

# *r*-index: Quantifying the quality of an individual's scientific research output

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## ABSTRACT

There are quite many methods to assess the output of a research scientist, primarily by the number of papers he (she) publishes, where they are published and the number of times a particular paper is cited by other journals. But none of the methods give a possibility to identify the quality of the paper published. I present here *r*-index or method that can provide an insight into the quality of the research output, at the same time balancing the role of impact factors in which that research output is published.

**Keywords:** Research evaluation, publication, scientometric analysis, impact factor, *h*-index

## INTRODUCTION


Impact factor (IF), citation count in citation index (CI) and *b*-index, (Hirsch 2005)<sup>[1]</sup> are of paramount importance in quantifying an individual's scientific research output; but what about the quality of the work cited? A scientist having a high CI citation count and *b*-index value doesn't necessarily prove that the published work is of high quality, though it gives an idea about the quantity (in terms of the number of citations). The traditional race for priority of important discoveries is increasingly intertwined with a struggle for limited funding and jobs, the winners of which are determined by measures of performance and impact (Young *et al.* 2008; Bonitz and Scharnhorst 2001; Statzner and Resh 2010).<sup>[2-4]</sup> Individual scientists, research institutions, countries, international organizations, and scientific journals are

increasingly evaluated based on the numbers of papers they publish and citations they receive six (Shelton *et al.* 2009; Meho 2007; Nicolini and Nozza 2008.<sup>[5-7]</sup> From all these levels, therefore, come pressures on researchers to publish frequently and in high-ranking journals. The quality of journals, which cite a researcher's paper, is more important than the quantity/number of times a paper is cited. I propose an *r*-index method, which would help provide the scientific community to gauge at the researcher's quality of work along with the quantity of his scientific work. The quality of the scientific work is a crucial hinge-point on which its development and progress depends; for example, Yoichiro Nambu, Makoto Kobayashi, Toshihide Maskawa, published their results on the discovery of the mechanism of spontaneous broken symmetry in subatomic particles in journals with a relatively lower IF. than the traditionally high IF journals like nature and science. However, the quality and implications of those results were strong enough to earn them a Nobel Prize for Physics in 2008. IF, CI, *b*-index do not give us an idea about the quality of the cited research work. Keeping in view the value of quality of the citable scientific research work, I propose the concept of *r*-index, harnessing both IF and CI and providing a simple method that could be used as a more specific mode of identifying potential quality work.

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<b>Quick Response Code:</b>	
	<b>Website:</b> www.jscires.org
	<b>DOI:</b> 10.4103/2320-0057.115867

## RESULTS AND DISCUSSION

The *r*-index can be calculated as the sum of the IF's of the journals, in which the paper has been cited, i.e.,

$$r\text{-index} = \sum \text{IF}(c_n);$$

where  $(c_n)$  is the number of citations.

The *r*-index can be calculated and used in two situations as explained below:

### Situation 1

Using *r*-index as a step-up method for *b*-index.

The following two cases of two researchers, S. Ram and R. Robert will provide an insight into the efficiency of the *r*-index method in conjunction with the *b*-index.

#### Case 1

Consider the case of S. Ram's work, if

Number of papers = 10

CI = 20

*b*-index = 3

#### Case 2

Now consider another scenario of Robert's work, if

Number of papers = 10

CI = 20

*b*-index = 3

What is the difference between case 1 and case 2? The work of both Ram and Robert appears to be equally potential, when we consider the *b*-index, but is it true? How to further probe to filter the best of the both? At this point, it is important to realize that the *b*-index doesn't give any information about the type of journals in which the papers are cited.

It is observed from the above cases that *b*-index of Ram (case 1) is 3, i.e., of the considered total number of 10 papers of Ram, at least 3 papers have been cited 3 times. Similar is the case of Robert's work (case 2).

Now let's calculate the *r*-index for Ram's work.

We know that the *b*-index = 3, Now if the IF of the journals that have cited Ram's work is 1 each, then,

*r*-index = 9 (sum of IF of 3 papers cited at least 3 times as obtained by the *b*-index).

Similarly, let's calculate the *r*-index for Robert's work.

We know that the *b*-index = 3, But, if the IF of the journals that have cited Robert's work is 10 each, then,

*r*-index = 90 (sum of IF of 3 papers cited at least 3 times as obtained by the *b*-index).

Hence, considering the *r*-index values [Figure 1], it is evident that work by Robert has been cited in high IF journals than that of Ram's, though both authors have same CI and *b*-index values. Here, the IF of the journal in which their work is cited is used as a proxy to indicate the quality of the scientific work that is published in that journal.

### Situation 2

Calculating the *r*-index with only the CI values.

Few scientists who earn a Nobel prize, invariably possess relatively very high *b*-index values (also because of the fact that *b*-index is dependent on the larger time frames, Carbon, 2011).<sup>[8]</sup> Among the rest of us, the CI is by far the calibration constant by which the research is assessed. The *r*-index can also successfully used to evaluate the quality of a publication (and not only the quantity in terms of the number of times it is cited) considering only the CI values.

Let's again consider two cases of two researchers, S. Ram and R. Robert to calculate the *r*-index:

#### Case 1

Consider that Ram's paper has CI = 2; and if the IF of the two journals in which cited is 1 and 7 respectively,

Then *r*-index ( $\sum \text{IF}[c_n]$ ) of S. Ram = 8 (i.e., sum of the IF's

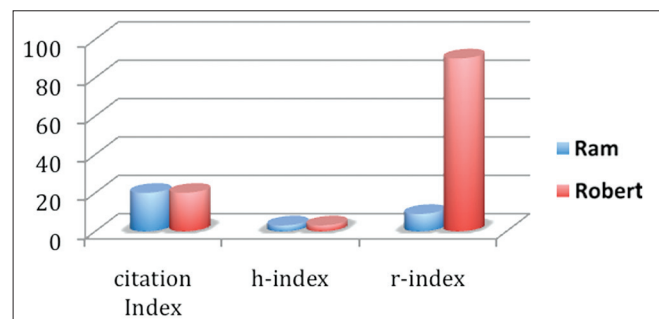


Figure 1: Potential use of *r*-index

of the journals in which the paper was cited,  $1 + 7 = 8$ .)

### Case 2

Now consider another scenario, a paper by Robert also with a CI = 2, but if the IF of the two journals cited is 40 and 20 respectively,

Then *r*-index ( $\sum IF [c_n]$ ) of R. Robert = 60, (i.e., sum of the IF's of the journals in which the paper was cited,  $40 + 20 = 60$ ).

Again, in both the above-mentioned cases one and two, what is interesting is that the CI is same, i.e., two, for both Ram and Robert; but with the help of *r*-index, we could filter to see which paper has been cited in high impact journals, or low impact journals, bringing out the true potential contribution of the paper more accurately. In this case, it is obvious that the paper by Robert has a potentially high quality than that of Ram's.

### CONCLUSION

In using the *r*-index method, neither the importance of IF, CI or the *h*-factor is underplayed, but a productive use of both is employed to identify the real worth of a scientific paper. Hence the use of *r*-index would provide a definitive edge for the evaluators/peers to judge the quality of a scientific paper (pertaining to any research area in any discipline, be it in Medicine, Physics, Chemistry etc.) even when they have an identical CI and *h*-index. The *r*-index can also be used to assess an individual's qualitative performance (not only the quantitative value) of the research publication based on his/her CI or

*h*-index, i.e., even if an individual has a high value of CI and *h*-index, it does not guarantee that the work has been qualitative, but if the *r*-index (either based on *h*-index or only the CI) is high, then it is certain that the research work has had qualitative potential so as to be in profound journals.

### ACKNOWLEDGMENTS

Thanks to Prof. B.N. Goswami for encouraging Interdisciplinary research at IITM and also to Dr. Anant Parekh for insightful discussions.

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**How to cite this article:** Rahul P. *r*-index: Quantifying the quality of an individual's scientific research output. J Sci Res 2013;2:80-2

**Source of Support:** Nil, **Conflict of Interest:** None declared