Differences between fields of science

- There are several classifications of fields of science, and the field to which a publication belongs may vary depending on the classification used.
- The publication practices of different fields of science differ in ways that are reflected both in the number of publications in citation databases and in the number of citations they accumulate. From the perspective of the production of publication metrics, the differences primarily lie in the language and form of publications (book, article, conference proceedings, etc.) and in the citation practices specific to the field of science.

Classification of fields of science

Different classifications of fields of science are key tools for publication metrics. There is a wide variety of classifications, and they assign publications into different fields of science according to different criteria. The same publications can be assigned to different fields of science or research areas, depending on how the fields are defined.

In Finland, the Statistics Finland's classification of fields of science is used, for example, in the Ministry of Education and Culture's publication data collection. Each publication is placed in one or more categories, either by its author or by the administrator of the research information system. This is a classification based on the substance of the publication, defined by the publication data recorder. This classification is used, for example, in the Vipunen reports and on the Research.fi website.

In international citation databases, publications are usually not assigned to fields of science individually but based on the classification of the **journal** or on the article´s **citation connections**. In addition to these, categories of research areas can be created using **search algorithms**. SciVal's *SDG Research areas* is an example of such a classification.

Defining the field of science based on the journals is the most common practice in the largest citation databases so far. One or more fields of science have been identified for each journal, and all articles published in the journal are automatically assigned to them. For the user, one of the advantages of the system is the transparency of the classification. The disadvantage, however, is that the classification is very rough, and the range of research areas of the articles published in the journal is usually wider than the fields defined for the journal. Small fields of science are often classified as part of a larger field of science because of their small size, which, then poses problems for the reliability of the normalised indicators. Articles are also published in journals outside their actual field of science. In most journal-based classifications articles published in multidisciplinary journals are left unassigned to a specific field of science. This is particularly problematic because often articles published in these journals (such as Nature or Science) are the ones with particularly high impact (Szomszor 2021). There are a large number of classifications based on journals, and citation databases have also developed them to meet the needs of certain national research evaluations.

In recent years, a classification based on the connections between citing and cited publications has emerged alongside the journal-based classification. The major analysis tools have their own classifications based on citation networks, including SciVal's *Topic clusters* and InCites's *Citation topics,* which is b ased on an algorithm developed by CWTS Leiden. The algorithms identify clusters of publications that cite each other and form fields of science of these publications. The classification based on the citation connections allows for a more refined classification that better reflects the substance and context of the article. For the user, the disadvantage of this classification is that the classification criteria are not openly available.

The order of the authors may indicate different roles in different fields of science

The order of the authors listed in a publication indicates the roles of the authors drafting it. With the help of the order of the authors, the analysis can be focused on publications where the subject of the analysis has been a leading author, for example. Practices in the fields of science vary in terms of the order in which authors are listed.

In most natural sciences, medical science and engineering, the authors are listed in order of their contribution to the publication, starting with the lead author, i.e. the author who played the greatest role in the drafting of the publication. The leader of the research project is listed last. Unlike in other natural sciences, in mathematics and some fields of physics, authors tend to be listed in alphabetical order, regardless of their contributions. In social sciences, authors can be listed either in order of contribution or alphabetically, depending on the field of science. For example, in psychology publications, authors are listed in order of contribution, but in many other fields in alphabetical order. In humanities, authors are usually listed alphabetically. (Puuska & Miettinen, 2008, p. 43–51)

The field of science has an impact on the citation count and accumulation rate

The number of sources used varies by field of science

In theory, it could be assumed that the citation counts of each field of science would depend on the total number of references used in the field's publications (Garfield, 1979; Moed et al., 1985). Garfield called this the *citation potential* of the field of science. The number of references used varies by field of science, and it could be expected that the probability of being cited would be higher in fields where the reference lists are long than in fields where they are short. However, this assumption would only hold true if there were an equal number of citing publications in each field of science, all citations were to publications published in the same field and all citations were countable. This is not the case.

In practice, citations are counted from the citation databases, and citations to publications that are not included in the databases are not counted. Thus, more than the length of the reference lists, the extent to which the field publishes in series and books indexed by the citation databases, and the proportion of citations to these, has a more significant impact on the typical number of citations in the field (Dorta-González & Dorta-Gonzáles, 2013; Patience et al., 2017).

Different fields of science cite sources of different ages

Citation practices in different fields of science differ in terms of the age of the sources used. The number of citations shared at any given time is influenced by how recent articles tend to be cited, and how long after their publication an articles continues to be cited – this also varies by field of science and affects the typical citation counts in the field (Moed et al., 1985; Dorta-González & Dorta-Gonzáles, 2013; Patience et al., 2017). Citing recent articles seems to increase the number of citations accumulating in the field of science (Patience et al., 2017).

If a very short citation window is used in the analyses, the uncounted citations may be concentrated in certain fields of science (Abramo, 2011).

Citation databases do not cover publications from all fields of science equally

The extent to which citation databases cover publications in different fields of science varies significantly. In general, publications in the fields of natural and medical sciences are much more widely available in the largest citation databases (Web of Science, Scopus, Dimensions) than publications in the fields of social sciences and humanities. However, natural sciences, medical science and social sciences include various research areas, some of which are well covered and others poorly covered by citation databases. More information about the coverage of databases is available in the chapter Most commonly used multidisciplinary citation data sources of this guide.

Differences in coverage are partly due to the fact that the citation databases (Web of Science and Scopus) index journals which publish **scientific articles more comprehensively than other publication channels**. However, in some fields of science, a significant proportion of research is published in books rather than articles (e.g. in various social sciences and humanities) (Larivière et al., 2006) or in conference proceedings (in computer sciences) (Freyne et al., 2010). A large proportion of publications from these research areas are excluded from the citation databases.

The coverage of scientific journals publishing articles in the citation databases is not the same for all fields of science. The most used citation databases (Web of Science and Scopus) only index **journals in which at least the title and abstract are in English**. Therefore, most journals in other languages, such as Finnish, are excluded from them. Publishing in English is more common in natural sciences and medical science than, for example, in many social sciences and humanities, where the research is more conneted to a particular place and culture. **The publishing language** therefore partly explains the poorer coverage of social sciences, arts and humanities in the citation databases.

For these reasons, it is simpler to carry out citation analyses for fields of science that publish the majority of their research findings as articles in international scientific journals (publishing in English) than for fields of science that publish mainly in Finnish or in formats other than scientific articles (e.g. books or conference proceedings). Research organisations' own research information systems can be used for publication analyses in fields of science less covered by the citation databases. In this case, the analysis is not based on citation data, but on other characteristics of the publications, such as the language of publication or the number or proportion of national and international co-publications.

The number of authors varies by field of science

There are differences in the average number of publication authors between research areas. For example, an article on astronomy, astrophysics, nuclear physics or particle physics can often have more than 100 authors, while a scholarly publication on history or literary research typically has only one author (Patience et al., 2017). Large numbers of authors are particularly common in fields of science where research requires large laboratories or other infrastructure or extensive cooperation in aspects such as data distribution. Differences in the number of authors are reflected in the average citations per article in the field of science, as the increase in the number of authors has been found to increase the number of citations an article receives (Adams et al., 2019; Patience et al., 2017).

Average citation numbers across fields of science therefore vary for reasons unrelated to research quality or impact

The variation in the total number of citations means that it is not possible to compare different fields of science, organisations or researchers on the basis of citations in a fair way (e.g. Garfield, 1979; Moed et al., 1985; Dorta-González & Dorta-Gonzáles, 2013; Mongeon & Paul-Hus, 2016), except by means of normalised indicators. For example, in practice, the h-index of a researcher carrying out purely sociological research cannot, in practice, rise nearly as high as a researcher's carrying out genetic research at a similar career stage.

ESI Research Field	minimum number of citations received by the top 1% of papers from 2018 (2022)	ESI Research Field	minimum number of citations received by the top 1% of papers from 2018 (2022)
MOLECULAR BIOLOGY & GENETICS	164	COMPUTER SCIENCE	86
MULTIDISCIPLINARY	143	ENGINEERING	81
MATERIALS SCIENCE	139	PHYSICS	81
IMMUNOLOGY	113	PHARMACOLOGY & TOXICOLOGY	75
CHEMISTRY	104	GEOSCIENCES	69
SPACE SCIENCE	100	AGRICULTURAL SCIENCES	64
BIOLOGY & BIOCHEMISTRY	98	PSYCHIATRY /PSYCOLOGY	64
ENVIRONMENT /ECOLOGY	96	ECONOMICS & BUSINESS	63
MICROBIOLOGY	96	PLANT & ANIMAL SCIENCE	52
NEUROSCIENCE & BEHAVIOR	94	SOCIAL SCIENCES, GENERAL	49
CLINICAL MEDICINE	86	MATHEMATICS	36

Table 1. Thresholds used in 2022 for each of Web of Science's ESI (Essential Science Indicators) Research Fields for Highly Cited Paper articles published four years earlier (2018).
Highly Cited Papers are articles that rank in the top 1% of most cited articles in their research field published in a specified year.
The figures show that the number of citations distributed varies by field of research. For example, an article published in a molecular biology or genetics journal in 2018 must receive at least 164 citations to be among the most cited 1% in 2022, whereas in the field of mathematics, articles with more than 36 citations rank in the top 1%.

Data extracted from the Clarivate service on 9 March 2022 https://esi.clarivate.com/ThresholdsAction.action

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