Struggling scientists: please cite our papers!

Graham H. Pyke

We scientists, whether struggling or not, need colleagues to cite our papers, and increasingly so; we also need to carry out worthwhile research. I present a strategy that simultaneously enhances citations and research quality, but is simple and straightforward. Yet it is rarely adopted, perhaps because it requires integration of a particular approach with necessary tools, aided through feedback, and the tools can be difficult to implement. The approach has four goals: high significance, high influence, excellent presentation and sustained effort. Achievement of these goals is more likely if the tools are used and helpful feedback obtained.

Keywords: Citations, goals and tools, research quality, struggling scientists.

CITATIONS to published articles are becoming increasingly important to individual scientists, the journals in which they publish, and the institutions where they are based[1,2]. Scientists compete for employment positions, promotion, research funds and students to join their research programmes, with the outcomes of such competition increasingly influenced by how frequently their published articles have been cited[3–6]. For example, one commonly used measure of citation success for individual scientists is the Hirsch index (i.e. *h*-index), which is the number *N* such that the scientist has published *N* articles each of which has so far achieved at least *N* citations[7–9]. Journals vie for readership and status, both of which are increasingly dependent on measures of citation success such as the journal impact factor, an index which is based on the average number of citations to articles recently published in a particular journal[10–12]. Funding to research institutions, including universities, is increasingly dependent on citations achieved by the researchers based there[6,13,14]. In addition, the number of students attracted to a particular university, with consequent effects on funds received, is increasingly dependent on citations. In some cases, for example, success in attracting fee-generating students may depend on whether or not a university is ranked within the top 500 in the world according to the Shanghai Jiao Tong Index, now also known as the Academic Ranking of World Universities, which is largely based on citations[15–17]. Citations matter hugely now and will undoubtedly matter more in the future. Put simply, we scientists need to have our papers cited (Figure 1), whether we consider it a sensible idea or not!

In this article I shall refer to published scientific articles, but my comments and suggestions can similarly apply to books and other kinds of presentation, be they written or oral, and to most, if not all, scholarly endeavours.

The extent to which a published article is cited is considered by many to be a measure of the level of influence (impact) achieved by that article, and so the total or average number of citations achieved by individuals, journals and institutions may provide associated measures of overall scientific performance[18–21]. Each citation suggests the relevance of one article on another, although there may be other factors involved as well[22]. Of course, the original article may be perceived as supporting or inspiring or otherwise having a positive impact on the citing article, or as being contradictory or incorrect or otherwise viewed negatively by the citing article; either way it has had influence. The accumulated citations to a particular article therefore provide a measure of the total influence of that article[23]. It is not the only measure of such overall influence, but it is a simple and obvious one. It is therefore unsurprising that total and average counts of citations have increasingly been used as measures of overall scientific performance as computer-based

Figure 1. Vagrant scientist appeals to passers-by (drawing by Hegen).

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technology has developed and facilitated keeping track of them[24–27]. Interest in the use of citations in the evaluation of articles, journals, individuals, research teams, institutions, and so on, has increased rapidly, especially since about 2004 (Figure 2), and the resulting literature is now extensive (i.e. about 4000 articles; Figure 2), covers a diverse array of issues and presents a range of points of view, with some articles having been highly critical of the approach or complained strongly about its consequences. Some critics of the use of citation-based metrics in such evaluations have argued that citations provide a poor or incomplete reflection of influence or impact[28,29], and that peer-review should not be abandoned from its traditional role in research evaluation[30–33]. Citation-based metrics may suffer from a number of associated problems, including unfairness[28,34], bias[35,36], discrimination[37–39] and manipulation[40]. Results depend on which of several available citation databases is used (e.g. *Scopus*, *Web of Knowledge*, *Google Scholar*), and there have been differences in opinion, sometimes strongly expressed, regarding their relative merits[41,42]. The focus on citations, as opposed to other aspects of research quality, may have unfortunate consequences for science, possibly affecting, for example, the development individual researchers[43] and disciplines of research[35]. Clearly, there is need for further discussion and consideration of research evaluation in general, and citation-based metrics in particular.

Based primarily on my personal experience and that of some of my colleagues, I have developed a strategy that can enhance citation success, independent of which database and metrics are used, while simultaneously improving research quality. I have published over 100 scientific articles, two of which have each generated 1000 or more citations, resulting in about 7000 citations in total (according to *Google Scholar*), and have been designated, by the Institute for Scientific Information (i.e. ISI) as a 'highly-cited' author. Here, and in analysis discussed below, I use *Google Scholar* as the citation database because it provides citation data in respect of about 95% of my scientific publications, omitting just a few that are unlikely to have resulted in many citations, and so results in the greatest possible sample size for my analysis. Perhaps I might have sought to test my ideas through some kind of 'double-blind' test, or the like, but this would clearly be impossible. Instead, I have discussed the issues concerning citations and research quality with a number of colleagues who have also been 'highly-cited', or its equivalent, including four co-authors (i.e. E. L. Charnov, P. R. Ehrlich, H. R. Pulliam, N. M. Waser) and a larger number of others. We all remember well our individual publications and other relevant aspects of our academic histories. My own experience, these discussions, and my analysis, have all agreed with the strategy I present below.

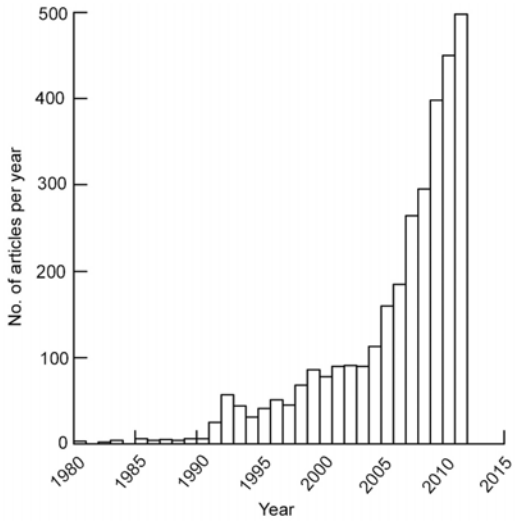

Figure 2. The number of articles published per year from 1980 to 2011 that consider citations in the context of bibliometrics. Data were determined using the *Web of Knowledge* to search for articles for which the topic was bibliometrics (taken to also include scientometrics, infometrics, informetrics, infomatics, *H*- or Hirsch-index, impact factor, citation frequency, citation count) combined with citations. For years prior to 1980, the search revealed just 11 articles. Data for years after 2011 are incomplete, and so these years were not included.

My recommended strategy is simultaneously simple and straightforward, even largely a matter of common sense, and yet rarely adopted, perhaps because it involves components that must work together and also because implementation of these components may be difficult. Though aspects or elements of my strategy have no doubt been considered in a variety of contexts, no such comprehensive strategy has apparently been proposed before and there is no obvious alternative.

My strategy has two main components – an *approach* (or mindset) and *tools* to make it work – and a third lesser component *feedback*. My approach consists of several goals or guiding principles, designed both to lead towards high-quality research and to help put existing research in the best possible context. The tools are procedures that can assist with pursuit of the goals, and feedback can indicate how well the goals are being achieved and suggest improvements. I shall discuss each of these components in turn.

Approach

My recommended approach includes four goals, that I label as significance, influence, presentation and sustain, leading to the acronym 'SIPS'. These goals may be applied to situations both where future areas of scientific inquiry are being considered and where research has already been carried out. They are all subjective but applicable. They may be stated as follows:

Significance is maximized: The significance associated with a particular research issue or question will depend primarily on the nature and extent of interest from others in the results of such scientific inquiry. In general, significance would increase with increasing numbers of inter-

ested scientific colleagues, but sometimes interest from the public would also warrant consideration. In some cases significance might depend on the extent to which the research is necessary for or likely to lead towards other significant research. Of course, significance will be context-dependent, in that some broad areas of research are more highly populated by scientists than others and research significance may also be enhanced through its novelty.

Influence is maximized: Seeking to influence, through changing how people think, what they say and what they do, seems the most important or fundamental goal, as that is really what both research quality and citation success are all about. As described above, a citation is a published recognition and acknowledgement of such influence. Of course, influence can occur in the absence of any attempts to achieve it, but seems more likely to occur if pursued than if not.

Presentation is excellent: An excellent article will be captivating, compelling and memorable. An article should, at every stage, be captivating, in the sense that it attracts and maintains the attention of a reader; only then will its story be told. In this manner, the title must attract the reader and encourage reading of the abstract, which in turn encourages reading of the introduction, and so on. An article, seeking to have some influence, will have to be compelling in presenting its arguments; otherwise its message will be lost. An article must also be memorable; otherwise other authors will not take note, nor think to cite it.

Sustain the effort: Researchers must sustain their effort in terms of the above three goals because of the long time-frames involved, as research projects often last a number of years, and especially for individual scientists whose careers may span decades.

Research excellence, and associated citation success, can only be achieved if these four goals are simultaneously pursued. The questions or issues that are addressed need to be significant in the sense that they are inherently of high interest to a lot of people; otherwise one can hardly expect to have much influence. Influence must be actively pursued; otherwise one can hardly expect to achieve it. Such influence will be achieved, if achieved at all, through presentation. All of this effort obviously needs to be sustained. Pursuing the four goals in combination is therefore necessary.

Of course, research excellence, and associated citation success, may also depend on other less tangible aspects that influence perceptions of colleagues and others when presented with the results of one's research. Other aspects would be how 'clever', 'brilliant' or 'rigorous' a body of research is perceived to be, in terms of its theoretical basis, methodology or interpretation. However, this consideration would seemingly lead only to being 'as clever and rigorous as possible' as an additional goal, and this would not be very useful. I shall therefore not attempt to further consider such intangible aspects of research excellence and associated goals as may result, but focus instead on the four goals identified above and various tools by which they can be achieved.

Tools

Significance tools

Significance increases with fundamental significance and relevance, but also depends on the context at the time the results of a particular study are published. There should always be an initial question that sets the stage for any ensuing research, and its significance is what I call the 'fundamental significance' of the research. In my case, for example, I have often sought to answer the question 'Why do animals forage in the ways that they do?' This is a question with high fundamental significance, because all animals forage, often spending much of their time in the process; foraging provides resources upon which depend maintenance, growth and reproduction, and foraging is an important part of inter-specific interactions and hence the structure of biological communities.

However, a particular study will rarely, if ever, attempt to answer such a question, but will ultimately consider a 'lower level' question. The higher the relevance of this ultimate question to the initial question the higher will be the overall significance of the study. In one of my studies, for example, I sought to test the hypothesis that bumble bees, foraging at flowers within a patch of monkshood (*Aconitum columbianum*), would employ a rule of departure from each cluster of flowers, based on nectar obtained per flower, such that the net rate of energy gain while foraging is maximized. In this case, determining whether or not observed foraging matches what is expected is a question that lies at the end of a short hierarchical sequence, with strong connections between each successive question, that proceeds as follows: First, do animals forage in ways that are consistent with optimal foraging theory (OFT) (which hypothesizes that animals make foraging decisions such that some measure of foraging success is maximized)? Secondly, do bumble bees forage in ways that maximize net rate of energy intake? The relevance of my ultimate hypothesis, which follows from this second question, was therefore high.

However, the significance of a particular study will depend not only on the inherent properties of the initial and ultimate questions, but also on *context* of both questions at the time that any results are published or expected to be published. In my case, when I published the results of the study mentioned above, the area known as optimal foraging theory was in a relatively early stage of development. There had been few attempts to evaluate it, especially ones carried out in the field, and bumble bees

were ideal animals with which to pursue such studies. The context at the time therefore enhanced the significance of my study, especially relative to the significance of a similar study carried out today.

Assessing, and maximizing, overall significance can therefore be facilitated by adopting a simple, albeit subjective, scoring system. It is possible, for example, to invent numerical scales for fundamental significance, relevance and the context factor, and combine them into an overall significance score. Of course, such a system is just a tool and its usefulness will always depend on the skill of the scientist doing the evaluation. Similar systems can be applied to other tools described below.

Influence tools

Influence increases with the targeted *audience size* and *influence level*, but, like significance is also *context* dependent. In the case of my study mentioned above, my targeted audience was large, as it could possibly include any biologist, especially those with interests in behaviour and/or ecology. My targeted influence was also high because I sought to convince people of the merits of OFT, as an approach for understanding foraging behaviour and as an ingredient in other investigations. The context factor was high, in similar fashion to the significance context, because relatively few similar studies had been published at the time and the OFT approach was then still quite new. In fact, it seems likely that the context factors for significance and influence will generally be similar, because the same factors should affect both, and in similar ways.

Presentation tools

In order for an article to be captivating, compelling and memorable it needs, more fundamentally, to be simple, concise, logical and clear. It should adopt KISS, which stands for 'keep it simple stupid', because complexity may confuse and distract a reader. It should also be concise, because readers will generally have short attention spans and many competing time demands, logical because a reader is unlikely to be convinced by illogical argument, and clear because ambiguity and uncertainty will also confuse.

The title of an article, because it is generally what the potential reader sees first, needs to be maximally captivating. To achieve this it should try to be brief and to convey what the article is about, while also being 'sexy' or 'attractive', but avoiding being 'over-the-top' or just plain silly. My title for this article could, for example, have been something like 'Citation success: what does it mean and how can it be achieved?' The fact that you have apparently read this far is perhaps evidence that my chosen title was better!

The main text of an article can be developed so that it is simple, concise, logical and clear, by starting with a sequence of points that are individually simple and clear and are presented in a logical order such that, in combination and without additional words, they tell the 'story' from start to end. Such a sequence of points can then provide a framework for additional text by, for example, using each point as the basis for the first sentence for each paragraph in sequence, with subsequent sentences in the paragraph providing supporting evidence or argument. This can have the desirable result that each paragraph contains just a single and upfront main point, as well as the evidence or argument required to justify the point. Of course, it is also possible to include, if necessary, sentences at the end of each paragraph that are 'throw-away' or 'dead-end' in the sense that they may make a minor point, but do not lead anywhere in the immediate context.

The sequence of points can also provide a basis for the abstract or summary, by first omitting some points, especially those relating to methods and sometimes also those relating to the results, and then combining and simplifying the remaining points. By so doing, the abstract or summary should accurately reflect the main elements of the story and, if important points are absent, it undoubtedly means that such points need to be inserted in the main text, each with its own paragraph.

This sequence of points can also provide a basis for assessing how captivating, compelling and memorable the article is likely to be. Reading it, or having others read it (see section below regarding feedback), may help with such an assessment, possibly suggesting addition or editing of points.

Sustain tools

There is no guarantee that an article, that presents well the results of a study aiming to be significant and influential, will have the desired impact, as judged through citations or any other measure, and no apparent one-size-fits-all approach to being able to sustain such an approach; but sustained effort does apparently work. To me, the things that are required to sustain the effort include obtaining an appropriate position, work environment and research support, maintaining the requisite levels of passion and determination, and doing these things in the context of a personally balanced life. Clearly, this is all highly idiosyncratic, and so you will really have to develop this tool yourself!

However you achieve it, persistence with the approach apparently pays off, but best intentions do not guarantee success. For me, both maximum and average number of citations per article have been markedly higher in cases where, based on my recollection, I sought to have influence in relation to a significant issue, than in cases where I did not (Table 1). Perhaps surprisingly, one of my published articles, where my recalled intention was to be significant and influential, has so far, despite reasonable time

Table 1. Total number of recorded citations for published journal articles in which, based on my recollection, I either was or was not seeking to have significant influence

Seeking to influence	Yes	No
No. of journal articles	23	64
Minimum no. of citations	0	0
Maximum no. of citations	1833	98
Average no. of citations per article	211	21
S.E.	85	3

Source of citation information is *Google Scholar*, which omits six of my published journal articles. Including these missing articles would not change the conclusions.

since it was published, achieved zero citations[44] (Table 1). Less surprising, however, is the observation that, for my other published journal articles, the minimum number of recorded citations is so far also zero (Table 1).

Feedback

Feedback can facilitate the implementation of the above tools. For example, someone who is not an author or otherwise familiar with the material in an article, perhaps even including someone not familiar with the subject area, should understand the research questions being pursued, along with any scoring systems developed to help assess the significance or influence associated with these questions, and should be reasonably convinced by the outcomes of such assessment. Additionally, if a sequence of points has been developed, as described above, then such a reader should be able to paraphrase an article after reading the resulting sequence, with reasonable accuracy, especially in terms of 'getting the message'. Otherwise, in the absence of a sequence of points, this requirement may be applied to a complete article. Furthermore, such a reader should similarly find the title, abstract, conclusions, and indeed the entire article, captivating, compelling and memorable. At all times such a reader should encounter text that is simple, concise, logical and clear, but may indicate otherwise. Working through the tools as part of a team of two or more people can also help. Getting assistance through feedback is clearly better than working alone.

Discussion

Citation success, whether we like it or not, is becoming increasingly important, to researchers, their journals and their institutions. However, through adoption of the strategy presented here, researchers can simultaneously enhance citation success and research quality. Citation-based assessments of researchers, journals and institutions are increasing, with financial and other rewards dependent on the outcomes of such evaluations. My recommended strategy can and does achieve enhanced citation success and research quality.

Achieving significant influence, which seems clearly the most important goal, requires mission, passion, a level of arrogance or self-worth, and confidence. Influence is fundamental, both to research quality and to citation success. The mission is the target influence across the target audience, and achieving a significant mission requires a commensurate level of passion. It is arrogant, to a degree, to believe that the desired influence is warranted, but this sense of self-worth is essential. Furthermore, without an appropriately high level of confidence, the desired outcome is unlikely to be achieved. Success in terms of influence requires these personal traits in combination. Additionally, of course, high levels of commitment and determination should help as well.

My recommended strategy has worked well for me and my highly cited colleagues, though none of us has ever adopted it explicitly, and it can work for almost anyone. With the clarity of hindsight, I realize that I have adopted it throughout my research career, though not continuously, and when I have adopted it, it has seemingly led to enhanced influence within my subject area and certainly to relatively high number of citations to my published articles. However, I never sought to achieve such citation success and, until recently, gave almost no thought at all to citations. Upon interrogation, my highly cited colleagues have confirmed that they too have implicitly adopted essentially the same strategy. Hence, it is not a means to manipulate the system to unfairly gain citations. It should work for anyone who wishes both to improve research quality and enhance citations, but will not necessarily result in someone becoming designated as 'highly cited'.

The 'secret' to success as a research scientist is, I believe: 'do what you do in terms of research because you love it and wish to make a positive difference within your subject area'. For both me and my highly cited colleagues, the first part of this has always been highly explicit, while the second part has been implicitly operating in the background, with us hardly or never recognizing it. However, this statement, which embodies both passion and ambition, conveys the essence of how we have all felt about what we have been doing. It is our 'secret' ingredient to success, and my recommended strategy provides a 'recipe' that incorporates it.

May you all do great research and be well, if not highly, cited!

1. Lovegrove, B. G. and Johnson, S. D., Assessment of research performance in biology: how well do peer review and bibliometry correlate? *Bioscience*, 2008, **58**, 160–164.
2. Bornmann, L. and Daniel, H.-D., What do citation counts measure? A review of studies on citing behavior. *J. Doc*., 2008, **64**, 45–80.
3. Ha, T. C., Tan, S. B. and Soo, K. C., The journal impact factor: too much of an impact? *Ann. Acad. Med. Singapore*, 2006, **35**, 911–916.
4. Weingart, P., Impact of bibliometrics upon the science system: inadvertent consequences? *Scientometrics*, 2005, **62**, 117–131.

5. Holden, G., Rosenberg, G. and Barker, K., Bibliometrics: a potential decision making aid in hiring, reappointment, tenure and promotion decisions. *Soc. Work Health Care*, 2005, **41**, 67–92.
6. Garcia, C. E. and Sanz-Menendez, L., Competition for funding as an indicator of research competitiveness. *Scientometrics*, 2005, **64**, 271–300.
7. Pratelli, L., Baccini, A., Barabesi, L. and Marcheselli, M., Statistical analysis of the Hirsch index. *Scandi. J. Stat*., 2012, **39**, 681–694.
8. Schreiber, M., Malesios, C. C. and Psarakis, S., Exploratory factor analysis for the Hirsch index, 17 *h*-type variants, and some traditional bibliometric indicators. *J. Informetr*., 2012, **6**, 347–358.
9. Bornmann, L. and Marx, W., Histcite analysis of papers constituting the *h* index research front. *J. Informetr*., 2012, **6**, 285–288.
10. Smith, D. R., Impact factors, scientometrics and the history of citation-based research. *Scientometrics*, 2012, **92**, 419–427.
11. Bornmann, L., Marx, W., Gasparyan, A. Y. and Kitas, G. D., Diversity, value and limitations of the journal impact factor and alternative metrics. *Rheumatol. Int*., 2012, **32**, 1861–1867.
12. Zitt, M., The journal impact factor: angel, devil, or scapegoat? A comment on J.K. Vanclay's article 2011. *Scientometrics*, 2012, **92**, 485–503.
13. da Luz, M. P., Marques-Portella, C., Mendlowicz, M., Gleiser, S., Freire Coutinho, E. S. and Figueira, I., Institutional *h*-index: the performance of a new metric in the evaluation of Brazilian psychiatric post-graduation programs. *Scientometrics*, 2008, **77**, 361–368.
14. Vanclay, J. K. and Bornmann, L., Metrics to evaluate research performance in academic institutions: a critique of era 2010 as applied in forestry and the indirect *h*-2 index as a possible alternative. *Scientometrics*, 2012, **91**, 751–771.
15. Billaut, J.-C., Bouyssou, D. and Vincke, P., Should you believe in the Shanghai ranking? *Scientometrics*, 2010, **84**, 237–263.
16. Kroth, A. and Daniel, H.-D., International university rankings – a critical review of the methodology. *Z. Erziehungswiss*., 2008, **11**, 542–558.
17. Matthews, A. P., South African universities in world rankings. *Scientometrics*, 2012, **92**, 675–695.
18. Vinkler, P., The garfield impact factor, one of the fundamental indicators in scientometrics. *Scientometrics*, 2012, **92**, 471–483.
19. Radicchi, F. and Castellano, C., A reverse engineering approach to the suppression of citation biases reveals universal properties of citation distributions. *PLoS One*, 2012, **7**, 1–9.
20. Quental, N. and Lourenco, J. M., References, authors, journals and scientific disciplines underlying the sustainable development literature: a citation analysis. *Scientometrics*, 2012, **90**, 361–381.
21. Liu, J. S., Lu, L. Y. Y. and Ho, M. H.-C., Total influence and mainstream measures for scientific researchers. *J. Informetr*., 2012, **6**, 496–504.
22. White, M. D. and Wang, P. L., A qualitative study of citing behavior: Contributions, criteria, and metalevel documentation concerns. *Libr. Q*., 1997, **67**, 122–154.
23. Thomaz, S. M., Michelan, T. S., Carvalho, P. and Bini, L. M., The influence of 'Homage to Santa Rosalia' on aquatic ecology: a scientometric approach. *Hydrobiologia*, 2010, **653**, 7–13.
24. Rorissa, A. and Yuan, X., Visualizing and mapping the intellectual structure of information retrieval. *Inf. Process. Manage*., 2012, **48**, 120–135.
25. Bar-Ilan, J. and Peritz, B. C., Informetric theories and methods for exploring the internet: an analytical survey of recent research literature. *Libr. Trends*, 2002, **50**, 371–392.
26. Noyons, E., Bibliometric mapping of science in a science policy context. *Scientometrics*, 2001, **50**, 83–98.
27. Cronin, B., Bibliometrics and beyond: some thoughts on web-based citation analysis. *J. Inf. Sci*., 2001, **27**, 1–7.
28. Aksnes, D. W. and Rip, A., Researchers' perceptions of citations. *Res. Policy*, 2009, **38**, 895–905.
29. Bollen, J., Van de Sompel, H., Hagberg, A. and Chute, R., A principal component analysis of 39 scientific impact measures. *PLoS One*, 2009, **4**, e6022.
30. Levitt, J. M. and Thelwall, M., A combined bibliometric indicator to predict article impact. *Inf. Proc. Manage.*, 2011, **47**, 300–308.
31. Franceschet, M. and Costantini, A., The first italian research assessment exercise: a bibliometric perspective. *J. Informetr*., 2011, **5**, 275–291.
32. Thelwall, M., Klitkou, A., Verbeek, A., Stuart, D. and Vincent, C., Policy-relevant webometrics for individual scientific fields. *J. Am. Soc. Inf. Sci. Technol*., 2010, **61**, 1464–1475.
33. Juznic, P., Peclin, S., Zaucer, M., Mandelj, T., Pusnik, M. and Demsar, F., Scientometric indicators: peer-review, bibliometric methods and conflict of interests. *Scientometrics*, 2010, **85**, 429–441.
34. Gagolewski, M. and Mesiar, R., Aggregating different paper quality measures with a generalized *h*-index. *J. Informetr*., 2012, **6**, 566–579.
35. Rafols, I., Leydesdorff, L., O'Hare, A., Nightingale, P. and Stirling, A., How journal rankings can suppress interdisciplinary research: a comparison between innovation studies and business & management. *Res. Policy*, 2012, **41**, 1262–1282.
36. Vanclay, J. K., Bias in the journal impact factor. *Scientometrics*, 2009, **78**, 3–12.
37. Ouimet, M., Bédard, P. O. and Gélineau, F., Are the *h*-index and some of its alternatives discriminatory of epistemological beliefs and methodological preferences of faculty members? The case of social scientists in quebec. *Scientometrics*, 2011, **88**, 91–106.
38. Lariviere, V., Vignola-Gagne, E., Villeneuve, C., Gelinas, P. and Gingras, Y., Sex differences in research funding, productivity and impact: an analysis of Quebec University professors. *Scientometrics*, 2011, **87**, 483–498.
39. Aksnes, D. W., Rorstad, K., Piro, F. and Sivertsen, G., Are female researchers less cited? A large-scale study of Norwegian scientists. *J. Am. Soc. Inf. Sci. Technol*., 2011, **62**, 628–636.
40. Falagas, M. E. and Alexiou, V. G., The top-ten in journal impact factor manipulation. *Arch. Immunol. Ther. Exp*., 2008, **56**, 223–226.
41. Jacso, P., Grim tales about the impact factor and the *h*-index in the web of science and the journal citation reports databases: reflections on Vanclay's criticism. *Scientometrics*, 2012, **92**, 325–354.
42. Bensman, S. J., The impact factor: Its place in garfield's thought, in science evaluation, and in library collection management. *Scientometrics*, 2012, **92**, 263–275.
43. Lawrence, P. A., Real lives and white lies in the funding of scientific research: the granting system turns young scientists into bureaucrats and then betrays them. *PLOS Biol*., 2009, **7**, e1000197.
44. Pyke, G. H., Mining a museum frog collection for environmental bio-indicators using specimens of the striped marsh frog (*Limnodynastes peronii*). *Pac. Conserv. Biol*., 2008, **14**, 200–205.

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