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## **Bibliometric mapping as a science policy and research management tool**

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### 3 Validation of science maps

The utility of a science map (for science policy support) and its evolution depends a great deal on the recognition on the one hand. The generated map should in some way refer to the 'real' situation. If not the policy relevance is unclear. Political decisions affect the actual situation, so that the map to be used to, for instance, evaluate the actual situation should be recognized as a representation. On the other hand, an 'appropriate' representation of the research field is not enough. In order to be a supportive tool to address policy-related issues, the structure (the map itself) is not enough. Then, the retrievable information as well as the way this information is disclosed plays an important role. Therefore, user validation is of vital importance. It appears that this validation has only scarcely been applied, let alone been developed as a standard procedure.

#### 3.1 Validation of science maps by field experts

The expert validation of a generated science field map is of vital importance for the utility of a mapping study. In order to get the most out of this validation, there are three aspects to be taken in consideration: the *selection* of experts, the way they are *addressed*, and the way the results are *presented*.

##### *Selecting experts*

The first concern is to find the appropriate experts in the field under study. The aim of a mapping study determines the profile of the experts. The validation of a map based on co-author relations, aiming at unraveling the collaborative linkages structure of a field, requires an expert who is acquainted with the social structure of the field, rather than with the cognitive structure. Or, if the study does not go into the details of the field but rather is directed at an overall structure, the expert should have an extensive, 'broad' knowledge of the overall structure of the field. The detailed knowledge of subfields is of less importance. It has been experienced that in certain fields the experts with such an overall view are hard to find. In Bauin et al. (1991) a mail survey to validate obtained mapping structures failed because the addressed researchers in the studied field appeared to be too specialized to be able to sufficiently overview the whole field. Moreover, the presentation of the results of mapping study is 'unconventional', as compared to 'normal', textual descriptions. Thus, the addressed expert should be acquainted or at least feel 'comfortable' with it before he is willing to co-operate.

##### *Addressing the expert*

Once an expert is found with the right profile in view of the aims of the study, it is important to address him or her in the proper way. It should be considered beforehand

what is expected from him or her. It takes *useful questions* to get *useful answers*. Bluntly proposing the generated structure, asking whether this is the right representation of the field sustains the paradox of Healey, Rothman and Hoch (1986), with respect to the utility of experts' comments.

A paradox exists in the validation of science policy indicators. If the results are counterintuitive to experts they are considered invalid; if the same as their usual intuitions, they are considered valid but uninteresting – they reveal only that which is already known.

(Healey, Rothman and Hoch 1986, p. 247)

A bibliometric map is a unique representation of a research field, without any specific convention beforehand. An unprepared expert is thus prompted with a representation of his or her field like a normal person with a map of the sewerage of his city (which can be quite 'counterintuitive') instead the well-known of the streets (which corresponds well with 'intuition'). The street map may be rejected, because the user, quite familiar with the city, does not need it. In the latter case of the sewerage system map, it may be rejected because it does not seem 'to make sense'. However, if the utility of the maps has been explained, he may become interested. Notwithstanding the familiarity with the city, the street map may disclose information on a detailed level regarding changed traffic circulation in less familiar parts of the city. The sewerage map may provide information regarding the rebuilding of his own house.

Another way in which the expert may be annoyed is expressed in the reaction (Winterhager, 1998): *Who do you think you are, claiming you can map **my** research field?* In order to attract and hold on to the expert's attention and enthusiasm, it is important to know precisely and subsequently focus on *what* specific information is presented by the maps and additional tools. The contents should refer to the expert's perception and knowledge of the field and its actors. Moreover, the *way* in which the information is presented is of vital importance. First, experts should be introduced properly into the matter, but should not be 'overwhelmed' by details about the data and methods if they are not interested. Second, the potential use of the map for the expert himself should be emphasized.

Finally, the actual presentation is important. Apart from the 'aesthetic' aspect (quality of presentation), the *interactivity* will attract users. Maps presented on a computer screen as opposed to those on paper, can be made clickable. Hence, the information 'behind' the map can (optionally) be disclosed. Thus, the 'black box' character of science maps is dealt with.

### *Presentation*

A science map is a visual representation of a structure of a science field. This makes it an outstanding interactive tool on a computer screen. On the one hand it enables a

user or expert to focus on areas of interest, without being overwhelmed by all other information included in a mapping study. On the other hand, it enables a user or expert to get information on a detailed level. If one is interested he can 'click on' to the building blocks of a map (the individual publications).

In 1996, CWTS started to develop digital maps in stead of maps on paper, in particular for the above reasons. The maps are retrievable and clickable in a HTML environment. It was a principle choice to develop them in this environment rather than in an application-specific environment (i.e., where the interactive maps are included in a specific software package), in order to assure general accessibility. Once the analyses have been conducted, the results are copied to a World Wide Web server so that in principle any person in the world with an Internet connection and a graphical web browser has access to these results. As the expert or user can give comments or ask questions immediately (for instance by e-mail), the validation can be performed during the analyses, rather than afterwards.

### 3.2 Kinds of validation

Co-citation maps have been put forward as a basis for early indicators, but their foundation on citations to the literature introduces a retrospective bias. Co-word maps reflect the structure of the research front directly, but the difficulty in interpreting them has made their strategic use a promise, rather than an accomplishment.

(Rip 1988, p. 256)

The validation of the obtained structure of a research field, is of vital importance for science mapping as a policy-supportive tool. In order to use the map and additional information for policy decisions and discussions, the obtained structure should refer to the 'real world'. It should be applicable to address topical policy questions and issues. In the previous chapter (section 2.1), it has been discussed how complex this reference can be. Yet, the expert, who is most likely a (senior) researcher, is not the only one involved in the validation procedure.

Rip (1997) identifies three parties to be involved in evaluative studies of science:

1. Science (scientists);
2. Science policy (policy makers);
3. Scientometrics (scientometricians).

The third party adds a dimension to the configuration of Figure 1-1. The three parties can be arranged in a triangle (Rip, 1997 calls it the 'eternal triangle') with at least two linkages where validation of the bibliometric maps are concerned. Healey, Rothman and Hoch (1986) introduced the integration of both 'internal' and 'external' validation

of maps of science. The internal validation is aimed at the *structure as a representation* of the field, the external validation at the *utility* of the map as a policy supportive tool.

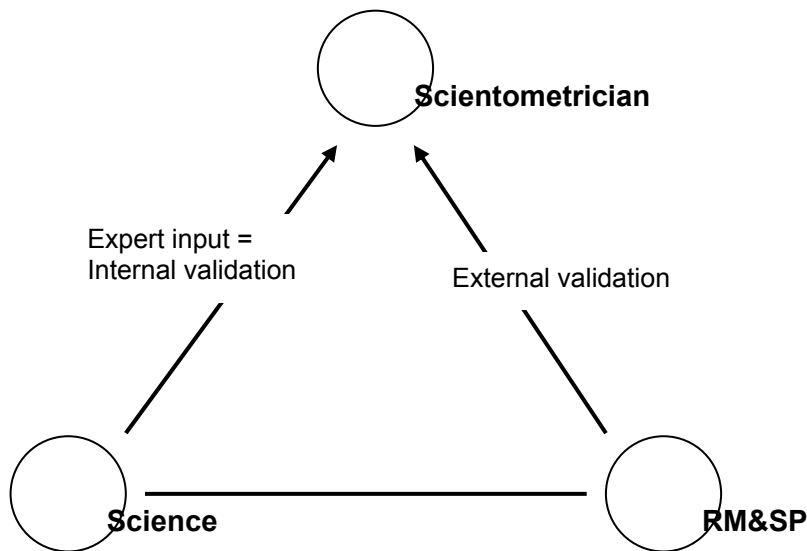


Figure 3-1 Visualization of Rip's 'eternal' triangle of scientometric evaluation, combined with the positioning of internal and external validation

In view of the validation of science maps (the scientometrician) only the relations with science and RM&SP are discussed here. The expert input (internal validation) can be used at different stages of the mapping analysis. Before the data is collected, the expert may provide information about which database to use, or which keywords to delineate the field. At the stage of the keyword selection for co-word analysis, the expert may provide input in suggesting essential keywords. This input will prevent words to affect the structure for reasons not so obvious to the scientometrician. This issue will be discussed further in Chapter 11. An other stage is when the analysis is finished and the results are available. Here, the expert input may provide information about the validity of the map. The maps and additional information are evaluated as being a 'valid' representation of the science field under study. All this concerns internal validation. To be more precise analytically, Rip (1997) identifies two kinds of *internal* validation: *extrinsic* and *intrinsic* validation. The former is a validation of the results by *field experts*, the latter is a validation of the data and method, aiming at robustness. Moreover, *intrinsic* validation links up with the *use* of the results, and thus with the external validation. The key in this linkage is 'point representation'. This term, borrowed from actor-network theory, points out that the result (the maps and

indicators) is a representation not necessarily mirroring the 'real world' but rather the world as defined by the creator, and methodologically robust. In that sense, a co-word map of a field is no more but also no less than that: a specific representation of a science field, as defined (delineated) by publications from a certain database, on the basis of co-occurrences of most frequently used words (core topics in that field). Once there is an agreement on the utility of such representations for answering questions about the field (external validation), these representations can be used. The intrinsic validation accounts for robust data, method and translation of addressed issues and (bibliometric) results. In that case, Rip argues, an internal extrinsic validation is not always needed. As noted before, however, the utility of a map depends a great deal on the reference to the 'real world'. In other words, the external validation of a science map is to a great extent depending on the (extrinsic) internal validation. This validation is established by the input of field experts. As a result, the extrinsic internal validation is *inevitable*.

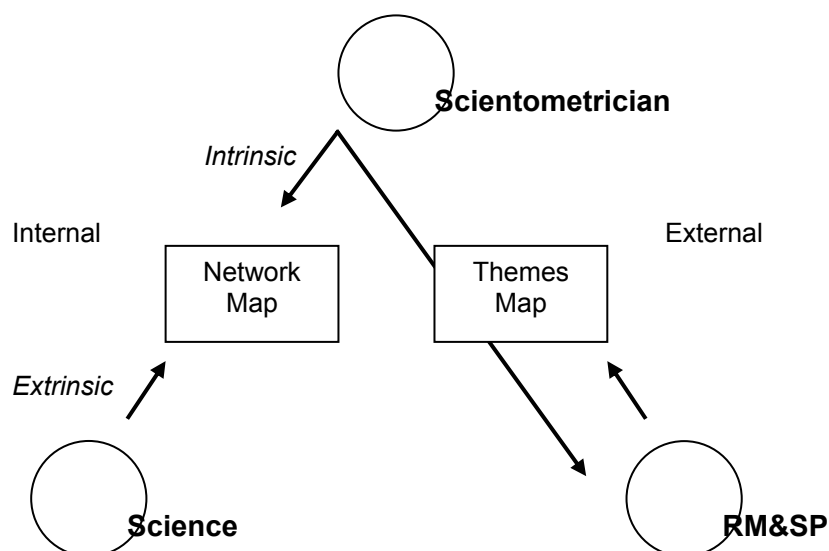


Figure 3-2 Schematic labeling of different kinds of validation

In view of the *types* of maps to be used for either internal or external validation, the network and themes map (c.f., section 2.5) are included in the scheme as well. These two map types maintain a direct relation in the sense that the themes map is directly derived from the network map.

A most important study using a combination of intrinsic validation and extrinsic validation is presented in Braam, Moed and Van Raan (1991). In that study, a

generated co-citation structure is validated by analyzing the keywords in the citing articles (research front) on the basis of intra-cluster coherence, inter-cluster difference of research topics. In this approach external information (i.e., this information that did not *directly* contribute to the structure), is added to the map.

In his triangle Rip (1997) notes both productive interactions and tensions between the parties. The interactive productivity opposes to the lack of *user-pull*, noted by Tijssen (1992).

... However, the use and appreciation of maps is still in its infancy as far as its applications in practical issues of science policy are concerned. Maps may prove a powerful aid for R&D managers and S&T policy makers in order to obtain a sense of the state and developments of scientific areas, for purposes of science policy decisions, research management and corporate planning. In this domain, the increasing sophistication of maps is still more a matter of developer-push than user-pull.

(Tijssen 1992, p. 34)

This lack may have caused part of the tension and it seems exactly *this* aspect that has blocked science mapping in the past decade. The articles reporting of validation of science mapping results refer almost exclusively to the internal validation. Only two (!) out of thirteen case studies in the late eighties and early nineties are provided with a validation round, included external validation<sup>4</sup>. In other words, only two of these studies were evaluated by the policy-related user, who was in most cases the funding institution. In almost all thirteen studies, experts provided internal validation, by agreeing upon (most of ) the structure.

As noted before, this internal validation is important, but for a policy supportive tool external validation is equally important. In Bauin et al. (1991), an extensive attempt is made to supply science maps with both internal and external validation. The need for this approach is expressed in the following.

The problem with this purchase/supply relationships is that often the supplier is unaware of the use to which his or her study has been put. Having developed a series of indicators, the feedback that is necessary in order to improve upon them and bring them closer into line with the needs of decision-makers is often not forthcoming.

(Bauin et al. 1991, p. 113)

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<sup>4</sup> These studies have been reported in Healey, Rothman and Hoch (1986), Oberski (1988), Turner et al. (1988), Franklin and Johnston (1988), Law et al. (1988), Bauin et al. (1991), Braam (1991, 2 studies), and Tijssen (1992), Peters and Van Raan (1993). In the studies reported by Bauin (1991), Franklin and Johnston (1988), and Healey, Rothman and Hoch (1986) utility aspects raised by the policy related users were discussed.



Both Tijssen (1992) and Bauin et al. (1991) refer to science mapping as a policy supportive tool as being in its *infancy*, and in view of the lack of reported user input since then in these kind of studies, we must conclude that it still is.

The way in which science mapping development would benefit from utility fits well into the present research policy. Van Steen (1995) pointed out the utility of science and technology (S&T) indicators for research policy, on the condition that the policy (user) input is improved, and that the researcher and user have a good relationship, in terms of communication. In Simpson and Craig (1997), an emerging model for scientific inquiry is sketched in which the intellectual agenda is set by *strategic relevance* rather than *scientific curiosity*.

With respect to this introduction of users in order to improve validity and utility of science maps, the points made in section 2.1 (*What do maps show?*) should be taken into consideration. The utility-related comments reported in the studies listed in section 1.3 indicate that the user input has been rather 'non-committal' and in most cases retrieved after the study was conducted. This input should, however, be used before and during the study is conducted. Moreover, the input should be directed at each principle listed in 2.1. The issue(s) raised by the user as to which the study is applied, should be discussed beforehand on the basis of the listed principles of science mapping. For instance, it should be determined through discussion with the field expert whether the issue can be addressed bibliometrically on the basis of *research output*. Then, it should be discussed in detail which *database* should be used, as well as which part of the *publication* database in relation to the issue to which the map is applied. In view of the dynamic part science mapping, an answer should be given to the question whether mapping is the appropriate tool. If field dynamics does not play a role, one may wonder whether the map should be created. In cases, it may suffice to generate a structure, in terms of identifying clusters of keywords representing subdomains (themes, areas of interest) within the field. The two dimensional representation may be a 'good looking' interface for some, for others this representation is incomprehensible and therefore useless.



- Rip, A. (1988). 'Mapping of Science: Possibilities and Limitations'. In: A.F.J. van Raan (Eds.), *Handbook of Quantitative Studies of Science and Technology*. 253-273.
- Rip, A. (1997). 'Qualitative Conditions of Scientometrics: The New Challenges'. *Scientometrics* 38. 7-26.
- Simpson, B. and J. Craig (1997). 'A Policy for Science Innovation: The New Zealand Experience'. *Science and Public Policy* 24. 70-78.
- Tijssen, R.J.W. (1992). *Cartography of Science: Scientometric Mapping with Multidimensional Scaling Techniques*. DSWO Press, Leiden University.
- Turner, W.A., G. Chartron, F. Laville, and B. Michelet (1988). 'Packaging Information for Peer Review: New Co-word Analysis Techniques'. In: A.F.J. van Raan (Eds.), *Handbook of Quantitative Studies of Science and Technology*. 291-323.
- Van Steen, J. (1995). 'S&T Indicators in Science Policy: How can they Matter?'. *Research Evaluation* 5. 161-166.
- Winterhager, M. (1998). Personal Communication

