limited informative value for research strength or quality. The limited suitability indicators include all basic indicators, as they are purely size-dependent indicators.

Table of Indicators for Authors

Used databases: Web of Science (WoS) and Essential Science Indicators (ESI), Scopus and SciVal, Google Scholar (GS)

	Indicator	Definition	Evaluation	Availability
Bibliometric Basic Indicators	Scholarly Output	Number of publications in the analyzed list of publications	Assessment in the context of the discipline and depending on academic age/career history	Scopus, WoS, GS, subject bibliographies, list of publications
	Citation Count	Full number of the citations of the above publications	Assessment in the context of the discipline and depending on academic age/career history	Scopus, WoS, GS
	Citations per Publication	Mean number of citations per publication	Assessment in the context of the discipline and depending on academic age/career history. If necessary, observe deviations from normal distribution.	Scopus, WoS
	Author Impact Factor source	Mean number of citations in the last full year on publications that were published in the two years prior to that	Assessment in the context of the discipline. Not applicable if in the last year and/or the year before that nothing was published. If necessary, observe deviations from normal distribution.	Scopus, WoS (division has to ensue)
	h-Index	Number h of publications by a scientist that have been cited at least h times	Evaluation in context of field and dependent on academic age/career history	Scopus, WoS, GS
Normalized Bibliometric Indicators	Number of Highly Cited Papers	Number of publications within the 1% most cited publications in the WoS (field normalized, evaluation period 10 years)	Exceptionally positive, if any existing	WoS, ESI
	Number of Hot Papers	Number of publications within the 0.1% most cited publications in the WoS (field normalized, evaluation period 2 years)	Exceptionally positive, if any existing	WoS, ESI
	Field-Weighted Citation Impact of the author	Mean field normalized citation frequency for all or selected publications of a person	Only meaningful if at least 50 publications are evaluated; consider distribution of individual values; use median if necessary. Citation numbers are above average if > 1 (if necessary for a number of publications to be defined)	SciVal
	Field-Weighted View Impact of the author	Mean field normalized number of "views" (within Scopus) for all or selected publications of a person	Only meaningful if at least 50 publications are evaluated; consider distribution of individual values; use median if necessary. View numbers are above average if > 1 (if necessary for a number of publications to be defined)	SciVal
	Outputs in Top Citation Percentiles	Number of publications in the top x% of the most cited publications in the discipline	Evaluate number in the context of the discipline and depending on academic age/career history; in principle, publications in the top percentiles are to be evaluated positively	SciVal
	Median Citation Percentile	Median of the normalized citation percentiles of the publications in the publication list	The higher the more favorable	WoS
	Author Impact Beamplot	Distribution of normalized citation percentiles	Visualization of the citation performance of the publications	WoS

Expertise: In addition, the expertise of authors can be evaluated by comparing them with colleagues from around the world, Europe or Germany in a fixed number of topics or topic clusters on which they have published (SciVal).

Not Suitable Indicators

Indicators for journals (e.g. Journal Impact Factor JIF, CiteScore CS) and key figures derived from them are not suitable for an individual evaluation. Values from journal rankings (e.g. A-journal) or key figures such as the cumulative impact factor do not allow direct conclusions to be drawn about the quality of the individual article or the performance of the author.

Rationale: There is no clear relationship between the average citation frequency of publications in a journal and the quality of individual articles published in it. The use of the Journal Impact Factor (JIF) contradicts the rules of good scientific practice, see DFG Guideline 15: "The scientific quality of an article does not depend on the publication medium in which it is made publicly available". The use of journal metrics for individuals is not DORA-compliant. TUM is a signatory to DORA and has thus committed itself to compliance with the recommendations. There is also international agreement that the JIF of a journal in which publication has taken place may not be used to assess research output. This applies analogously to other journal metrics.

Cumulative impact factors are calculated according to various, unspecified algorithms, e.g., as an arithmetic mean or as the sum of the JIFs of the journals in which an individual has published. When used, it is assumed that publication in a highly cited journal should be taken as a mark of quality for the individual article published there and its author. This assumption is incorrect.

Explanations:

- JIF and CS depend on the publication and citation behavior of individual disciplines and show extremely different values for different disciplines. Such values lack significance without context, and there is no interdisciplinary comparability.

- Even in journals with above-average JIFs, there are publications that are scarcely or not at all cited (example: 15% to 20% of the publications from the journal "Science" are never cited even years later, in the journal "Nature" the proportion of never cited publications is between 20% and 25%).

  - Many journals do not (yet) have a JIF, because it is only calculated for journals that have been listed in the Web of Science for at least five years. Journals with a regional focus do not have a JIF and/or CS, regardless of their quality, as they are not referenced in Scopus or WoS. Congress publications, contributions to edited works or monographs are not considered in the JIF. A substantial part of the scientific literature is thus not included in the evaluation of researchers.

- The JIF of a journal and the CS are recalculated annually. The values can fluctuate greatly.

- Since the JIF and the CS are an average values, but the distribution of citations is usually extremely skewed, the indicators are even highly controversial for journal evaluation.

- Since the cumulative impact factor does not exist as an indicator, it must be calculated by oneself. There are no standard algorithms to calculate it (e.g., which year's JIF is used; is there proportional weighting depending on the position in the list of authors).

Indicators for the Assessment of an Individual Articles

Suitable Indicators

All indicators for individual publications listed in the table below are field-normalized, i.e. they consider field-specific publication and citation practices.

Table of Indicators for Single Publications (Article-level Metrics)

Used databases: Web of Science (WoS) and Essential Science Indicators (ESI), Scopus and SciVal

Indicator	Definition	Evaluation / Requirements	Availability
Highly Cited Paper	Belongs to the 1% most cited publications in the WoS (field normalized, evaluation period 10 years)	Exceptionally positive	WoS, ESI
Hot Paper	Belongs to the 0.1% most cited publications in the WoS (field normalized, evaluation period 2 years)	Exceptionally positive; for very new publications only	WoS, ESI
Citation Percentile	Compares the citations with similar publications and indicates in which percentile the publication ranks; similar means: • same discipline • same publication age • same document type	Only possible for publications with a minimum age of 3 years	Scopus
Field-Weighted Citation Impact for publications	Field-normalized citation frequency of a single publication	> 1 means above average	Scopus
Field-Weighted View Impact for publications	Field-normalized number of „Views" of a single publication	> 1 means above average	SciVal

Indicators of Limited Suitability

Limitedly suitable indicators for single publications are the number of citations and alternative usage metrics ("altmetrics").

Reason: There is no clear correlation between the citation or usage frequency of an article and its quality.

Mainly the following type of articles appear in the list of highly cited articles:

- older articles, because these have had more time to be cited. New articles (almost) never appear via this method,

- articles with a large number of authors (because more authors later cite this article themselves),

- publications from certain fields (e.g. medicine and physics), in which more authors contribute to a publication and in which more citations are made,

- publications on methods (e.g. PCR in the life sciences - these are cited if the method is used),

- reviews (which are particularly frequently cited in general),

- publications of economic interest (e.g. usability for the pharmaceutical industry).

Conversely, publications with negative results are scarcely cited, although they are important for research.

The number of citations of a publication is strongly dependent on the citation database used.

Altmetrics measure the visibility of a publication at a very early stage, long before it is cited. The significance of altmetrics on quality is still controversial at this stage, although some studies have observed positive correlations.

Not Suitable Indicators

Not appropriate for evaluating individual publications are journal name prominence (e.g., deriving a quality judgment from the fact that an article was published in "Nature") and any journal metrics.

Consulting and Training at the University Library

General introduction to Academic Identity Management and Bibliometrics

In the course "Visibility and Impact of Research: Bibliometrics, Scholarly Communication and Publication Strategies" you will gain an overview of the most important bibliometric indicators and learn how to improve the visibility of your research through academic identity management and effective publication strategies.

For more information, appointments, and registration, visit https://www.ub.tum.de/en/course/visibility-and-research-impact

Request an appointment for a bibliometrics and impact consultation.

We can help you clean up your author profiles and improve the visibility of your publications. Make an appointment for an individual consultation at your office, a branch library of TUM or online via web conferencing. Further information, dates and registration can be found at https://www.ub.tum.de/en/consultation-bibliometrics-impact

Contact Information & Contact Persons

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