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Research evaluation and Mode 2 science

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Abstract This paper analyzes the characteristics of the two main methods currently used for the evaluation of research—peer review and bibliometrics—in light of the transition from a traditional 'mode 1' form of scientific research to a new 'mode 2' form. The new mode operates within a context of application in that problems are not set within a disciplinary framework. It is carried out in non-hierarchical, heterogeneously organised forms which are essentially transient. One consequence of these changes is that mode 2 makes use of a wider range of criteria in judging quality of research.

Keywords Research · Science mode 2 · Peer review · Bibliometrics

1 Introduction

It is by now widely believed, and in general accepted by public opinion, that there is a need to identify the criteria for measuring from a quantitative point of view and analysing from qualitative point of view the scientific output of teachers and researchers as well as the entities (universities, research institutes, departments, etc.) in which they work, in order to demonstrate the value and impact of what is produced by scientific research.

The Italian experience with this subjects began in 1993 with the legislative decree 537, which introduced the evaluation of universities and established the centres for evaluation and the institution of the 'Osservatorio per la valutazione del sistema universitario'.[1] In 1999 this was replaced by the 'Comitato nazionale per la valutazione del sistema universitario' (CNVSU). In 2004 became operative the 'Comitato di indirizzo per la valutazione della ricerca' (CIVR), established with the legislative decree 204 of 5 June 1998: the CIVR initiated the first triennial evaluation of research for the years 2001–2003,[2] some 13 years after the first experiment of this kind promoted by Margaret Thatcher in the United Kingdom in 1986.[3]

The completion of the first Italian evaluation exercise (2001–2003)—during which 17,329 research products from 20 scientific-disciplinary fields produced within 102 entities (77 universities and 25 public research bodies) were evaluated using the peer review method over the course of 18 months between 2004 and 2005—gave a strong impetus to the issue of evaluation, bringing to the attention of institutions and the public the need for an effective link between research results and the allocation of resources. The 'best' research should be rewarded, and evaluation made it possible to verify if resources were being used efficiently, thus accounting for the ways in which public money was being spent.

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[1] Art. 5 states: *Le università, ove già non esistano, sono istituiti i nuclei di valutazione interna con il compito di verificare, mediante analisi comparativa dei costi e dei rendimenti, la corretta gestione delle risorse pubbliche, la produttività della ricerca e della didattica, nonché l'imparzialità ed il buon andamento dell'azione amministrativa* (In universities, where these do not already exist, is to be instituted an internal assessment with the aim of verifying, through a comparative analysis of costs and returns, proper management of public resources, the productivity of research and teaching, as well as the impartiality and the success of administrative actions).

[2] For an overview, see [18].

[3] Today the RAE-Research Assessment Exercise (http://www.rae.ac.uk) has become the REF-Research Excellence Framework (http://www.ref.ac.uk/).

It was in the way of this need for public accountability that universities were charged with the obligation of identifying areas of excellence and the strong points of their research in order to attract financing and place themselves competitively. To this end in 2010 was instituted the Italian National Agency for the Evaluation of the University System and Research (Agenzia nazionale di valutazione del sistema universitario e della ricerca, ANVUR), which managed the second round of evaluations of the quality of research for the period 2004–2010—the largest undertaken so far—involving more than 68,000 professors and researchers in universities and research institutes in 133 entities, and requiring the analysis of almost 200,000 products by some 10,000 reviewers. The results[4] are to be used by the entities involved in order to take steps towards improvement, while the Ministry for Education, Universities and Research (MIUR) will use them to distribute funding in amounts established on the basis of merit.

The methods and criteria adopted in these circumstances have been widely criticised from several angles, especially, but not only, as regards the humanities.[5]

Before going into a discussion of the available instruments, it is useful to take a step back and open a brief parenthesis regarding what the objectives of such an evaluation should effectively be, because of the risk that—as the old saying goes 'when a wise man points at the moon, a fool only sees his finger'—concentrating on questions of methodologies will overshadow the more profound significance of the question.

Evaluation is difficult and requires indisputable technical competence, but above all a need for clarity of intent and farsightedness in understanding that there are some aspects which, though not necessarily quantifiable, can be extremely significant. The prize—the objective—can not be merely the distribution of funds: what is at stake is the possibility of knowing how to decipher a reality that is extremely faceted and composite—research—in order to make improvement possible. The evaluation of research must serve this end: it cannot be an end in itself, but a means, useful precisely for guaranteeing the growth of research itself (i.e., qualitatively) and its improvement over time, contributing to the society's well-being.

Here I will offer a reflection on this, briefly examining the characteristics of the two principal methods of evaluation used today—peer review and bibliometrics—in light of the transition from the traditional 'Mode 1' form of scientific research to the so-called 'Mode 2', characterised by a greater interaction among different disciplinary fields, a plurality of organisational models, variety and differentiation of the centres of production [10].

2 Towards Mode 2 scientific research

In order to attempt to respond to the objectives we have set for ourselves, it is useful to consider first of all the radical mutation in the way that knowledge is produced, which is intrinsic to the concept of 'knowledge society'. With respect to evaluation, the first question to be addressed, in our opinion, is not that of methodology but rather that of the object of methodology and of the context in which it is developed. In order to do this it is helpful to go back to 1994 when Michael Gibbons and others, in the book *The new production of knowledge: the dynamics of science and research in contemporary societies* [1994], spoke for the first time about a new organisation of science, defining it thus:

> The new mode operates within a context of application in that problems are not set within a disciplinary framework. It is transdisciplinary rather than mono- or multi-disciplinary. It is carried out in non-hierarchical, heterogeneously organised forms which are essentially transient. It is not being institutionalised primarily within university structures. Mode 2 involves the close interaction of many actors throughout the process of knowledge production and this means that knowledge production is becoming more socially accountable. One consequence of these changes is that Mode 2 makes use of a wider range of criteria in judging quality control. Overall, the process of knowledge production is becoming more reflexive and affects at the deepest levels what shall count as "good science" [Gibbons et al. 1994: VII].[6]

The authors coined the term 'Mode 2' to denote this new modality of producing and disseminating knowledge, as opposed to 'Mode 1', the traditional method of conceiving the production of knowledge. This older, traditional paradigm for scientific research, characterised by a determined taxonomy of disciplines, was being pushed aside in favour of a new way of producing knowledge, one of an interactive and transdisciplinary nature, shaped to the complexity of the emerging problems that science was being asked to solve. Mode 2 is characterised by a growing impermeability of

[4] For the results, see http://www.anvur.org/index.php?option=com_content&view=article&id=481:informazioni-sulla-vqr-2004-2010-pubblicazione-dei-risultati-della-valutazione-it&catid=23&Itemid=188&lang=it.

[5] For more on this, see the debate on the website of ROARS (Return on Academic Research): http://www.roars.it/online (accessed 2 December 2013).

[6] 'Post-academic science' and 'Mode 2 science' are some of the terms used by the scholars who study these emerging configurations of research in contemporary science; see also [4].

boundaries between scientific research and technological development, and above all by a substantial mingling among different disciplinary sectors: disciplines are melding and intersecting, research is being carried out in places that are no longer solely institutional. The great discoveries can (and do) occur in the most unexpected ways.

The context in which this change is taking place is characterised by its global dimension and by strong pressure on scientific research also in terms of public relations: science is no longer carried out by a relatively small number of institutions tied to the government, but by institutions that are increasingly tied to markets and economic productivity. In Mode 2, the so-called 'peers' can not be identified with certainty because there is no codified taxonomy of disciplines, while there is a great diversification with respect to places where knowledge is produced. In short, the context we are talking about is characterised by three factors that are determining the transformation of scientific research as a reflection and outcome of a radical social transformation:

1. globalisation and the mass migration of people towards fields of knowledge and countries;
2. the progress of information technology;
3. the convergence of science ([14]: 14–25; [22]).

In this regard it is the very nature of scientific discoveries that is changing, and making it so that disciplines which were once very far removed are now drawing closer.

One example of this is found in the research project coordinated by Mijail D. Serruya of Brown University in Rhode Island, who oversaw the creation of a device capable of 'reading' the intention on the part of a monkey to make a certain movement and to reproduce this same movement on a computer. The research team was composed of specialists in biology, cognitive sciences, neurosciences, medicine, psychology, mathematics and more [20]; Johansson 2006: pp. 3–5].

Another interesting example is that of Yitand Zhang, a Chinese American mathematician who recently found the solution to one of the oldest problems of prime numbers, known as the 'twin primes conjecture'.[7] Zhang's career was played out on the fringes of the academic community as it is traditionally conceived: now a lecturer at a provincial university, before that he had worked a while as an accountant, delivering orders for a restaurant in New York, in a motel in Kentucky, and in a sandwich shop.[8]

The scientific research that will improve the world appears destined to be born at the crossroads of several disciplines and in unexpected places. Alan Leshner, the Chief Executive Officer of the American Association for the Advancement of Science, has been reported as saying that sciences divided into disciplines, as we once knew it, is dead, and that the majority of the great discoveries will be the result of the encounter between disciplines [22]. If research goes in this direction, and evaluation is to be used for the improvement of research, then that evaluation must be capable of measuring the characteristics of a scientific output that travels on quite different tracks.

3 Evaluating Mode 1 research: bibliometrics and peer review

Before considering, even briefly, the question of methodology, it seems useful to mention what are considered today to be the objects of the activities of evaluation of research products (journal articles, monographs, etc.):

1. Internal quality: this is the recognition that the research has been carried out properly in reference to the canons that prevail at a given moment in time, such as originality, relevance, methodological rigour, clarity of exposition, and so forth. It is evident that this concept of quality lends itself to evaluation by the scientific community of reference that knows and shares canons of the same sort. The basic logic behind the judgment of quality turns out to be entirely internal to the discipline. Further, this judgment of quality, in addition to varying over time since the canons of reference may vary, presents a strong element of subjectivity;
2. Impact: this is recognition bestowed on a scientific contribution by the community of peers according to the number of citations over a given interval of time. An article that is cited a great number of times is one that has an elevated impact within the scientific community. It should be noted that it is very hard for a niche work of science or one that deals with a pioneering concept to have a measurable impact, even when it satisfies the prevailing canons. This occurs because the impact lies beyond the internal characteristics of the product and depends instead, for example, on the scientific trends of the moment. This risk is particularly felt in the humanities, where fragmentation, in the sense of the consolidated separation of disciplines, is such an evident characteristic that it can penalise those research works that can be considered multidisciplinary or interdisciplinary;
3. Importance: this refers to the capacity to influence, in the long term, the research carried out by others, and to

[7] The results were presented on 13 May 2013 during a seminar at Harvard University. See the report at: http://matematica.unibocconi.it/news/la-non-solitudine-dei-numeri-primi (accessed 2 December 2013).

[8] See the ROARS website: http://www.roars.it/online/sullimprevedibilita-delle-scoperte-scientifiche/ (accessed 2 December 2013).

blaze a trail to new ways to develop science. The importance of a contribution can be appreciated and evaluated only in the long term.

Coming now to the choice of instruments, it is evident with regard to internal quality that the only valid instrument is peer review: the only way to say if an article is valid or not is to have someone (competent) to read it. In addition to the qualitative evaluation we also have a quantitative evaluation, which is substantially comprised of two components: the citational analysis (bibliometrics) and the use analysis. Because of space limitations, we will not consider use analysis here, but it includes the latest generation webometrics such as 'usage factor' (UF) and 'web impact factor' (WIF).[9]

Bibliometrics, an area of study that is situated within the context of scientometrics,[10] has developed in recent decades thanks to the online availability of large databases, and uses mathematical and statistical techniques to analyse the distribution models of publications and explore the impact of research within the scientific community [13]. Its objective is the evaluation of scientific research—in terms of productivity, impact, popularity, prestige, etc.—by means of the use of quantitative methods.[11]

When, in the 1950s, Eugene Garfield, founder of the Institute of Scientific Information (ISI, today Thomson Reuters), set up the Science Citation Index (SCI) with the dual aim of helping researchers to choose the articles of greatest interest for their field of research and librarians to make effective policy decisions about acquisitions, he probably would never have imagined the impact that such an instrument would have on the scientific community. The driving idea behind the ISI database, attributable to its founder, was to publish a repertory of scientific publications that would include a list of the works cited by each work taken into consideration. The aim was to facilitate bibliographical research, which, beginning with an important work of the past, would make it possible to identify more recent works that develop the results. The idea led to the creation of an electronic archive of citations named, as mentioned, the SCI. The archive was immediately popular in the fields of chemistry and biology, where it constituted a useful database for bibliographical research; it was less popular in physics, where, on a world scale, there had been created an informal system of communication by means of preprints. It was even less useful in mathematics, where there were journals such as *Mathematical Reviews* (published by the American Mathematical Society) exclusively devoted to the publication of reviews of articles of mathematics.

SCI is part of the Web of Science, which, together with the Social Sciences Citation Index (SSCI) and the Arts and Humanities Citation Index (AHCI), has the objective of providing more relevant coverage, not extensive but selective, of journals (and of other bibliographical sources), such that the criteria for admission that a journal must meet in order to become part of the index are rather stringent. Connected to the Web of Science is the Journal Citation Reports, which presents a series of indicators about the impact of a scientific journal, including the well-known 'impact factor' (IF).

This indicator, created with the aim of indicating the weight (impact factor) of a journal within its specific disciplinary filed, is the relations between the overall number of citations received in a given year by the articles published by a certain journal in the two previous years, and the number of articles published in that journal: practically, the average number of citations received by a single article published by a given journal within a certain period of time.

The citational analysis, which uses the citations in intellectual scientific productions to establish connections to other works or researchers, is thus the cardinal instrument of bibliometrics. This is based on the principle that the research products most often cited are generally those which have the greatest intellectual influence [7]. Bibliometrics is thus a quantitative approach to evaluation, aimed at measuring scientific impact in numerical terms.

To the evaluation of research must also be applied an qualitative approach—based on the judgment of peers, thus 'peer review'—which turns out today to be the principal method of for evaluating quality.[12] The *ex-ante* peer review method of evaluation is a consolidated practice for the exact sciences but is still scarcely applied in the context of

[9] In 2004 Björneborn and Ingwersen defined Webometrics as "the study of the quantitative aspects of the construction and use of information resources, structures and technologies on the Web drawing on bibliometric and infometric approaches" [2].

[10] Scientometrics is a relative recent field of research born in the 1960s–1970s as the science concerning the measurements and analysis of science and the output of scientific disciplines. Modern scientometrics is based on the works of Derek John De Solla Price (1922–1983) and Eugene Garfield, the founder of bibliometrics and the Institute for Scientific Information (ISI), and the creator of the well-known bibliometric indicator called Impact Factor (IF). There are various scientific journals of reference in this field; among the most important are *Scientometrics*, *Journal of the American Society for Information Science and Technology* (JASIST), *Social Studies of Science* and the e-journal *Cybermetrics. International Journal of Scientometrics, Infometrics and Bibliometrics*.

[11] See [16]; [3]; [23]. Lotka, Bradford and Zipf are considered to be the authors of the three 'classical laws' of bibliometrics.

[12] This is a mechanism that dates back to the eighteenth century and became prevalent in STM fields (that is, science, technology, medicine) after the second world war as a response to the growth on the world scale of intellectual output. The first body to introduce peer-review in the modern sense of the term was the Royal Society of London in 1752; see [21]. See also [8].

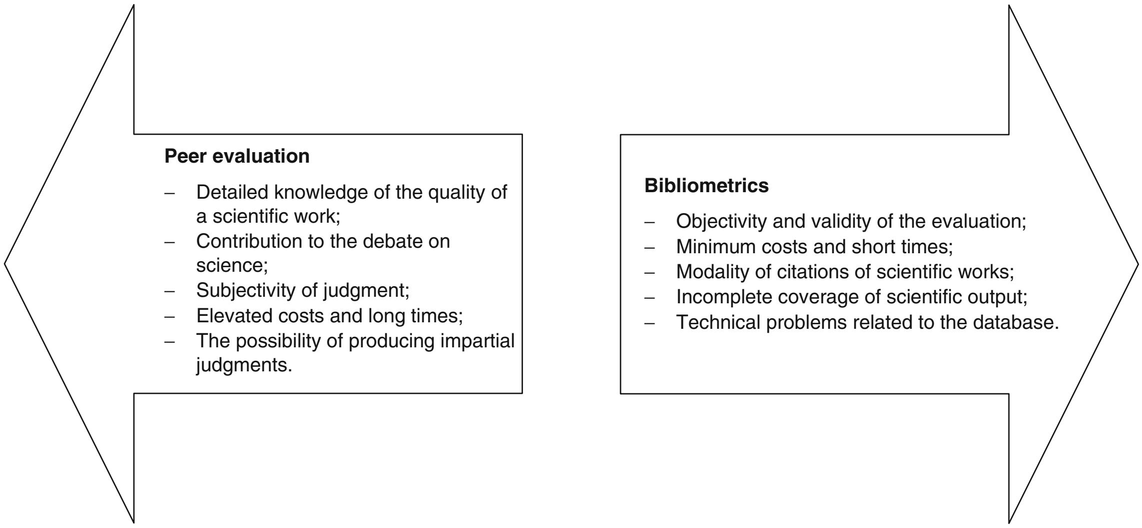


Fig. 1 Qualitative methods vs. quantitative methods. Image by the author, after [19]

the humanities.[13] *Ex-post* peer review is the method used in the first experiments with evaluation carried out in Italy, the triennial reviews carried out by the CIVR, essentially inspired by the Research Assessment Exercise (RAE) of the United Kingdom.

Up until today we have primarily seen the 'exclusive' use of one or the other of the two methods, seen as opposites rather than complements:

> In essence, it can be said that the dilemma of evaluation is constituted of the fact that of the instruments available, one—peer review—is reasonably accurate but extremely costly, the other—bibliometrics—is not very accurate but not very costly. For this reason in nations with greater experience in this matter, bibliometrics is used with caution and only rarely constitutes the only measure for judgment [Banfi and De Nicolao 2013; my trans.].

Regarding the relationship between bibliometrics and peer review (Fig. 1), it is interesting to note that, in fact, bibliometrics can be considered a form of 'indirect peer review': the citation of a publication is always considered to be a form of judgment on the part of the citer with respect to the cited, and yet it comes to be considered more objective and economical than peer review proper.[14]

As is well known, the themes of the debate regarding which methodology of evaluation is best differ radically between the humanities and social sciences and the physical and natural sciences[15] (Fig. 2). While for physical and natural sciences bibliometric indicators are—even though with some exceptions—by now recognised within the scientific community, the same cannot be said for the humanities and social sciences, where doubt is cast on their validity and applicability.[16]

In the so-called hard sciences there is by now an almost universal inclination towards indicators based on the analysis of citations, exploiting potentials and indications

[13] According to Maria Cassella: "For historic, epistemological and economic reasons in the humanities, peer review is less used than it is in STM, in as much as: 1. the community of the humanities is self-referential, little cohesive and very fragmented. The review system is instead based on an adequate number of scholars who agree to act as reviewers; 2. the monograph is by far the dominant form of publication in the humanities and, traditionally, monographs are not subject to the peer review process; 3. the funds allocated for research in the humanities are far fewer than those allocated for the disciplines in STM. It is well known that reviewers donate their work without compensation. In spite of this, peer review represents a cost for the editorial system, costs that have grown after the adoption by publishers of automated systems for managing the review process; 4. from the social point of view there is a greater interest on the part of those whose work is subject to a quality control in research produced in the biomedical field than there is in the humanities" ([5] pp. 119–120; my trans.).

[14] See ([6]: 55). With regard to peer review, see also [12].

[15] For an overview of the natural sciences, social sciences and humanities, see [15]. The author undertakes the arduous task of defining the principal characteristics of each field, underlining their specificities: from the type of data and the methods used to specific terminology, from sensitivity to social context to the relationship with human wellbeing.

[16] This was discussed during the round table regarding the problems of evaluation entitled *Il problema della valutazione della ricerca scientifica per le discipline e le facoltà umanistiche*, Department of Philosophy, University of Milan, September 2010. http://dipartimento.filosofia.unimi.it/index.php/eventi/756-il-problema-della-valutazione-della-ricerca-scientifica-per-lediscipline-e-le-facolta-umanistiche (accessed 2 December 2013).

Fig. 2 Henk Moed's comparison of hard sciences and humanities [17]

	Hard Sciences	Humanities
Object	natural phenomena	phenomena of the human mind
Relationship researcher to object	interchangeable observer	full person, personal experience
Perspective	regularities in data patterns, laws	unique, irreproducible aspects (ideographic)
Language	mathematical	natural language
Organisation	international research front	Diffuse boundaries between scholarly and public debate
Knowledge growth	incremental	object recaptured as a whole
Base units	research groups	individuals
Research activities	short term projects	life time achievements
Circulation speed of information	high	low
Publication types	journal articles	books
Publication language	English	domestic language
Aggregation level	research groups	individual
Time horizon	short (2 PhD generations)	long (lifetime)

provided by bibliometrics, but in the humanities and social sciences the debate is far from over.[17]

4 Conclusions

In conclusion it seems useful to briefly mention the recent evaluation of the quality of research in Italy, without going into the details of the results, which was the subject of a heated debate during the summer of 2013. The exercise of evaluation was carried out in the 14 disciplinary areas identified by the Comitato Universitario Nazionale (CUN); in each area, the ANVUR constituted a 'Group of Experts in Evaluation' charged with evaluating the products of research. The evaluations were based on the method of peer review, and for the articles indexed in the ISI and Scopus databases, on the bibliometric analysis. For the purposes of evaluation the products taken into consideration were journal articles, books and book chapters, critical editions, translations and scientific patents, etc. It was only apparently a single exercise in evaluation, because in reality it was the sum of no fewer than fourteen separate evaluations, sixteen in fact, if we consider that CUN areas 8 (civil and architectural engineering) and 11 (historical, philosophical, pedagogical and psychological sciences) are each composed of two sub-areas, one bibliometric and one non-bibliometric, so that it is not possible to use citational analysis. This arrangement was a faithful reflection of the ANVUR's belief that it is impossible to compare different disciplinary areas; thus, such a comparison of the quality of research between the different areas was never considered for inclusion as one of aims of the evaluation.

The way the evaluation was formulated faithfully reflected the characteristics of Mode 1 scientific research.

If it is true that in the future there will be an increasing necessity to breaking down certain boundaries (disciplinary, institutional, and others) in order to resolve the complexity of the problems scientific research is called to deal with, then it's a good idea for the agencies put in charge of evaluation to begin to equip themselves by asking, for example, what questions must be posed to properly evaluate a research work that goes in this direction.

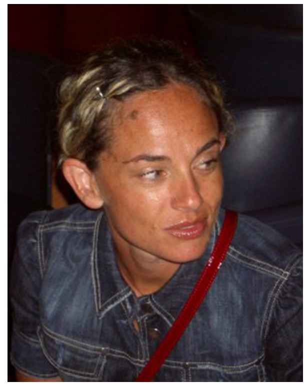
Translated from the Italian by Kim Williams.

[17] The same thing is true for other disciplines as well. For more on this, see the lecture by well-known Alessandro Figà Talamanca [9].

References

1. Banfi, A., De Nicolao, G.: Potenzialità e limiti degli indicatori bibliometrici nella valutazione della ricerca scientifica. Paradoxa **7**(2), 34–48 (2013)
2. Björneborn, L., Ingwersen, P.: Toward a basic framework for webometrics. J. Am. Soc. Inform. Sci. Technol. **55**(14), 1216–1227 (2004)
3. Bradford, S.C.: Sources of information on specific subjects. Engineering **137**, 85–86 (1934)
4. Bucchi, M.: Sc egliere il mondo che vogliamo. Cittadini, politica, tecnoscienza. Il Mulino, Bologna (2006)
5. Cassella, M.: Social peer-review e scienze umane, ovvero della qualità nella Repubblica della scienza. JLIS.it **1** (1), 111–132 (2010). http://leo.cilea.it/index.php/jlis/article/download/30/35. Accessed 2 Dec 2013
6. Cerroni, A.: Valutare la scienza sociale nell'epoca della società della conoscenza. In: Baldissera, A. (ed.) La valutazione della ricerca nelle scienze sociali. Bonanno Editore, Rome (2009)
7. De Robbio, A.: L'Open Access come strategia per la valutazione delle produzioni intellettuali. In: Gargiulo, P., Bogliolo, D. (eds.) CIBER 1999–2009, pp. 104–124. Ledizioni, Milan (2009)
8. Di Donato, F.: Come si valuta la qualità nella Repubblica della scienza? Una riflessione sul concetto di peer review. Bollettino telematico di filosofia politica (2007). http://eprints.rclis.org/12602/. Accessed 2 Dec 2013

9. Figà Talamanca, A.: L'impact factor nella valutazione della ricerca e nello sviluppo dell'editoria scientifica (2000). Lecture presented in Lecce, 2 October 2000, at the Seminar "SINM 2000: un modello di sistema informativo nazionale per aree disciplinari". http://siba2.unile.it/sinm/4sinm/interventi/fig-talam.htm. Accessed 2 Dec 2013
10. Gibbons, M.: Mode 2 society and the emergence of context-sensitive science. Sci. Public Policy **27**(3), 159–163 (2000)
11. Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., Trow, M.: The new production of knowledge: the dynamics of science and research in contemporary societies. SAGE, London (1994)
12. Gillies, D.: How should research be organized?. College Publications, London (2008)
13. Garfield, E.: Mapping the structure of science. In: Garfield, E. (ed.) Citation indexing: its theory and application in science, technology and humanities, pp. 98–114. Wiley, New York (1979)
14. Johansson, F.: Effetto Medici. Innovare all'intersezione tra idee, concetti, culture. ETAS, Milan (2006)
15. Kagan, J.: The three cultures: natural sciences, social sciences, and the humanities in the 21st century. Cambridge University Press, Cambridge (2009)
16. Lotka, A.J.: The frequency distribution of scientific productivity. J. Wash. Acad. Sci. **16**, 317–323 (1926)
17. Moed, H.F. Research Assessments in Social Sciences and Humanities (2008). Lecture presented in Bologna, during the Conference "Evaluation in the Human Sciences," 12–13 December 2008. http://www2.lingue.unibo.it/evaluationinthehumanities/Research%20Assessment%20in%20Social%20Sciences%20and%20Humanities.pdf. Accessed 2 Dec 2013
18. Reale, E. (ed.): La valutazione della ricerca pubblica. Un'analisi della valutazione triennale della ricerca. Franco Angeli, Milan (2008)
19. Reale, E.: La valutazione della ricerca nelle discipline umanistiche e sociali: riflessioni introduttive. https://nuva.uniud.it/ricerca/valutazione_ricerca/La%20valutazione%20della%20ricerca%20-%20Dott.ssa%20Reale.pdf 2010. Accessed 2 Dec 2010
20. Serruya, M.D.: Brain-machine interface: instant neural control of a movement signal. Nature **416**, 141–142 (2002)
21. Spier, R.: The history of the peer-review process. Trends Biotechnol. **20**(8), 357–358 (2002)
22. Ubiquity Staff. An interview with Frans Johansson: The Medici effect. Ubiquity (October 2004): 1–1 (2004). http://ubiquity.acm.org/article.cfm?id=1029387. Accessed 2 Dec 2010
23. Zipf, G.K.: The psycho-biology of language: an introduction to dynamic philology. Routledge, London (1936)



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