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The Kinship or *k*-Index as an Antidote Against the Toxic Effects of *h*-Indices#

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Abstract: In a bilingual paper entitled 'Bibliometrics as weapons of mass citation – *La bibliométrie comme arme de citation massive*',[1] recently translated into English,[2] we have argued that the current fashion of ranking people, papers and journals is anything but harmless. The point was forcefully supported by Richard Ernst in a post-face entitled 'The Follies of Citation Indices and Academic Ranking Lists.'[3,4] We received a surprising number of passionate responses, such as '*It's written out of my heart*' (TH); '*Je soutiens cette entreprise courageuse de tout coeur*' (VT); '*Impact Faktoren sind ein Marktinstrument gewisser Verlage* (FS); '*Il y a un combat à mener*' (SB). Some thoughtful responses have been incorporated into this Essay, albeit in attenuated form. We suggest that the 'fertility' of individual scientists be appreciated in terms of kinship rather than through personalized indices.

Keywords: Bibliometrics · *h*-indices · *k*-indices

What Are *h*-Indices Claiming to Measure?

In his surprisingly influential paper,[5] J. E. Hirsch defined the *h*-index as a quantitative measure[6] of the 'impact and relevance' of the work of individual scientists 'for evaluation and comparison purposes, *e.g.*, for university faculty recruitment and advancement, award of grants, *etc*.' According to Hirsch: 'For the few scientists that earn a Nobel prize, the impact and relevance of their research work is unquestionable. Among the rest of us, how does one quantify the cumulative impact and relevance of an individual's scientific research output?'[7]

Hirsch argues that: '…between two individuals (of the same scientific age)[8] with similar number of total papers or of total citation count and very different *h*-values, the one with the higher *h* is likely to be *the more accomplished scientist*'.[9] But what is an accomplished scientist?

In an attempt to give some weight to his definition, Hirsch noted[5] that the highest *h* among physicists is E. Witten's ($h = 110$ in 2005.) Hirsch lists the 'top' physicists and biologists – regretfully noting *en passant* that physics is less popular than biology.

For a *connoisseur* of magnetic resonance, the following ranking is instructive (the numbers[10] can be determined, with some caution, from the ISI data base): M. Karplus ($h = 142$), K. Wuethrich[11] (121), A. Bax (118), A. R. Fersht (103), C. M. Dobson (99), A. M. Gronenborn (96), H. M. McConnell (94), R. R. Ernst,[11] (88), D. M. Grant (79), L. E. Kay (72), R. G. Griffin (72), K. Ugurbil (71), H. S. Gutowsky (70), H. W. Spiess (68), H. Kessler (66), B. D. Sykes (66), W. L. Hubbell (65), I. D. Campbell (64), E. Oldfield (64), A. Pines (64), H. J. C. Berendsen (63), G. N. Lamar (63), G. Vankoten (63), S. Haroche (61), I. Bertini (60), G. E. Maciel (58), R. Freeman[12] (58), R. Kaptein (57), J. Klinowski (56), J. H. Freed (55), D. E. Wemmer (54), C. Griesinger (52), C. A. Fyfe (51), J. H. Prestegard (51), M. H. Levitt (51), D. M. Grant (50), C. P. Slichter (50), R. K. Harris (49), G. Bodenhausen (49), P. Mansfield[11] (47), R. E. Richards (45), P. T. Callaghan (45), G. van Koten (44), H. H. Limbach (44), P. C. Lauterbur[11] (43), W. S. Warren (39), L. Emsley (38), J. S. Waugh (37), M. Mehring (36), A. Abragam (29), B. Bluemich (27), L. Frydman (27), A. W. Overhauser (24), J. Bardeen[11] (24), D. P. Weitekamp (24), N. F. Ramsey (20), J. Jeener (18), I. Solomon (18), I. I. Rabi[11] (17), G. N. La Mar (16), F. Bloch[11,13] (14), E. M. Purcell[11] (11), C. Cohen-Tannoudji[11] (8), B. D. Josephson[11] (4), A. Einstein[11,14] (4), E. Zavoisky (3), and A. Kastler[11] (2). Obviously, many Nobel prizes[11] would not have been awarded if the Swedish Academy had paid attention to *h*-indices.

It takes some insight into the sprawling field of magnetic resonance, which runs from quantum information processing to structural biology, to appreciate if this kind ranking makes sense or not. There seem to be quite a few 'false negatives', *i.e.*, outstanding scientists with dismal *h*-indices. On the other hand, some celebrities with splendid *h*-indices are known to run large groups, possess vast numbers of instruments, and dispose of virtually unlimited budgets. It helps to write plenty of reviews, to focus on popular themes, to invent sexy acronyms, and to write simulation programs.

We should like to invite scientists of various disciplines – not only organic, inorganic, medicinal, and physical chemistry, but also linguistics, anthropology, *etc.* – to compile a similar list of their respective heroes. To help the reader in this sobering enterprise, Chemistry World Magazine publishes an '*h*-index ranking of living chemists'.[15] Chances are that the outcome will make them shiver! This is perhaps the most powerful antidote against a blind belief in the virtues of *h*-indices.

Is Federer better than Nadal? Is Beethoven better than Mozart?

What are *h*-indices claiming to measure? Talent? Genius? Influence? In the world of top-level sports, rankings appear to be legitimate. But it is far from obvious that similar classifications should be applied to other fields of human endeavor. Let us suppose, for the sake of the argument, that a comparison of Beethoven's and Mozart's genius would be legitimate.

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Should one monitor the cumulative sales of their CDs, keep track of radio broadcasts, or count downloads from iTunes? Music lovers will rightly cringe at such ideas.

Yet nobody seems to cringe when *h*-indices show Rabi to be 'better' than Josephson, Cohen-Tannoudji better than Einstein, Bloch better than Purcell, Wüthrich better than Ernst, Mansfield better than Lauterbur, *etc*.

One could imagine defining a *p*-index to measure the impact of a painter. This might be based on the price that the painter's works fetch at Sotheby's. True, some painters – say Velázquez, Rembrandt, or van Gogh – are credited with an 'impact and relevance' that is unquestionable, much like Hirsch said about scientists who have earned Nobel prizes. But what about contemporary painters, whose works have not yet been tested by the passage of time? Suffice it to examine paintings that are offered for sale in art galleries in Paris or New York. Does their price reflect their value? A painting that François Pineau puts on display in the *Punta della Dogana* in Venice seems to owe much of its value to the prestige of the site and the costly renovation of the venue. The same applied to papers that are enshrined in 'prestigious' journals...

What is Good about *h*-Indices

Let's cite Hirsch again: 'For a prospective graduate student considering different graduate programs, a ranking of groups or departments in his/her chosen area according to their overall *h*-index would likely be of interest, and for administrators concerned with these issues the ranking of their departments or entire institution according to the overall *h* could also be of interest.'[5]

In defense of Hirsch's brainchild, there are indications that *h*-indices may help to combat nepotism, discourage the promotion of mediocre scientists, and discourage other manifestations of old-boy networks (IF).

Generally speaking, younger generations who grew up in the age of bibliometrics seem to be less critical of *h*-indices. For some, clear-cut 'objective' criteria, what to strive for, and where to direct one's ambition, give a welcome sense of clarity, a soothing cure against the anxiety induced by the unmanageable explosion of publications and websites.

In contrast to many *aficionados* of his *h*-index, Hirsch is keenly aware of the shortcomings of his brainchild: 'There are however a number of caveats that should be kept in mind. Obviously a single number can never give more than a rough approximation to an individual's multifaceted profile, and many other factors should be considered in combination in evaluating an individual.'[5] Though it expresses the magnitude of earthquakes by a single number, the Richter scale does not allow one to foresee their effects in Haiti, Tokyo and Fukushima. Hirsch recognizes the need to distinguish disciplines: 'There will be differences in typical *h*-values in different fields, determined in part by the average number of references in a paper in the field, the average number of papers produced by each scientist in the field, and also by the size (number of scientists) in the field.' He also recognizes that 'a high *h* is a reliable indicator of high accomplishment, [while] the converse is not necessarily always true.' Indeed, Alfred Kastler's $h = 2$ hardly fits with the impact of his ground-breaking work on dynamic nuclear polarization, the latest fashion in magnetic resonance.

What is Bad about *h*-Indices

Whatever the shortcomings of his index, we should give Hirsch credit for his lucidity. His original idea seems to have been transformed by a perverse society that is obsessed with rankings,[17] seen as a panacea to relieve from the pain of decision-making processes.

It appears that Hirsch did not anticipate the manipulations, emergence of networks of supportive clients, influence-mongering, and outright corruption that the release of his malicious *jinn* has stimulated.

As we mentioned in our earlier paper,[1,2] there seem to be many similarities between classifications in science and ranking in banking, between *h*-indices and DOW, FTSE and CAC-40 indices.

The great danger is that young scientists, especially those at the start of their careers, expect their advancement to depend on their *h*-indices, and therefore pick a popular field. This would lead to focus on areas that are fashionable but have little relevance for society.

Can *h*-Indices be Rescued? The Myth of Normalization

Hirsch suggested a simple expedient to combat narcissistic excesses: 'Finally, in any measure of citations ideally one would like to eliminate the self-citations. While self-citations can obviously increase a scientist's *h*, their effect on *h* is much smaller than on the total citation count.' So Hirsch need not blush for quoting himself in 11 out of 18 references in one of his recent papers.[18] Even promoting[19] or challenging[20] *h*-indices can boost one's impact.

Is it possible to amend the definition of *h*-indices to obtain a more adequate measure of a scientist's 'accomplishments'? Should one divide his *h*-index by his age? By the number of years after he published his first paper? After becoming independent, however that may be defined? (Much of GB's impact is rightly ascribed to his mentors Freeman, Vold, Griffin and Ernst – and their influence continued far beyond 1985 when GB became formally independent.) Should one divide an individual's *h*-index by the size of his 'kingdom'? By the number of his co-workers? By his research budget? By the sum of all resources absorbed by his group since acquiring 'independence'? Should one normalize *h*-indices by the number of competing scientists who are active in the same area? How can one define such an area? How should we normalize the *h*-index of, say, our friend Kamil Ugurbil? Should we divide his *h*-index by the number of scientists who are active in the area of functional magnetic resonance imaging? Or in the broader field of general MRI? Of neurosciences? Of cognitive sciences? The broader the definition, the larger the community, and the more our friend's *h*-index will shrink…

Clearly, these rhetorical questions beg a simple answer: *none of the attempts to normalize h-indices are practical*. The simple conclusion is: one should *never* compare *h*-indices of people who are young or old, in charge of groups that are small or large, endowed with budgets that are meager or outrageous. So what, we pray, are *h*-indices really good for?

Are there any Alternatives?

The most straightforward answer is: do your homework! Do not delegate decisions to a secretary, a website, or a computer! In the words of Richard Ernst:[3,4] 'And as an ultimate plea, the personal wish of the author remains to send all bibliometrics and its diligent servants to the darkest omnivoric black hole that is known in the entire universe, in order to liberate academia forever from this pestilence. And there is indeed an alternative: Very simply, start *reading* papers instead of merely rating them by counting citations!' It must be feared that this 'darkest omnivoric black hole' will have a bright future…

From the abundant harvest of messages received in response to our earlier paper,[1,2] let us cite Anil Kumar's simple words: '*You will be glad to note that I have never attempted to look at my h-index. To me it means NOTHING. If others choose to read, not read, quote or not-quote my papers, it does not bother me.'* Many will dismiss such views as idealistic. Few are inclined to despise the impact of their

own work. Democritus (*ca.* 470–380 BC) wrote:

βούλεται μᾶλλον μίαν ευρεῖν αιτιολογίαν ἠ τὴν Περσῶν οι βασιλείαν γενέσθαι

Freely translated: A true scientist-philosopher would rather discover a single truth about underlying causes of natural phenomena than be chosen to be the King of the Persians.[21]

Darwin's Triumph

In a recent contribution about research policy[22] that was cited in *Nature,*[23] we read with considerable *Schadenfreude*: 'In Australia, the metric of numbers of peer-reviewed publications was linked to the funding of many universities and individual scholars in the late 1980s and early 1990s. The country's share of publications in the Science Citation Index (SCI) increased by 25% over a decade, but its citation impact ranking dropped from sixth out of 11 OECD countries in 1988 to tenth by 1993.' The policy makers who run Australian science deserve every bit of their misery! They tried to maneuver between Scylla and Charybdis, and ran aground amidst contradictory metrics. Governments, funding agencies, research institutions, universities, beware! If you make poor decisions based on bibliometrics, we shall all go down the drain. If scientists are supported primarily on the grounds of their marketing abilities, the survival of creative thinkers is endangered. It must be feared that Darwin's darkest predictions might be corroborated by the self-destruction of the scientific community.

The consensual views of the French Academy of Sciences[24] appear to underestimate the dangers of bibliometrics, but colleagues in Brazil appear to be more combative,[25] while some of the strongest indictments come from the community of mathematicians.[26]

Notwithstanding the advice of Ernst and Democritus, we fear that *h*-indices will continue to create havoc. Rankings, however flawed, enjoy the reputation of being better than no rankings at all. Let us hope, at least, that science policy makers will dilute flawed criteria like *h*-indices with some enlightened judgment.

Better still, since our administrators apparently cannot resist the temptation to 'measure' the talents of those who need to be administered, let us try to give some satisfaction to the unquenchable thirst for indices of science policy-makers. The idea is to counter-balance the numerical and individualist thrust of *h*-indices by an appreciation of the *ability to foster quality*. To obtain a measure of the intellectual fertility of a scientist λ, his or her index k_λ could be build on a simple list of the Master and PhD students who worked under his or her supervision, extended to encompass post-doctoral associates, with some *qualitative* measure[27] of their careers and success. Scientists who do not supervise any PhD students (and those who are still at the beginning of their careers) would be free to adapt the idea as they see fit.

The emphasis on kinship would allow a shift from the sterile narcissism of *primi uomini* to their 'intellectual offspring.' They should of course refrain from taking responsibility of the success of their past students, who are likely to draw ideas not only from their official advisors, but also from fellow PhD students, post-docs, research staff, and from great minds whose works can be found in libraries and websites. Not to mention that they may have ideas of their own! Ultimately, the *ex nihilo* emergence of novel ideas lies at the heart of research.

New insights could emerge from scientific kinship diagrams, revealing multiple descending and ascending lineages and alliance relationships. Such links of kinship would disclose connections of thought which would enable us to map the network of a scientific field.

It might seem paradoxical to investigate lines of kinship within the field of scientific production. Science might seem deprived of the feelings and sociability that come with affiliation, blood ties and alliances. However, like kinship, science is transmitted. If socially-defined kinship permits the transmission of names, material goods, and representations (blood, honour, ancestry), scientific kinship operates likewise to transmit knowledge, competence, erudition, know-how, methodology, and even culture. Scientific production is nourished by the past and is projected into the future. Just as families pass on their heritage from one generation to another, scientific reproduction builds on the inheritance from a previous generation of scholars, as well as the transmission of findings and theoretical orientations to those working in one's field in the future. Even if lines of apprenticeship and collegiality can appear very different from affinal and consanguineal family ties, the similarities between these two domains can be revealed using the anthropological tools of kinship. Beyond the mere metaphoric use of kinship terminology, as in expressions like 'founding father' or 'spiritual son', we should establish genuine genealogies of scientific kinship, founded on the transmission from master to student of a particular heritage, which may consist of a body of work, an approach, a technique, or the use of an instrument.

It is clear that our proposal extends far beyond the mere definition of a *k*-index, which is intended to combat the deleterious effects of *h*-indices. We propose to construct a chart of elective kinship, produced through the transmission of scientific theory, methods, and popular forms of speech. The 'elementary structures of [scientific] kinship' (Levi-Strauss) may be categorized by disciplines, national identities, or cultures, so that *k*-indices could reveal the means of reproduction of science rather than a mere accountancy.

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[1] A. Molinié, G. Bodenhausen, 'Bibliometrics as Weapons of Mass Citation. *La bibliométrie comme Arme de Citation Massive', Chimia* **2009**, *64*, 78–89.

[2] A. Molinié, G. Bodenhausen, 'Bibliometrics as Weapons of Mass Citation. *La bibliométrie comme Arme de Citation Massive',* English translation, *Bunsen Magazin* **2010**, *5*, 188–198.

[3] R. R. Ernst, 'The Follies of Citation Indices and Academic Ranking Lists – A Brief Commentary to *'Bibliometrics as weapons of mass citation'*, *Chimia* **2009**, *64*, 90.

[4] R. R. Ernst, 'The Follies of Citation Indices and Academic Ranking Lists – A Brief Commentary to *'Bibliometrics as weapons of mass citation'*, *Bunsen Magazin* **2010**, *5*, 199–200.

[5] J. E. Hirsch, 'An index to quantify an individual's scientific research output', *Proc. Nat. Acad. Sc. USA* **2005**, *102*, 16569–16572.

[6] For a definition of *h*-indices, reproduced as appendix to our earlier paper,[1,2] see *http://en.wikipedia.org/wiki/H-index*.

[7] Curiously, the decisions of the Nobel committee seem never to be questioned by Hirsch. Physicists may be less divided on such issues than chemists, who quibble forever.

[8] Since he mentioned age, Hirsch appears to be aware of problems of normalization.

[9] Our italics. Note the semantic shift between *scientific impact* (an apparently neutral empirical measure) and *the more accomplished scientist* (a statement about quality.)

[10] These numbers were compiled in October 2010 from the ISI Web of Knowledge.[14]

[11] Nobel laureate.

[12] Ray Freeman, supervisor of GB's D. Phil., offers an example of problems with namesakes. If one narrows down the search to R. Freeman active in 'physical sciences' and residing in Cambridge, one obtains $h = 26$, but if one (rightly) includes Oxford, his h increases to 55. If one remembers that he spent many years with Varian Associates in Palo Alto, one obtains $h = 58$, but adding his earlier period at the National Physics Laboratory in London has no effect. So it appears that $h = 58$ is a 'good' number. But if one drops all geographic restrictions, one obtains $h = 72$, while a search in all fields of the generic form 'Freeman R*' leads to $h = 137$. Unless one is familiar with his curriculum, it not easy to determine a reliable number. To illustrate another absurdity, we have separately listed G. van Koten and G. Vankoten (!), as well as G. N. La Mar and G. N. Lamar, since we do not know how to merge their records.

[13] The ISI data base appears to be incomplete, although it claims to cover all papers between 1899 (!) and 2010. For F. Bloch, only 17 papers could be found between 1934 and 1982.

[14] Only five papers could be found for A. Einstein between 1935 and 1944. None of his famous 1905 papers are mentioned in the ISI data base.

[15] 'Living chemists have been ranked in a league table based on what some argue is the fairest measure of research achievement ever devised', *http://www.rsc.org/chemistryworld/News/2007/April/23040701.asp*.

[16] Clearly, an unambiguous identification of authors, in the manner of a world-wide social security number, or a DOI for documents, would be desirable. Barring such identifiers, it is vital to use the 'Author Finder' function of the WOS search of ISI, to use both first *and* middle initials (RG Griffin, rather than R Griffin or R* Griffin), to drop umlauts (as in Wüthrich) and accents (as in Molinié), to check for areas of activity (*e.g.*, 'Life sciences & biomedicine' + 'Multidisciplinary science & technology' + 'Physical sciences'), and check the 'Institution Name Abbreviations' (*e.g.*, 'Ecole Polytech Fed Lausanne' + 'Swiss Fed Inst Technol' + 'EPFL' + 'Swiss Fed Inst Technol Lausanne EPFL'.) We have used the ISI data base 'Web of Science' rather than 'All Databases' over the 'Timespan' of 'all years' between 1900 and 2011, using the authorization available for staff and faculty of the EPFL *via* VPN.

[17] After the Stone Age, the Bronze Age and the Iron Age, we appear to have entered the Dot. Age.

[18] J. E. Hirsch, 'Electromotive Forces and the Meissner Effect Puzzle', *J. Supercond. Nov. Magn.* **2010**, *23*, 309–317.

[19] Hirsch's paper on h-indices[5] has been cited no less than 524 times so far.

[20] L. Zuppiroli, 'La bulle universitaire', Editions d'en bas, Lausanne, **2010**.

[21] M. Quack, 'Time and Time Reversal Symmetry in Quantum Chemical Kinetics', in 'Fundamental World of Quantum Chemistry', Vol. III, pp 423–474, Ed. E. J. Brändas, E. S. Kryachko, Kluwer, Dordrecht, 2004.

[22] L. Butler, *Res. Policy* **2003**, *32*, 143–155.

[23] B. S. Frey, M. Osterloh, 'Motivate people with prizes', *Nature* **2010**, *465*, 871–872.

[24] Académie des Sciences (Paris), '*Du bon usage de la bibliométrie pour l'évaluation individuelle des chercheurs*', Rapport remis le 17 janvier 2011 à Madame la Ministre de l'Enseignement Supérieur et de la Recherche.

[25] K. Metze, 'Bureaucrats, researchers, editors, and the impact factor – a vicious circle that is detrimental to science', *Clinics* **2010**, *65(10),* 937–940; DOI:10.1590/S1807-59322010001000002.

[26] D. N. Arnold, K. K. Fowler, 'Nefarious Numbers', *arXiv:1010.0278v4* [math.HO] 17 Nov. **2010**.

[27] It must be feared that addicts who are hooked on bibliometrics will promptly distort our proposal beyond recognition. The worst they could do is re-define our k-index as the sum of all h-indices of an individual's past MSc and PhD students. Needless to say, taking a simple sum over flawed h-indices does not cure their inherent weakness.