

Comparative evaluation of Indian physics research: impact factor vs citations frequency

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Decline of science in India

Our caretakers of science and several letters in this esteemed journal have warned politicians and planners from time to time that 'science in India is on decline', qualitatively and quantitatively. The present declining status of science in India is a result of a cumulative effect. Some of the factors responsible at the grass-roots level are:

- Proliferation of schools/colleges without sufficient teachers and proper laboratory facilities.
- Frequent changes of syllabi without having qualified teachers.
- Abolishing the basic courses of science subjects in the name of updating the course.
- Quota systems operating in school/college admissions, rather than merit.
- Starting of new departments like those of microbiology, biotechnology, etc.

without even basic facilities and subject faculties.

- Making Ph D an essential qualification for promotion, even for those who do not have the background/aptitude for research.
- Giving more weightage to extra-curricular activities over scientific achievements for promotion.
- Publishing fake data, due to lack of monitoring of such corrupt practices.
- Poor or at times absence of review and monitoring of research reports/achievements of a project.
- Delay in release of funds by implementing agencies.
- RAs, SRFs and JRFs getting their fellowship after a delay of 6–9 months.
- No job opportunities due to ban on fresh recruitments. In the absence of fresh recruitment, young researchers

frequently change their area of work.

- Appointing staff according to the funds available. No uniform payment structure for contract teachers.
- The '10 to 5' working hours; a typical office culture prevailing in many research institutions.

The present generation is facing a tough time surrounded by bewildered, myopic politicians, aspirant mediocre scientists and science managers. We will soon see the fruits of this gross negligence of science. Our Green Revolution is fading and the leadership has systematically destroyed the breeding ground of intellectuals. Decline of science is inevitable.

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Comparative evaluation of Indian physics research: impact factor vs citations frequency

The research evaluation based on journal impact factor (IF) is sometimes misleading and not really objective^{1,2}. This is more so because IF is a measure of the merit of the journal per se and not of its papers. Citation count is considered a more reliable indicator of a paper's worth³. In this short study, the Indian papers in physics have been examined for their impact on the professional community, measured on two performance indicators – journal IF and citation frequency – with a view to bring out the gap in the two evaluations, if any. The study is important because journal IF is increasingly being applied in India for deciding appointments to academic and research positions, assessment promotions and pruning nominations for research awards.

For this study, a sample set of 1101 research papers in physics, published by Indian authors in 1997, was collected from 29 high impact physics journals, having IF between 1 and 6.14. The bibliographic data of research papers as well as their citation data were taken from *Web of Science* for 1997. The citation data pertained to the period 1997 to July 2003.

Most of the 1101 papers considered in this sample were collaborative in nature, involving multi institutions both from India and abroad. Among these, 902 papers had institutional affiliation of the first author to India, implying thereby that such works were of Indian origin. In the remaining 199 papers, the institutional affiliation of the first author was to countries abroad but had Indian participation, implying that such works had originated in laboratories abroad. Since the purpose of this study is to examine the disparity in the impact of research of Indian origin under two different parameters, the data analysis was confined to 902 papers as these were considered as works mainly of Indian origin.

The journal IF data were collected from *Journal Citation Reports*, ISI, Philadelphia, USA for 1997. The average IF of 902 papers was 2.386. The high average journal impact suggests that the papers under study are works of some merit. These 902 papers had received 6235 citations in six years since their publication in 1997. The average citation per paper is 6.91.

There is a strong perception within the scientific community that papers published

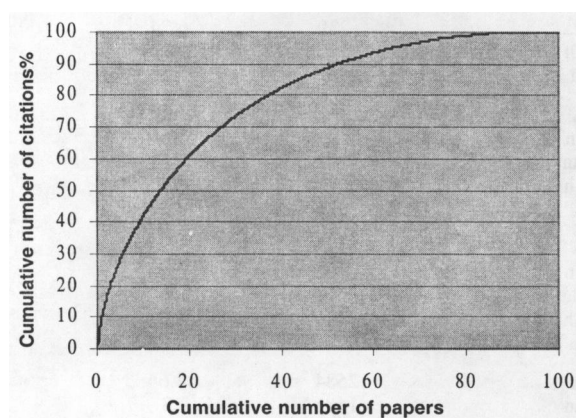
in high impact journals tend to receive high citation count and those reported in low impact journals would receive low citation. The two indicators of research evaluation are also considered as highly correlated, mainly because journal IF in any case, is derived from citation count.

However, the data in this study reveal a different picture. The majority of papers (57%), though reported in high impact journals (IF ~ 3 to 6.14) received, contrary to expectations, low citation counts (between 0 and 7 per paper). The average citation per paper in this sample is 7. Any paper receiving 7 or less is presumed as a low citation paper. However, 20% papers received high counts between 31 and 81 per paper, though published in relatively lower impact journals (IF ~ 1 to < 2).

Thirteen percent papers did not receive even a single citation in six years since their publication in 1997. 57% papers received citations between 1 and 7 per paper. As expected, only 29% papers received high citations between 8 and 81 per paper. Given the high IF of the journals reporting these papers (between 1 and 6.14) and their average IF (nearly 2.4), it is indeed surprising that 71% of these Indian papers

Table 1. Distribution of 902 papers by citation frequency and journal IF

Citation count per paper	Number of papers in IF range			Total count	Total%
	1 to < 2	2 to < 3	3 to < 6.14		
0	61	30	28	119	13.2
1–7	262	158	100	520	57.6
8–15	53	54	59	166	18.4
16–30	22	21	29	72	8.0
31–157	6	10	9	25	2.8
Total	404 (44.8%)	273 (30.3%)	225 (24.9%)	902	100

**Figure 1.** Distribution of citations to Indian papers published in physics during 1997.

in physics had received low citations, between 0 and 7 per paper.

These facts only seek to highlight the point that citations to a paper do not depend upon journal IF, although journal IF does depend upon citations. Certainly, journal IF cannot be taken as the only indicator for measuring the quality of a research paper. It is more so because acts of citation only seek to underscore the theoretical and practical significance of a paper, or its intrinsic value for future research⁴. Citation count probably sounds a more accurate and objective indicator of research quality. Statistically also, the Pearson correlation coefficient between journal IF and citation count computed on 902 records was low (0.21).

The pockets of excellence in research seem to be confined to a select few papers

and not to any larger set of papers. For example, only 10% papers accounted for 42% citations, 20% for 61% citations, 30% for 73% citations, and 50% for 89% citations (Figure 1). This observation further confirms the prevalence of a wide gap in research evaluation based on journal IF and citation frequency.

The study finds that there is wide disparity in the evaluation of research measured on journal IF and citation count. As expected, research papers published in high impact journals failed to receive proportionately high citation, in six years since their publication in 1997. This trend was applicable to the bulk of Indian physics output considered in this study. Majority of such papers had their citation frequency below the average citation count for the whole sample. Nearly 13% papers

did not receive even a single citation in six years since their publication.

The disparity is because citations do not depend upon journal IF, although journal impact does depend upon citations. Citations depend mainly on the theoretical and practical significance of the research reported in the paper. Citation count seems a more reliable indicator of a paper's worth than the journal IF. Evaluation based on journal IF can be sometimes misleading and hence not objective.

These findings are based on a study of 902 papers published in 1997 by Indian authors in 29 high IF physics journals. Though specific to the field of physics, these findings have serious implications on current research evaluation practices followed in the country. Besides judging the quality dimension of research output, citation count is also a useful indicator for identifying pockets of excellence in research. For example, in this study it is found that barely 10% of Indian physics papers had accounted for very high per cent of citations (42%). This has implications for rewarding merit.

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Science in India

According to an analysis by Arunachalam¹, India's rank in world output of scientific papers covered in the Science Citation Index (*SCI*) slid down from 8th in 1980 to 15th in 2000, with the number of papers indexed in *SCI* falling from

14,987 in 1980 to 12,127 in 2000. On the other hand, China and South Korea have shown considerable increase (e.g. 924 to 22,061 papers from 1980 to 2000 by China). Therefore, he concluded that scientific output, as reflected by number of papers

covered in *SCI*, has gone down or at the most stagnated. Some other authors^{2–4} have contested this view and have pointed out that the number of papers published alone cannot be used to measure the state of health of science. The cita-