

Treating bibliometric indicators with caution: their dependence on the source database

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Database comparisons

Treating bibliometric indicators with caution: their dependence on the source database

L Quoniam, H Rostaing, E Boutin, H Dou

Nowadays, with computer-supported analysis of databases, constructing bibliometric or scientometric indicators may be considered easy. The problem is more to verify the accuracy of the global analysis, including the sampling of data. The global coherence of an analysis depends on the adequacy of all the steps. Using on-line databases, an experiment was designed to demonstrate this. Keeping the same protocol for data collection, the same indicators are used over the various samples. The results from three separate databases are profoundly different.

SCIENTIFIC PRODUCTION and collaborative stability¹⁻³ are used as indicators of the activity of a laboratory even though they are quantitative not qualitative indicators.⁴ We have tested the accuracy of these indicators through various on-line bibliographic databases. Since we were dealing with researchers' work in detail, we looked only at our own laboratory, according to the code of practice for information brokers.⁵

Data collection

Among our laboratory activities are bibliometry, scientometry and informetry. We used these three words, well recognised and defined nowadays,⁶ as keywords with the Dialog Dialindex to get the databases with the best coverage in this area. Our purpose was not to build the best data collection in each database, but more to show the individual perception of each database, using keywords recognised by the scientists of the area. gives the main responses.

Cost considerations led us to use as much information as possible from CD-ROM to constitute our internal database. Lisa was collected from CD-ROM for 1994, and Pascal for 1987-94. Because there are so many duplicates between SciSearch, Social SciSearch and Current Contents Search, the latter database was not considered. An internal database was downloaded from Dialog from the other two without duplicates.

There is some variability between the CD-ROM versions and the original databases, so the internal databases do not have exactly the same number of references as shown in Table 1. For example, Pascal

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Table 1. Data collection strategy with Dialog Dialindex

| Number | Base collection in 01/1995 | Bibliometry | Scientometry | Informetry | 1, 2 or 3 |
|--------|----------------------------|-------------|--------------|------------|-----------|
| 61 | Lisa(Library&infoSci) | 2005 | 203 | 59 | 2071 |
| 144 | Pascal | 1380 | 457 | 93 | 1606 |
| 202 | Information Science Abs | 884 | 298 | 52 | 931 |
| 7 | Social SciSearch | 388 | 158 | 53 | 566 |
| 440 | Current Contents Search | 317 | 155 | 63 | 479 |
| 434 | SciSearch | 270 | 147 | 10 | 410 |

does not exist in CD-ROM before 1987. The producers of the three internal databases are different (English for Lisa, French for Pascal, and American for SciSearch). Two of these databases are multidisciplinary (SciSearch and Pascal), and one thematic (Lisa). The number of bibliographic notices collected is reported in Table 2.

Analysis

From these databases, we performed several analyses for internal purposes. We now present a few of them. Instead of building a common database without duplicates, we kept the databases separate to demonstrate the particularity of each one. Each has its own indexation practice, sources and point of view. Applying the same treatment over each separate database will outline the specificities.

Fields constitution and indexation practice

Outlining the databases' specificity could seem obvious but is very important. SciSearch is the only database including author's citations, but it has a weak keyword index (240/803 references) which is better in both Pascal and Lisa. SciSearch is also the only database which gives a description of the activity of the journal. Pascal is the only database that provides the country of publication. Our next analysis emphasises one specificity — the data collection practices.

Sources and abstracting practice

To outline this point we determined the groups of co-authors. We have devised software which builds groups (for example authors' groups) using a propagation algorithm.⁷ It is not based on a classic clustering technique, but the natural structure of

Table 2. Number of bibliographic notices in internal databases

| Internal database | Number of bibliographic notices |
|---|---------------------------------|
| SciSearch + Social SciSearch 01/95 Dialog | 803 |
| Pascal from 1987-1994 CD-ROM | 1191 |
| Lisa from 1994 CD-ROM | 2229 |

co-authoring,⁸ using only the co-presence of items in references. This means that the algorithm determines all the co-authors of an author. Then it determines the co-authors who work with the original co-authors, and continues until there are no new co-authors in the group.

Then, the algorithm builds a new database, linking for each group, the affiliations, keywords and papers used by this group in the whole of the studied database. When one group is finished, other groups are built up until the last author enters a group or is recognised as an individual author.

This algorithm may be applied over any field in the studied database. We chose authors' groups, but we could build keyword groups. The fields linked to the group may also be chosen depending on the purpose of the analysis. The algorithm works very well with authors, because the relations between them are finite. Other researchers have published a similar algorithm, but without the linked fields to each built group.^{9,10}

The thresholds used for this analysis are explained in Table 3. The Table 4 represents our laboratory in the SciSearch database with those thresholds.

With these parameters, our laboratory, through SciSearch, is perceived as small (three persons), without collaborations and publishing few (a maximum of three articles) in journals in information science and library science.

With exactly the same parameters, we analysed the Lisa databases. First, it is important to note that it is impossible to extract affiliations from of the Lisa CD-ROM. The author field is also not homogeneous. A bibliometric treatment of this field requires manual control of the database. Table 5 shows the output of the treatment.

The perception of our laboratory begins to change. It appears to have four authors that still publish few (a maximum of eight papers in the last six years). The initial specificity of our laboratory appears (chemistry).

Table 3. Analysis parameters

| | |
|---|---|
| Author minimum frequency: | 2 |
| Co-authors minimum frequency: | 1 |
| Relations with other fields minimum frequency: | 2 |
| Other fields in SciSearch: affiliation, publication year, source, journal subject category, author keywords, keywords plus. | |
| Other fields in Pascal: affiliation, publication year, source, English descriptors. | |
| Other fields in Lisa: source, publication year, keywords | |

Table 4. Our laboratory group in the SciSearch database

| |
|---|
| Authors |
| Dou H (3); Quoniam L (2); Hassanaly P (2) |
| Co-author's relations |
| Dou H [hassanaly p (2), quoniam l (2)] |
| Hassanaly P [dou h (2), quoniam l (2)] |
| Quoniam L [dou h (2), hassanaly p (2)] |
| Affiliations |
| Dou H [marseille; france (3)] |
| Hassanaly P [marseille; france (2)] |
| Quoniam L [marseille; france (2)] |
| Journal subject category |
| Dou H [information science & library science (2)] |

Note: Numbers in parenthesis are frequencies

With exactly the same parameters we analysed the Pascal database. Table 6 shows the result.

The initial specificity of our laboratory appears (chemistry), but also a rather good definition of our activity in information science: automated processing, classification, code, data analysis, data processing, decision making, downloading, graphics, information layout, information processing, on line processing, patent document, relational analysis, research indicator, research program, scientific research, scientific technical information, software, statistical analysis, technological awareness, tool, user interface. Our publications in French journals appear too (*Cahiers de la documentation*).

Our working group is now made up of 18 authors which publish normally (a maximum of 20 publications over a seven-year period). Collaborations appear with the IBM CEMAP Center of Paris (Huot and Bedecarrax), with the IRIT in Toulouse (Dousset, Dkaki, Koussoube), with the CEDOCAR (Centre de Documentation des ARMées) (Paoli, Dionne, Hilaire, Longevialle) and the CNRS URA 1409 G.O.A.E. (Kister).

The graph of our team is shown in Figure 1. The thickness of links is a function of the number of co-publications between authors. Keeping in mind just the thick links, the structure of collaboration appears. There are thick links between members with the same affiliation, thin links between members with

Using the same parameters the three databases were analysed for one French laboratory: results varied from only showing three authors and no collaborations, through four authors with no collaborations, to 18 authors who publish normally

Table 5. Our laboratory group in the Lisa database

| |
|--|
| Authors |
| Dou (8); Hassanaly (7); Quoniam (6); La Tela (2) |
| Co-author's relations |
| Dou [hassanaly (7), la tela (2), quoniam (6)] |
| Hassanaly [dou (7)] |
| Hassanaly [la tela (2)] |
| Hassanaly [quoniam (5)] |
| La Tela [dou (2)] |
| La Tela [hassanaly (2)] |
| La Tela [quoniam (1)] |
| Quoniam [dou (6), hassanaly (5), la tela (1)] |
| Sources |
| Dou [scientometrics (3)] |
| Hassanaly [scientometrics (2)] |
| Quoniam [scientometrics (3)] |

Publication year

| |
|--------------------------------|
| Dou [1989 (2), 1988 (2)] |
| Hassanaly [1989 (2), 1988 (2)] |
| Quoniam [1989 (2)] |

Keywords

| |
|--|
| Dou [chemistry (2), bibliometrics (6), library materials (6), stock (6)] |
| Hassanaly [chemistry (2), bibliometrics (6), library materials (6), stock (6)] |
| Quoniam [bibliometrics (5), library materials (5), stock (5)] |

Note: Numbers in parenthesis are frequencies

different affiliations. This graph was generated automatically using an algorithm created in our laboratory.¹¹

Discussion

Depending on the indicators, macro- or micro-level bibliometry^{12,13} and the application country, the choice of database may be more important than the choice of indicator. An indicator may be considered efficient when it does not change the perception of the reality. What happens if the reality of the database is wrong?

We showed that an American multidisciplinary database and an English specific database may

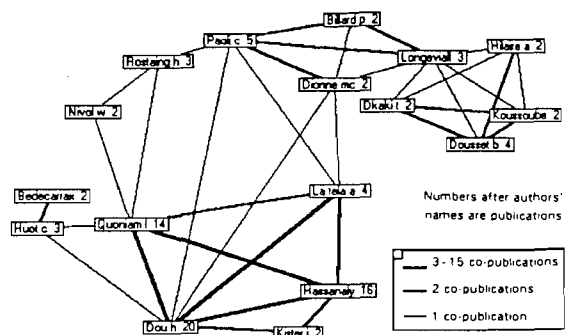


Figure 1. Co-authors relations in the Pascal database

Table 6. Our working group in the Pascal database

Authors

Dou H (20); Hassanaly P (16); Quoniam L (14); Paoli C (5); La Tela A (7); Dousset B (4); Rostaing H (3); Longevialle C (3); Huot C (3); Nivol W (2); Koussoube S (2); Kister J (2); Hilaire A (2); Dkaki T (2); Dionne Mc (2); Billard P (2); Bedecarrax C (2)

Co-authors relations

Bedecarrax C [huot c (2)];
 Billard P [dionne mc (1), longevialle c (2), paoli c (2)];
 Dionne MC [billard p (1), dou h (1), la tela a (1), longevialle c (1), paoli c (2)];
 Dkaki t [dousset b (2), hilaire a (1), koussoube s (2), longevialle c (1)];
 Dou H [dionne mc (1), hassanally p (15), huot c (1), kister j (2), la tela a (7), paoli c (1), quoniam l (10)];
 Dousset B [dkaki t (2), hilaire a (2), koussoube s (2), longevialle c (1)];
 Hassanaly P [dou h (15), kister j (2), la tela a (6), quoniam l (8)];
 Hilaire A [dkaki t (1), dousset b (2), koussoube s (1), longevialle c (1)];
 Huot C [bedecarrax c (2), dou h (1), quoniam l (1)];
 Kister J [dou h (2), hassanally p (2)];
 Koussoube S [dkaki t (2), dousset b (2), hilaire a (1), longevialle c (1)];
 La Tela A [dionne mc (1), dou h (7), hassanally p (6), paoli c (1), quoniam l (2)];
 Longevialle C [billard p (2), dionne mc (1), dkaki t (1), dousset b (1), hilaire a (1), koussoube s (1), paoli c (2)];
 Nivol W [quoniam l (1), rostaing h (1)];
 Paoli C [billard p (2), dionne mc (2), dou h (1), la tela a (1), longevialle c (2), rostaing h (1)];
 Quoniam L [dou h (10), hassanally p (8), huot c (1), la tela a (2), nivol w (1), rostaing h (1)];
 Rostaing H [nivol w (1), paoli c (1), quoniam l (1)]

Affiliations

Bedecarrax C [paris, fra (2)]; Billard P [paris, fra (2)]; Dkaki T [toulouse, fra (2)]; Dou H [marseille, fra (18)]; Dousset B [toulouse, fra (4)]; Hassanaly P [marseille, fra (14)]; Hilaire A [toulouse, fra (2)]; Huot C [paris, fra (3)]; Kister J [marseille, fra (2)]; Koussoube S [toulouse, fra (2)]; La Tela A [marseille, fra (7)]; Longevialle C [paris, fra (2)]; Nivol W [marseille, fra (2)]; Paoli C [marseille, fra (2), paris, fra (3)]; Quoniam L [marseille, fra (11)]; Rostaing H [marseille, fra (3)]

Sources

Dou H [Cahiers de la documentation(2), Scientometrics (3)];
 Quoniam L [Cahiers de la documentation (2), Scientometrics (3)]

Publication date

Dkaki T [1991 (2)]; Dou H [1990 (2), 1992 (4), 1991 (4), 1987 (4), 1989 (4)]; Dousset B [1991 (2)]; Hassanaly P [1991 (2), 1990 (2), 1987 (4), 1989 (5)]; Koussoube S [1991 (2)]; La Tela A [1990 (2), 1987 (2)]; Paoli C [1991 (2)]; Quoniam L [1992 (2), 1990 (2), 1991 (4), 1989 (5)]; Rostaing H [1993 (2)]

Keywords

Bedecarrax C [bibliometrics (2), bibliometric analysis (2), database (2), application (2), data processing (2), data analysis (2), patent document (2), relational analysis (2)];
 Billard P [bibliometric analysis (2), database (2)];
 Dionne MC [bibliometric analysis (2), database (2), bibliographic data (2)];
 Dkaki T [bibliometrics (2), graphics (2), information layout (2), data processing (2), information processing (2)];
 Dou H [classification (2), decision making (2), tool (2), research program (2), method (2), firm strategy (2), case study (2), research indicator (2), information processing (2), cword analysis (2), frequency (2), information science (2), patent document (2), methodology (2), congress (2), published document (2), evaluation (2), code (3), bibliographic data (3), scientific technical information (3), data analysis (3), on line processing (3), data processing (4), statistical analysis (4), europe (4), france (4), bibliography (5), bibliometrics (6), downloading (6), scientific research (6), scientometrics (8), chemistry (10), bibliometric analysis (10), database (12)];
 Dousset B [bibliometrics (2), information layout (2), data analysis (2), bibliometric analysis (2), software (2), user interface (2), graphics (3), data processing (3), information processing (3)];
 Hassanaly P [decision making (2), tool (2), research program (2), scientific technical information (2), research indicator (2), information processing (2), cword analysis (2), frequency (2), code (2), information science (2), patent document (2), methodology (2), congress (2), automated processing (2), data processing (3), data analysis (3), europe (3), france (3), on line processing (3), statistical analysis (4), downloading (4), scientific research (5), bibliography (5), scientometrics (6), chemistry (8), database (9), bibliometric analysis (10)];
 Hilaire A [data processing (2)];
 Huot C [bibliometric analysis (2), database (2), application (2), data processing (2), data analysis (2), patent document (2), relational analysis (2), bibliometrics (3)];
 Kister J [scientific research (2), tool (2), research program (2)];
 Koussoube S [bibliometrics (2), graphics (2), information layout (2), data processing (2), information processing (2)];
 La Tela A [chemistry (2), scientometrics (3), data processing (2), statistical analysis (2), bibliography (2), scientific research (2), bibliometric analysis (3), database (7), downloading (4)];
 Longevialle C [data analysis (2), bibliometric analysis (2), database (2)];

(continued)

Table 6 (continued)

| |
|--|
| Nivol W [bibliometrics (2), bibliometric analysis (2), method (2)]; |
| Paoli C [bibliographic data (2), database (3), bibliometric analysis (4)]; |
| Quoniam L [informetrics (2), classification (2), code (2), bibliographic data (2), information processing (2), example (2), scientific literature (2), data analysis (2), patent document (2), methodology (2), congress (2), published document (2), automated processing (2), evaluation (2), bibliometry (3), statistical analysis (3), on line processing (3), downloading (4), data processing (4), europe (4), france (4), scientific research (4), bibliometrics (5), scientometrics (5), database (7), chemistry (8), bibliometric analysis (10)]; |
| Rostaing H [bibliometrics (2), scientific literature (2), bibliometric analysis (2), technological awareness (2), information processing (2)]; |

Note: Numbers in parenthesis are frequencies

grossly underestimate the activity of a French laboratory. Anyone might imagine that the French multidisciplinary database would overestimate the activity of this laboratory. We are not convinced of this, because the Pascal database seems exhaustive in information science, and other bibliometrics teams (which do not publish in French) are also underestimated in the American and English database in comparison with the French database.

On the other hand, it is feasible that other teams are overestimated in both American and English databases. Yet most teams maintain the same importance from one database to the other. A consideration of both estimations (under and over) is the minimum for an 'objective' evaluation. This is why we keep separate databases from various producers to emphasise the contrast between databases. Then it is possible to try to explain their different points of view.

For location considerations, and to minimise the political problems of evaluating researchers,⁵ we just used the sample of our own working group. The bibliometrician, who uses on-line databases, has no influence over the data collection of the producer or the server of the database. Nor can he/she control the accuracy of indexation. The most control is over the misspelling of author names or affiliations. An accurate estimate of the validity of the database must be performed before building bibliometric indicators. An analysis involving several databases is very often the best solution.

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Research Evaluation

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Special issue on S&T indicators: Part II
Guest editor Anthony F J van Raan

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Conference on Science and Technology Indicators**

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Roles of bibliometrics in scientific communication

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Netherlands)
Pages 237-241

Nowadays, with computer-supported analysis of databases, constructing bibliometric or scientometric indicators may be considered easy. The problem is more to verify the accuracy of the global analysis, including the sampling of data. The global coherence of an analysis depends on the adequacy of all the steps. Using on-line databases, an experiment was designed to demonstrate this. Keeping the same protocol for data collection, the same indicators are used over the various samples. The results from three separate databases are profoundly different.

CHI Research's early work on the citation linkage between patented technology in the USA, and the underlying research science base using 1987/88 US patents has been massively expanded to include citations from 1993/94 US patents, and an analysis of the cited US papers and the agencies supporting them. There is a very strong within-country component to the linkage: inventors in the US system cite their own country's papers approximately three times as often as would be expected, when adjusted for the size of the country's science. The linkage is strongest in the highly scientific areas of technology, and is quite subject specific. Over the six years separating the studies, there has been a remarkable three-fold increase in linkage. A large fraction of these papers cited in patents originate in the US university system, and are supported by US research support agencies.

Using an Italian questionnaire not specifically designed to study geographic phenomena, the potential and limitations of the regionalisation of innovation information is analysed. There were difficulties involved in introducing the territorial dimension into the existing questionnaire and proposals are made for incremental amendments to the survey method for collecting and presenting the data, aimed at capturing the regional interdependencies. These include a request for the location of the main source of information, the broad geographic area from which technology has been acquired or transferred, and the sector and region of origin of the innovation.

Some of the problematic issues in the measurement of innovation in the service sector are discussed, in particular the applicability of the definitions and methodologies set out in the OECD Oslo Manual on the statistical measurement of technological innovation, which was used in the recent European Community Innovation Survey of the manufacturing sector. The results of a pilot survey in Italy and other surveys are compared and some suggestions made for the design of a questionnaire for the service sector. It is suggested that the Oslo Manual framework can be used to collect innovation data in the service sector with some changes in the definition of innovation and in the list of expenditure items. The economic impact of technological and organisational innovation, though considered a crucial issue, is still not amenable to statistical measurement.

Science and technology indicators have been used since the 1960s, yet it is only within the last few years that more pressing policy needs for wider-ranging measures of human resources in science and technology (HRST) began to emerge. The measure of stocks of HRST, and the development of indicators which make international comparisons possible, will be a major step forward. The objective of this paper is to present the concepts of HRST and some indications for the measurement of basic HRST populations.

A study was carried out to determine the volume and esteem of scientific publications in 16 subfields of clinical medicine and biomedical research for the UK and 11 other OECD nations for 1988-93 as part of the UK Government's Technology Foresight Programme. The subfields were defined by means of sets of specialist journals and, for multi-disciplinary and general journals, keywords in the titles of the papers. The esteem of the papers was based on subjective views of scientific administrative staff of the relative value of papers in different classes of journal. The weighted sum of the numbers of papers from each country as a percentage of the world total was compared with the percentage based on the simple sum, to give a 'journal esteem factor'. This provides a more judgement-based and timely assessment of research quality than the commonly used indicators based directly on numbers of citations.

In view of changes in scientific communication towards an electronic environment, this paper sketches the development of bibliometric tools for use in a scientific publishing environment. The main areas of application are: quality control of individual products; market analysis; strategic analysis for long-term planning; and product development. Each of these requires different indicators and tools, which are critically discussed. The influence of the type of journal and scientific discipline on the usefulness and interpretation of the impact factor is addressed briefly, and requirements for indicators are discussed against the background of possible future changes in the scientific communication process. This leads to speculation on the role of bibliometrics, and how to organise it, in an electronic communication environment.

In volume 5 of the journal **Research Evaluation:**

Basic indicators for describing the stock of human resources in S&T, Werner Grünwald (Eurostat, Luxembourg) *et al*, December, 217-224.

Bibliometric study of highly-cited European physics papers in the 1980s, Wolfgang Glänzel (Hungarian Academy of Sciences) *et al*, August, 113-122.

Changes in Latvia's science indicators in the transition period, Janis Kristapsons *et al* (Latvian Academy of Sciences), August, 151-160.

Elements of evaluation of S&T policy in Austria, Michael Steiner (Graz University) *et al*, April, 98-108.

Evaluation of national biomedical research outputs through journal-based esteem measures, Grant Lewison (Wellcome Trust, UK), December, 225-235.

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