The rules of the game are changing:

Scientific impact factors and publication strategies among logicians

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1   Introduction

Publication impact factors are more important now than 10 or 20 years ago, both for individual researchers and for journals. Citation indices such as Thomson Reuters (formerly ISI) Web of Knowledge, (http://wokinfo.com/) or Publish or Perish (www.harzing.com, based on Google Scholar scholar.google.com) are standardly consulted by job selection committees prior to interviewing candidates.[1] Individuals and journals post their h-indices online, and they compare their h-indices with those of their peers. (The h-index of an individual is the largest number n such that n of its publications are all cited at least n times. The definition also applies to research institutes, journals, etc.) We think it is important to be aware of these developments. It is particularly important for researchers at the start of their career that they are aware of how successful researchers operate in this changing academic environment.

Logicians work across the spectrum of faculties and departments. They are found in philosophy, linguistics, computer science, cognitive science, and mathematics departments. A development particularly affecting logicians with positions in Science Faculties is the strong trend in those faculties to select and promote personnel on the basis of quantitative measures, chiefly the h-index based on Web of Knowledge. One of the consequences is that in many science faculties in the Netherlands and abroad, researchers are actively discouraged to submit their work to journals without Web of Knowledge impact factor, such as *Studia Logica*, *Journal of Logic, Language and Information*, and *Journal of Philosophical Logic*. This makes some logicians turn to journals of neighbouring fields

[1]Another player in scientometrics is the Elsevier Scopus citation database, see http://www.info.sciverse.com/scopus/.

(such as artificial intelligence, cognitive science and computer science) that do have Web of Knowledge journals, even if their papers would be very interesting for a logic journal. Is this a desirable development?

It seemed wise to step back and consider the background, the facts, and the strategies. We quickly recall what the h-index is and purports. We then discuss answers to a questionnaire on publication strategies sent out to seven well-known logicians, trying to determine whether the issue 'lives' among the community, and whether the tricks of the trade are quantitative or not. Following is an overview of h-indices of some well-known logicians (other than the interviewees), and as further reference material the h-indices of last year's Vidi grant winners, a recognition in the Netherlands of successful early-career logicians. Finally, we come with several recommendations and suggestions.

2   The Hirsch index

The h-index and the g-index are two different measures to assess an academic's scientific impact that are based on the number of the citations of his/her publications. The h-index was proposed by J.E. Hirsch[13]. The g-index was proposed by L. Egghe, as an improvement on the h-index [7]. Given a list of publications and for each publication how often it has been cited:

> The h-index is the maximum number n such that n publications have at least n citations each.

> The g-index is the maximum number n such that n publications have at least n^2 citations in total.

If n publications have exactly n citations each, that makes $n \times n = n^2$ citations altogether, in which case the g-index equals the h-index. Otherwise, the h-index is lower than the g-index. The g-index favours authors some of whose publications are cited much more frequently than all other publications. The h-index is much better known and in use than the g-index. There are yet other indices, for example, correcting for self-citations, or for co-authorship, or for recency. None of these is as much the talk of the town — and of selection committees — as the h-index, so we will focus on that one.

Let us give some examples. Consider a list of six publications with their number of citations in decreasing order as follows: 333111. There are three publications with at least three citations each, the h-index of this list is therefore 3. We write $h(333111) = 3$. On the other hand, $h(332111) = 2$: now there are not three publications with at least three citations, but there still are two publications with at least two citations each. These two have in fact three citations, but that does not matter. Also $h(311111) = 1$, and $h(911111) = 1$: although the author has a publication cited nine times, we cannot reward him or her for that achievement with a higher h-index.

Rather than the number of your publications, an indication of the impact of your work is how often your work is cited by others. Egghe calls the number of publications the *quantity* of your output and the number of citations its *quality*. Hirsch's explicit purpose to propose the h-index is to have a simple measure for the impact of one's academic output.

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Having more publications does not necessarily give you a higher h-index than having less publications. Consider the following playful but unrealistic example. Assume that there are no self-citations in your work and that the level of interest your work excites in the community per year is constant: you will get twelve citations next year regardless of whether you produce one or twelve publications or anything in between. For simplicity, assume these are your only publications. It is then clear that more is not better: having all twelve publications gives you a worst case profile of $h(111111111111) = 1$. Whereas having six only gives you a worst case profile of $h(222222) = 2$. Doing your very best and producing three publications, of therefore higher quality, may get you $h(444) = 3$.

The h-index can also be applied to journals, to groups of researchers, and to institutes, in the obvious way. For example, the h-index of a journal is the highest number n such that n of the publications that appeared in that journal have been cited at least n times. The h-index of the journal *Synthese* (on the Google Scholar scale, explained below) is 84. Its most cited publication is 'General Semantics' by David Lewis, from 1970. The h-index of (Hans van Ditmarsch and Rineke Verbrugge) applies to their (two) co-authored publications only. It is 2.

There remains the issue how we determine the list of publications, and the number of citations. Both Hirsch and Egghe based their findings on Web of Knowledge, a commercial product by Thomson Reuters. Egghe already mentions that "the real citation data can be much higher" because Web of Knowledge uses a restricted set of journals, it does not count citations in articles that are in press, and, for an example that may bewilder logicians, it does not count citations to and in *books*. This is where programs such as Publish or Perish come into the picture. After its release in 2004, Google Scholar (see `http://en.wikipedia.org/wiki/Google_Scholar` and `scholar.google.com`), quickly became a competing standard for citation analysis of academic output. Anne-Wil Harzing and her team at the University of Melbourne in Australia, see `http://www.harzing.com/`, developed a program fittingly called *Publish or Perish*, that uses Google Scholar data for citation analysis. It was released in 2007. The main difference between Web of Knowledge and Publish or Perish is that the analyses in the former are based on an approved corpus of journals, using a recency-based citation measure. A journal appears in the corpus if its Journal Impact Factor (JIF) exceeds a certain threshold.[2] On the other hand, Google Scholar covers all publications that are found online, disregarding when and where published. Typically, this means more publications and higher figures.

3 Questionnaire on the h-index: How individual logicians cope

- *What is your opinion on the tendency that publication impact factors and citation measures increase in importance? When did this start, and how does it compare with 10 years ago, and with 20 years ago? Is this development good or bad? Is the situation for logic different from that for other disciplines?*

- *Is your publication strategy influenced by your individual results in citation indices such as ISI (Web of Knowledge) or Publish or Perish (based on Google Scholar)? Do you know your own h-index, in*

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[2]What is the Journal Impact Factor? In a given year, the impact factor of a journal is the average number of citations to those papers that were published in that journal during the two preceding years. For example, the impact factor of journal X in 2010 is based on the citations to papers published in X in 2008 and 2009. Suppose 20 papers were published in those two years, and that four of these were cited, namely 4, 5, 2, and 3 times, respectively. The impact factor is then $14/20 = .7$. The reality is a bit more complex. For example, only citations in indexed journals count, and whether a journal is indexed depends on its impact factor.

ISI or in PoP, prior to us asking you this question? (Please answer just 'yes' or 'no', and for which of ISI [3] / PoP.)

- *Do you consider a journal's impact factor (SCI, science citation index) before you submit to a journal?*
- *How do you advise your graduate students on publication strategies? To which three journals would you most likely recommend a young talented logician whom you mentor to submit their work?*
- *What is your policy on citing work of other researchers in your own publications? What is your policy on citing your own prior work in your publications?*
- *If you are a journal editor, do you specifically aim to increase the impact factor of your journal?*
- *Does your department, faculty, or university have policies that aim to preclude you from submitting your work to journals below a fixed impact factor? Please expand which threshold. What is your opinion about such policies?*
- *If you intend to publish interdisciplinary work (i.e., logic and another research area), do you tend to submit that to journals of that other field if they have higher impact factors than logic journals? (The highest logic journal impact factor is around 1, whereas, for example, in psychology impact factors of 11 occur.)*

We composed a list of questions on the issue of scientific impact measurements in logic (above). Next, we approached eight researchers across the spectrum of logic, to which we received seven responses. The questions addressed both their general opinion on impact tendencies, their individual publication strategy, and how this influences their responsibilities as advisor, editor or academic manager. The interviewees were Henk Barendregt, Johan van Benthem, Joe Halpern, Vincent Hendricks, Wiebe van der Hoek, Jeff Horty, and Hannes Leitgeb. We compile and discuss some, but not all, of their answers.

What is your opinion on the tendency that publication impact factors and citation measures increase in importance? When did this start, and how does it compare with 10 years ago, and with 20 years ago? Is this development good or bad? Is the situation for logic different from that for other disciplines?

The tendency for logicians in philosophy was to respond that the change is about to come but has not arrived yet in full, whereas the tendency for logicians in computer science was to confirm the greater importance of citation measures. Joe Halpern, in refreshing contrast, observed that the situation has not changed at all: it is merely that there are now also more quantitative data available for assessment. Henk Barendregt worries about once having sinned because of praising an individual in a hiring procedure over another individual for having a higher h-index — but after seeing the consequences, promised himself never to sin again. A selection of comments:

Jeff Horty: "In philosophy, I feel that if a person has a low h-index, that's not necessarily bad, while a high h-index is usually, though not always, good. I do note that — again in philosophy — department rankings by h-index differ significantly from department rankings according to good reputational surveys."

Hannes Leitgeb: "My impression is that at least in philosophical logic, impact factors and citation measures do not play a significant role as yet. On the job side, it was only once that I observed a university looking into this, but even then it seemed it did not have any effect on the outcome of the hiring process. This also made good sense in that case since for certain topics in philosophical logic,

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[3] In the questionnaire, held in Spring 2010, we still refer to the name ISI in use at that time, instead of the now current Thomson Reuters Web of Knowledge.

the circles of people who are working on such a topic can be very small, hence one might never be able to reach a great number of citations even for an excellent paper. For the same reason, philosophical logicians would usually have a difficult time competing with scholars in science subjects in terms of citation numbers as the latter may reach greater numbers more easily simply because more people are working in these subjects."

Joe Halpern: "I think that impact has always been important. It seems to me that people have always been aware of which are the most prestigious conferences and journals in each area, and which are the most important papers. The difference between now and ten years ago is that the data are more quantitative. Not only do we have a qualitative sense of what are the important papers, we can quantify it with a citation count. On the whole, I think that is a good thing, although there is a danger of too much (uncritical) focus on the numbers. I don't think that there was much difference between the situation 10 and 20 years ago, nor do I think that the situation is particularly different for logic."

Wiebe van der Hoek: "It is a move from a quantitive overload in publications, like for instance seen in Computer Science, to a greater attention to quality."

Is your publication strategy influenced by your individual results in citation indices such as Thomson ISI (Web of Knowledge) or Publish or Perish (based on Google Scholar)? Do you know your own h-index, in ISI or in PoP, prior to us asking you this question? (Please answer just 'yes' or 'no', and for which of ISI / PoP.)

We received a resounding unanimous "NO" to the first question. This surprised Hans, as he finds himself influenced by his individual h-index results: what he considers his best works are not necessarily his most cited works, and he uses the number of citations, in combination with direct feedback from other researchers, obviously, as a correction on directions for future research. Concerning the second, none of the interviewed knew his own ISI (Web of Knowledge) index, although most knew their Google Scholar based index, or had used a Google scholar-based website at least once to determine their own h-index.

Do you consider a journal's impact factor (SCI, science citation index) before you submit to a journal?

This question gave rise to a nearly as resounding "NO" as the previous question— Wiebe van der Hoek's nuanced "yes" could just as well read as "no". The tendency of all responses is as follows:

Vincent Hendricks: "If the journal has had report, has good ideas, and an aim and scope congruent with my interest, then that is where I go."

Wiebe van der Hoek: "Yes although for computer science and logic journals those factors are rather meaningless compared to for instance journals in medicine. I must say that in interview panels that I was a member of, impact factors never played an important role, although the status of the publication venue does. In the UK, computer scientists tend to look at the list of classifications that was published by the Australian CORE [Computing Research and Education Association] initiative, especially since it emerged that there was a high correlation between how CORE ranked journals and how the RAE [Research Assessment Exercise] panel did."[4]

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[4]The current CORE classification of computer science conferences and journals can be found at `http://core.edu.au/`

Joe Halpern: "While I don't consider a journal's impact factor directly, it is very important to me [to] publish in what I consider to be the top journals and conferences. I strongly suspect that my views of the top journals are quite closely correlated with their impact factor, so I am indirectly considering impact factors."[5]

How do you advise your graduate students on publication strategies? To which three journals would you most likely recommend a young talented logician whom you mentor to submit their work?

For logic and philosophy, the *Journal of Philosophical Logic* and the *Review of Symbolic Logic* were mentioned more than once, and for logic and computer science *Artificial Intelligence* and *Journal of AI Research*. Also, other surprising matters came up:

1. encouragement to *also* publish in open-access journals (e.g., Henk Barendregt advises his students to publish both in open source journals in and higher impact journals); and

2. a warning sign about the reduced prestige of special issues. We have heard that warning in other quarters as well.

We wonder if the call for open-source journals is in fact heard by 'young talented logicians' or if they are better advised to first go for the high-impact journals and only when tenured and established should more divide their interest to further the laudable goal of further encouraging open-source journals (among which, not to forget, various high-impact journals are found).

Wiebe van der Hoek: "I advise them to consult senior members of staff before submitting. The top ranked journals for my kind of work are currently the AI journal, and JAIR, but there are also very respectable other venues, conferences like IJCAI, AAMAS, KR, AAAI. I also advise other people not to put all their cards on one venue. Also, special issues of journals are becoming to have less prestige than regular issues: that was even mentioned explicitly in the 2008 UK RAE."

What is your policy on citing work of other researchers in your own publications? What is your policy on citing your own prior work in your publications?

On this issue we had expected a lot of details and tricks of the trade, but this was not the case. Our interviewed logicians cite work of other researchers if it is relevant and cite their own work if it is relevant. Wiebe van der Hoek further mentions the following: "Of course, in a handbook chapter or book a policy for citing becomes more important: it shows who you think are members of your community."

If you are a journal editor, do you specifically aim to increase the impact factor of your journal?

No respondent does so, but everyone agrees on what is, for example, formulated by Jeff Horty: "No. If the measures work, though, this might be a byproduct of publishing good work;" and by Joe Halpern: "I do try hard to maintain a high standard, which I believe is closely related to increasing

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[5]Joe Halpern later added to his comments that some research indicates that there is a fairly strong positive correlation between impact factor and open-access journals. See [14, 2].

the impact factor."

Does your department, faculty, or university have policies that aim to preclude you from submitting your work to journals below a fixed impact factor? Please expand which threshold. What is your opinion about such policies?

Here, the responses vary rather widely. Sometimes these policies are in place, sometimes not, and sometimes on the way. At this stage of our questionnaire, it should not come as a surprise that these policies are more advanced in the United Kingdom than in other parts of the world. Or we should rather say that based on this very small sample, the responses confirm our own experiences and knowledge about the UK. We came to think of this question as Rineke Verbrugge recalls explicit departmental policies in the Netherlands encouraging her to publish in, for example, medical journals (with her specialization that is on the intersection between logic and cognitive science this is an option), and she is worried by that kind of pressure.

Joe Halpern: "I am not precluded from publishing anywhere, and I would object if someone tried to preclude from publishing somewhere."

Vincent Hendricks: "The Danish universities only recently jumped the bandwagon so there is no threshold in place yet."

Hannes Leitgeb: "In my current department there is no policy like that. For the reasons stated above [logicians working in very small, specialized, communities], it would also be problematic to adopt such a strategy."

Johan van Benthem: "I recently noticed in Amsterdam that 'it' is coming."

Wiebe van der Hoek: "My Department does have policies (no strict rules), induced by a University wide strategy. The UK [Research Assessment Exercise] RAE helps in this: the categories that are defined by the RAE panel for publications (level 1*, 2*, 3* and 4*), and we discourage staff to submit to venues that we judge lower than 3* (which is supposed to stand for internationally leading)."

Jeff Horty: "No."

If you intend to publish interdisciplinary work (i.e., logic and another research area), do you tend to submit that to journals of that other field if they have higher impact factors than logic journals? (The highest logic journal impact factor is around 1, whereas, for example, in psychology impact factors of 11 occur.)

We close with another resounding 'NO', followed by a response by Joe Halpern more on choice of impact than on choice of impact factor, that we think contains a lesson every researcher could take at heart, not only in Computer Science:

Joe Halpern: "I often publish interdisciplinary work, and think hard about how I can impact the various communities involved. The best strategy is often to publish in a high-impact Computer Science conference, and then publish in the appropriate field related journal. "

Let us close with some final words from a respondent. Johan van Benthem: "I know that it is

becoming more and more important. I imagine we should counsel our students."

4 H-indices for some logicians

We determined the h-indices for some well-known logicians, and for some up-and-coming logicians. Our choice was somewhat but not entirely arbitrary. We chose some well-known logicians that were not among the interviewees in the previous section: Melvin Fitting, Dov Gabbay, Hans Kamp, Henri Prade and Moshe Vardi. As an objective sign of 'up-and-coming' we selected the Vidi winners in the 2009 round that are logicians. These are Rosalie Iemhoff, Barteld Kooi, Thomas Müller and Sonja Smets. We then discovered that there are, not surprisingly, many Thomas Müllers, even working in related areas. Having a common name or a namesake active in a similar area makes it difficult to determine the h-index. Therefore, we did not determine his h-index.

name	Google Scholar h-index	Web of Knowledge h-index
Melvin Fitting	27	9
Dov Gabbay	45	9
Hans Kamp	28	5
Henri Prade	86	46
Moshe Vardi	71	24

We observe that these figures vary very widely, and that the selected senior logicians have a (somewhat meaningless) average Google Scholar h-index of about 51 and an Web of Knowledge index of about 18. In contrast, the average Google Scholar index of the up-and-coming logicians (minus Thomas Müller) is about 11 whereas their average Web of Knowledge h-index is about 3. Clearly the peer esteem for such already well-established young logicians cannot be measured in any meaningful way by either Google Scholar or by Web of Knowledge—the latter even less so, as they are almost invisible there.

How we obtained these results The Web of Knowledge results were determined on 5 January 2011, based on Thomson Reuters Web of Knowledge (see for the current version `http://apps.isiknowledge.com/`). The Google Scholar h-indices were also determined on 5 January — we were assisted in that by the program Publish or Perish, version 3.1 (December 2010). In the case of the Vidi winners, Publish or Perish was used to verify our data, not to establish them. To establish data, consulting the Google Scholar pages and correct the findings seems more reliable. On the other hand, for the famous logicians we determined the Google Scholar h-indices in Publish or Perish only, with, again, corrections: there are simply too many results for well-known researchers. It should be noted that for Henri Prade, Publish or Perish (PoP) gives a warning message: "Results limit reached. The query reached 1000 results, which is the maximum that Google Scholar allows. This may affect the query coverage." In other words, the h-index may in principle even be higher, but this exceeds the abilities of Google Scholar. In fact we doubt that this makes a differences, as the results on the bottom end of this list are publications with no, one, or very few, citations, that do not contribute to the h-index.

The Publish or Perish results for Henri Prade used search term 'H Prade' with deletion of non-intended Prades from that outcome.[6] Search results for 'Henri Prade' only, give a lower (and indeed

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[6]Henri Prade's Web of Knowledge results required deletion of the medical publications of another H. Prade.

too low) result. The discrepancy is because some publications store the author's initial only and not his/her full first name, or first names. Moshe Vardi's Publish or Perish h-index was determined with the term 'M Vardi' plus exclusions.[7] Melvin Fitting's h-index was straightforward to determine. Hans Kamp's Publish or Perish h-index was determined with term 'H Kamp' plus corrections..

If you know the publications behind the results, there are more observations to make. Top of Barteld Kooi's list is 'Concurrent dynamic epistemic logic for MAS', presented at the 2003 AAMAS conference, which is listed with 249 citations. This is a different item from the book 'Dynamic Epistemic Logic' that also determines Kooi's h-index. But Hans van Ditmarsch, being a co-author in both, knows that most of the citations attributed to the former are in fact to the latter. For unknown reasons, Google Scholar has included most but not all citations to 'Dynamic Epistemic Logic' in those to 'Concurrent dynamic epistemic logic for MAS'. Currently, where attribution of citations to the proper articles is concerned, Web of Knowledge tends to be more reliable than Google Scholar, which is still available only in a beta-version.

5 Why logicians have low h-indices

From the data so far, it appears that Web of Knowledge (previously ISI) h-indices of logicians are low, compared to researchers in other areas.

Again, it should be noted that books and handbooks (such as 'Handbook of Logic and Language' [5] and 'Handbook of Philosophical Logic' [9]) do not appear in Web of Knowledge ratings. Strangely enough, mathematicians in general have a PoP h-index just above their Web of Knowledge h-index, unlike mathematical logicians.

We conjecture a number of reasons for low Web of Knowledge h-indices among logicians, provocatively formulated as follows:

- *Logic journals are not indexed in Web of Knowledge.*
  They tend to be specialist journals, catering to small communities. Even when covered by Web of Knowledge, they have a low impact factor (we recall that the impact factor is based on recent citations to an indexed scientific publication in an indexed scientific publication, where 'recent' means 'at most three years ago'. Note that the impact factor of logic journals may be negatively affected by the time lag for publication: if an article has to wait two years between submission and publication, all its references are already too old to count for the journal impact factor (see [16] for a similar issue in psychology; this phenomenon is in marked contrast to the short submission-to-publication times of many physics, medicine and biology journals). Also the tendency of logicians to refer to older, 'classical' papers rather than the newest arrivals may limit logic journals' impact factors.[8]

- *Logicians write monographs, handbooks, and edited volumes.*
  These determine Google Scholar ratings, but not Web of Knowledge ratings, as none of these categories figure in Web of Knowledge.

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[7]Moshe Vardi's Web of Knowledge results required deletion of some astrophysical publications of another M. Vardi.

[8]This picture of non-apearance in Web of Knowledge seems to change rapidly. Logic journals that are indexed in Web of Knowledge include: *Theoria*, *Logic journal of the IGPL*, *Journal of Logic and Computation*, *Bulletin/Journal/Review of Symbolic Logic*, and *Mathematical Logic Quarterly*, among others.

- *Logicians prove new theorems.*
  Their publications have few references, unlike those of their counterparts in areas as biology, psychology, sociology, physics, medicine. The h-indices of celebrities in such areas are much higher than those of famous logicians, both in Google Scholar and in Web of Knowledge.

- *Logicians think, they do not read.*
  That is of course a provocative falsehood. But at least, in their reading, logicians seem not to focus mainly on journals, but more on books and proceedings.

- *Logic is not an experimental discipline.*
  Experimental sciences may have more need for citations, namely to give a track record of prior experiments.

More research needs to be done to understand these causes of relatively low Web of Knowledge impact. Some issues that have been noted for computer science may work out similarly for logic [10, 8, 17, 18, 3]. Interesting critiques of current practices in academic ranking can also be found in [15, 1, 12].

6   How to advance the cause of logic and logicians

So far, the "Web of Knowledge h-index trend" has turned out to be quite disadvantageous to logicians, due to our publication culture that differs markedly from what is usual in, for example, physics. This plays out, for example, in faculty hiring procedures where applicants from different areas are compared to one another. There, logicians who are esteemed very highly in the logic community often fail to impress the selection or promotion committees.

Let us give some first ideas of what could be done to remedy the situation. In the following, we assume that logicians' first priority of course should be to take care of the content and quality of their scientific work. Given that, it seems that some other actions and considerations may help:

- It would be an important step if a high-quality *logic journals* would be *included in Web of Knowledge*. Logicians who are editors of such journals can promote such inclusion.

- Also, it would be good if logicians take action to *persuade Web of Knowledge that they include scientific books* in their impact counts. Citations to books seem to be a fair reflection of peer esteem in the logic community. Many logicians read journals and conference proceedings for current scientific results, but prefer to read books to acquire a sense of the larger framework and an overview of how results fit together. Books like 'Modal Logic' by Blackburn and colleagues [6], 'Dynamic Logic' by Harel and colleagues [11], and 'The Lambda-Calculus: Its Syntax and Semantics' by Barendregt [4] definitely fill such a need.

- In faculty boards and hiring committees, logicians should *create awareness that h-indices differ markedly from community to community*, and explain that for logicians, the Google Scholar h-index reflects peer esteem much better than the Web of Knowledge h-index.

Let us end this article by noting that we as authors are personally no great proponents of a single quantitative measure such as the h-index. Nevertheless, we do feel that the logic community is in need of becoming more "h-index savvy", if only because the rules of the larger game of academia

are changing. This has started to strongly influence the hiring and promotion of, especially younger, logicians, and the evaluation of whole departments. The younger generation needs to know its own position and what rules it's up against, and we as somewhat older generation can mentor younger logicians. Moreover, we can try to use our influence in appropriate ways to advance the cause of logic.

Acknowledgments

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