

hubris with a long history. A cursory examination of the history of the Royal Society of London makes it clear how involved the society was throughout the 18th and early 19th centuries in offering advice on scientific matters to official commissions. The British Association for the Advancement of Science (BAAS), founded in 1831, frequently offered advice to the British Parliament in areas in which the Royal Society was thought to be failing. Such counsel is arguably an important element in building the general culture of society.¹

Would the 1860 clash over *On the Origin of Species* between Thomas Huxley and Samuel Wilberforce at a meeting of the BAAS have had anything like the resonance that it did if the role of the BAAS in scientific matters had not been generally recognized? The outcome, by showing clearly how imperfect Wilberforce's understanding was, compromised the position of the established church in matters in which it had been regarded as authoritative.

Reference

1. See, for example, J. Morrell, A. Thackray, *Gentlemen of Science: Early Years of the British Association for the Advancement of Science*, Oxford U. Press, New York (1981).

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On the value of author indices

Letter writer J. Richard Gott III (PHYSICS TODAY, November 2010, page 12) and PHYSICS TODAY readers should be relieved to learn that Albert Einstein's h-index as given by the Institute for Scientific Information (ISI) is 50, not 27 as Gott reported; hence it is higher than Gott's 46. Although Einstein's h-index is substantially lower than Edward Witten's 125, remember that Einstein published between 1901 and 1955, when the entire body of scientific literature was very much smaller than in Witten's publishing lifetime, 1976–present. To get an idea of the scaling involved, in the first six months of 1948, *Physical Review* had a total of 1476 pages, whereas in the first six months of 1998, *Physical Review A–E* had 39 141 pages—many more papers with many more references. Werner Marx, Lutz Bornmann, and Manuel Cardona have published an exhaustive analysis that clearly illustrates the point about differ-

ent citation impacts of papers published in different time periods.¹

I cannot think of any other physicist publishing in Einstein's lifetime who would have an h-index comparable to his 50. For example, ISI gives an h-index of 26 for Erwin Schrödinger (1914–61), 30 for Werner Heisenberg (1921–76), 32 for Enrico Fermi (1922–55), and 44 for Paul Dirac (1924–85). Cardona and Marx give an h-index of 41 for Max Born (1900–70) and 45 for Heisenberg, corrected for some ISI omissions.² I know of no physicist publishing before 1956 who has an h-index higher than 50. Thus Einstein's h-index today properly reflects his stature relative to his contemporaries, and comparing h-indices of physicists living in vastly different time periods, as Gott does in his letter, doesn't make sense.¹

Of course, the h-indices of Einstein and of his eminent contemporaries have increased because of many posthumous citations. Einstein's h-index at the time of his death in 1955 was a “measly” 20. I would not be surprised if some of his physicist contemporaries whom we know little about today had higher h-indices than Einstein's then and much lower ones than his today. Similarly, some physicists today with h-indices higher than those of their contemporaries may have their fortunes reversed decades after they are gone. Just as with good wine, the h-index's reflection of merit, when properly used, gets better with time.

References

1. W. Marx, L. Bornmann, M. Cardona, *J. Am. Soc. Inf. Sci. Tech.* **61**, 2061 (2010).
2. M. Cardona, W. Marx, *Ann. Phys.* **17**, 497 (2008).

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In the November 2010 issue of PHYSICS TODAY (page 12), J. Richard Gott III criticizes the h-index as an inaccurate measure of the impact of a given author's work; he recommends its replacement by an index he calls the E-index in honor of Albert Einstein. The h-index was proposed in 2005 by Jorge Hirsch,¹ in a paper that has been cited about 660 times in five years, a phenomenal impact for work on bibliometrics. The main reason for the large impact is the h-index's simplicity and transparency and the ease of obtaining the index using the Web of Science. At least 37 variants of Hirsch's h-index have been proposed since, and an E-index already exists.²

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Some of Gott's objections, and ways to take them into account, have been dealt with in the literature. His first objection is that the h-index does not reward an individual for his or her most important paper. Those of us who use the h-index profusely are aware of that concern and simply correct it by looking at the number of citations for the individual's two or three most cited papers.

Gott also objects to the low h-index of scientific giants like Einstein. That also has been discussed in the literature and attributed to the different publication and citation culture—in particular, the low average number of citations per paper—in Einstein's day.³ A normalization method to correct that problem through time adjustment is presented in reference 3. Once that procedure is applied, Einstein reaches an h-index of 139, higher than any of those mentioned by Gott.

Another objection concerns informal citations—that is, those only mentioning names or initials instead of giving complete references—which Gott calls eponymous or name citations. Again, that has already been discussed at length.⁴ The most conspicuous case may be that of C. V. Raman, who has an h-index of 17 with 2500 formal citations; 150 000 informal citations according to INSPEC, the Information Services for the Physics and Engineering Communities database; and 1 million informal citations according to Google Scholar.

Combining formal and informal citations into one index is somewhat misleading because they are based on different metrics with different limitations. For example, abstracts from papers prior to 1991 are not available in the Web of Science. Furthermore, the weighting factors Gott used for calculating his E-index seem to be highly arbitrary, which makes his index opaque, especially when compared with the h-index. Finally, there is extensive literature discussing the relative share of first authors and coauthors in bibliometrical indicators.⁵

References

1. J. E. Hirsch, *Proc. Natl. Acad. Sci. USA* **102**, 16569 (2005).
2. C.-T. Zhang, *PLoS ONE* **4**(5), e5429 (2009).
3. W. Marx, L. Bornmann, M. Cardona, *J. Am. Soc. Inf. Sci. Tech.* **61**, 2061 (2010).
4. W. Marx, M. Cardona, *Scientometrics* **80**, 1 (2009).
5. L. Egghe, *J. Am. Soc. Inf. Sci. Tech.* **59**, 1608 (2008).

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The h-index, impact factors, and similar absurdities are increasingly divorced from the original purpose that spawned them. Citations were intended for forward-referencing, to be able to follow the subsequent development of a topic or field. Just as our publications carry references to past papers to place them in context, citations allow us to see how the work develops into the future.

Originators of science citations may never have meant them to be an evaluation of an author's worth. Yet it seems that awards and promotions are increasingly based on the h-index and other concocted indices. No studies have justified such use, and there is no reason to claim that two people with the same h value are somehow of equal worth. Deans and other administrators, in moments of reflection, will concede that an h-index cannot be used for promotion decisions, but the tempting simplicity of a single number—as with IQ and indicators in the past—is sometimes hard to resist, especially when one is not familiar with the work itself.

The innumeracy is compounded when h is divided by some time unit, such as years ranked as assistant or associate professor or years since PhD. How is that meaningful? We as physicists should know better than to invest meaning simply because we can multiply or divide two numerical quantities. The sole purpose of computing such indices seems to be to make some case for timeliness of promotion. If such a case could be reasonably made, we could do away with any promotion deliberations and just replace them with some automatic gate or threshold.

Even as the amount of literature on- and off-line explodes and purportedly quantitative measures of abilities proliferate, people seem to actually read the literature less and less. Referencing to previous work is often grossly inadequate, especially with authors using electronic search sites and limiting their searches to recent publications. I've also heard of gaming the system, with friends agreeing to cite each other's papers, regardless of relevance, simply to boost their h-index.

In the light of all this, I propose a new index, the r-index. A primary meaning of the "r" is as one of the original three r's, reading. The r-index is the fraction or ratio of the references cited that the author has actually read in full at least once.

My tone should make it clear that I do not want or expect anyone to start computing the r-index, or the h-index,

or the latest "E-index" with further rococo embellishments (PHYSICS TODAY, November 2010, page 12). Physicists spawned the h-index. It is for physicists now to banish it from any rational discourse.

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Gott replies: Jorge Hirsch acknowledges his h-index cannot be used to compare people across epochs. That's where I started. Werner Marx and Manuel Cardona think people can be compared across epochs, and they and Lutz Bornmann propose a "renormalized" h-index to do it.¹

But even comparing contemporaries, Hirsch notes,

For an author with a relatively low h that has a few seminal papers with extraordinarily high citation counts, the h index will not fully reflect that scientist's accomplishments. Conversely, a scientist with a high h achieved mostly through papers with many coauthors would be treated overly kindly by his or her h.²

My E-index addresses those problems by weighting all papers in proportion to their citation impact and dividing credit for each paper among its *n* authors: counting $\frac{1}{2}$ first-author citations and $\frac{1}{2}$ fractional ($\frac{1}{n}$) citations. Vladimir Krasnopolsky (PHYSICS TODAY, September 2004, page 12) proposed giving $\frac{1}{2}$ citation to the first author of a multiauthor paper with the remaining $\frac{1}{2}$ divided between coauthors—close to what I am doing.

Marx and Cardona actually favor including informal last-name citations, saying,

The data reveal that the formal citations often measure only a small fraction of the overall impact of seminal publications. Furthermore, informal citations are mainly given instead of (and not in addition to) formal citations. As a major consequence, the overall impact of pioneering articles and researchers cannot be entirely determined by merely counting the full reference based citations.³

The E-index includes informal citations by adding last-name citations in titles and abstracts to the average of first-author and fractional citations. That recovers additional "lost" citations that Albert Einstein and other greats are getting, mostly from recent times, and allows comparison with recent physicists