H-Index:
An Alternative Metric for Ranking Scientists

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ABSTRACT

The ability to design an instrument sufficiently versatile to effectively gauge the impact of a scientist's work within his/her own specialized field is a daunting task—to say the least. Initially, the Journal Impact Factor (JIP) was developed for selecting and comparing the journals within *The Science Citation Index (SCI)*. Unfortunately, it was never intended to evaluate a scientist's work; rather, it was designed to assess journals. Due to growing dissatisfaction, another technique or instrument was sought whose purpose was to simultaneously evaluate a scientist's works and the number of citations each work received from other scientists. Just such an instrument emerged: the H-Index. Today, it is rapidly gaining attention from scientists around the globe. Accordingly, the purpose of this article is twofold: to describe the features, strengths, and weaknesses of the H-Index and to suggest how it may affect high school, undergraduate, and graduate students.

Introduction

Eugene Garfield (1955), founder of contemporary science citation analysis, published *The Science Citation Index (SCI)* and developed the Journal Impact Factor (JIP), a technique for selecting and comparing the SCI's journals. He maintained that the JIP can be stated as a simple equation: Ascertain how many times the journal was cited during the two previous years and divide that number by the number of articles said journal published. The JIP is currently a pivotal component of the ISI Web of Knowledge, facilitating scientists' ability to access and determine the caliber of journals that have published their colleagues' selected works. The Web of Knowledge's breadth and longevity has no peer; hence, the Journal Impact Factor, in spite of having competitors, endures unequivocally as the gold standard (Gugliotta, 2009).

Despite the aforementioned, the JIF is, however, clearly not without problems. For example, citations of Review journals, which summarize extant research, are by and large cited significantly more frequently than journals publishing new findings.

In addition, most people rate individual scientists by employing the JIF as a proxy, regardless of the fact that it was intended to rate only journals. Finally, the JIF can be gamed because sometimes authors have been encouraged by editors to cite articles from their own journal. Accordingly, something had to be done to more reliably rank a scientist in his/her own respective discipline (Gugliotta, 2009).

Jorge Hirsch, who had refuted the BCS theory (a theory in physics dealing with low-temperature superconductors), had been essentially shunned by his colleagues in his field of specialization and was unable to publish in the truly high-visibility journals, i.e., journals with higher JIFs. Hirsch maintained that rating systems should focus directly on a research scientist's work—not which journal published his/her work. Hirsch (2005) then introduced his rating system, the h-index, which concentrates on how frequently your work was cited by other researchers—not on your selected journals for publication.

In describing how the h-index functions, Hirsch stated the following: "A scientist has index h if h of [his/her] N_p papers have at least h citations each, and the other (N_p – h) papershave at most h citations each" (H-Index). More specifically, a scientist having an index of h implies that he/she has published h papers such that others have cited each of them at least h times. For example, a scientist would rank all of his/her papers published based on the number of citations per paper. Assume the following: paper ranked #1 received 15,000 citations; paper ranked #2 had 10,000 citations; paper #29 had 30 citations, but paper #30 received only 25 citations. We conclude from this that your h-index is 29. The h-index, as a result, generates not only the number of a scientist's publications but also the number his/her citations received for each publication. Thus, the h-index reflects a better alternative than traditional bibliometric indicators employed in the past for evaluating the impact of a specific researcher's work (Gugliotta, 2009).

Advantages and Disadvantages of the H-Index

Like all instruments designed to assess a specific product or process, perfection is always out of reach—regardless of how noteworthy the intent. Consequently, like its predecessors, the h-index has advantages and disadvantages, too.

Advantages of the H-Index

The h-index has the following perceived advantages: (a) It was designed to resolve other bibliometric indicators' shortcomings (e.g., total number of a researcher's papers or citations) because a researcher's total number of scientific papers does not necessarily reflect high quality results, while participation in a single major influential publication may disproportionately affect his/her total number of citations; (b) a researcher's scientific output in terms of quality, sustainability, and topical diversity are simultaneously measured by the h-index; (c) methodological papers offering novel techniques or methods affect the h-index less so than other traditional metrics; (d) it has demonstrated considerable face validity when applied to Nobel Prize winners and to National Academy of Sciences in Physics and Astronomy membership; (e) successfully selected candidates for postdoctoral research

fellowships' h-index scores have been shown to be persistently higher than that of non-successful candidates (Bornmann & Daniel, 2005); and (f) the h-index provided greater discriminatory power than raw citation numbers for ranking faculty in information sciences (Cronin & Mecho, 2006).

Disadvantages of the H-Index

The h-index has the following perceived disadvantages: (a) It is intrinsically disadvantageous for scientists having a short career, even if they made seminal discoveries; (b) since this metric places the burden on individuals, it also motivates researchers to conform or adhere to conventional wisdom, precisely the antithesis of what Hirsch sought; (c) apportioning credit for multiple-authored papers is problematic for the h-index; (d) the context of citations is also problematic for the h-index; (e) gratuitous authorship, as a confounding factor, is not accounted for by the h-index; (f) singular successful publications also are not accounted for by the index; and (g) self-citations cannot be accounted for by the index, either ("H-Index", n.d.).

Implications

Hirsch's novel approach for ranking a scientist amongst his/her colleagues in the same specialized field amounts to a paradigm shift and has gained significantly greater acceptance in the scientific community, because the h-index simultaneously assesses one's quantity of publications and one's quality of publications, i.e., one's impact via citations associated with the publications. His/her h-index can be used to rank or compare faculty within science departments as well as rank or compare the various science departments within the same university. It can also facilitate a prospective student's (undergraduate, graduate, or postdoctoral) decision to attend a specific university. It can also substantially increase a university's odds of receiving grant monies.

Fortunately, the h-index can benefit not only veteran or novice scientific researchers but also high school and undergraduate students. With respect to the former, students enrolled in AP science courses, but other students as well, could use this ranking system when assigned written reports or perhaps limited laboratory experiments focusing on either a specific topic or a specific scientist. It would be an excellent way to introduce them to the research leaders in certain scientific fields, which could influence their future career choice in a scientific field—a decision that could prove advantageous for us in this globally competitive age. In addition, undergraduate students enrolled in Honors science courses, as well as other students, could also employ the h-index to carry out class assignments and to pursue future careers.

Finally, Hirsch was assuredly not oblivious to the fact that a scientist's multifaceted profile can be only roughly approximated by a single number. Thus, he asserted that numerous other factors need to be combined when evaluating someone's impact on the scientific world; he also maintained that exceptions to the rule must never be ignored or ruled out, either.

References

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