India needs to strengthen quantitative studies of science

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India should learn from the West in giving more thought to studying the processes of knowledge production and utilization. In a field that can provide important data on graduate science education standards, brain drain and publishing trends, we have just started to scratch the surface.

A recent study conducted at the Institute for Scientifc Information, Philadelphia, has shown the dramatic rise in the influence of physics research done at Princeton University in the 1980s. The study looked at the citation impact of physics research papers published from five top-rated US universities, viz. Harvard, Princeton, Caltech, MIT and Cornell, during the period 1973–1988. The average number of citations won annually by Harvard University physics papers fell from a fabulous 2.36 in 1973–77 quinquennium to about 1.7 in the quinquennium 1984–88. During the same period Princeton's citation impact rose from a moderate 1.85 to about 2.3, thanks largely to the work of Edward Witten and the group known as the 'Princeton String Quartet' comprising J. A. Harvey, D. J. Gross, E. Martinec and R. Rohm on string theory, which is among the hottest areas of theoretical physics. In fact, physics papers published by Princeton physicists in the five years 1984–88 in 142 of the world's highest-impact physics journals such as *Physical Review Letters*, *Reviews of Modern Physics* and *Journal of Physics* (in many sections), were cited 131% more frequently than the average physics paper. To complete the story of the better-known US university physics departments, right now Caltech has a better citation impact than MIT and Cornell, but all the three are way below Princeton. And Cornell's citation impact has declined rapidly too.

In another study—never mind the controversy on methodology it gave rise to—John Irvine of the Science Policy Research Unit at Sussex and colleagues from several institutions on both sides of the Atlantic showed that in Margaret Thatcher's Great Britain science was on the decline and at a rate not too conducive to Britain's comfort. In fact, within months of the publication of the study, there was an exodus of the best of British university professors to the greener pastures of North America, not only in the sciences and engineering but also in economics and the social sciences.

There has been a growing interest in the advanced countries of the West in the past decade to develop quantitative techniques for the study of the processes of knowledge production and utilization. Tremendous strides have been made within the short span of ten years. These studies have developed in two independent but interrelated streams: one leading to the mapping of knowledge—constructing an atlas of science as it were, with the cognitive links between different emerging research fronts clearly delineated—based on concept-relating tools such as cocitation cluster and coword analyses; and the other providing the tools to evaluate the pace of the growth of knowledge, and its impact and influence on further production of knowledge as well as on factors outside of science *per se*, viz. profitability of corporations and economic development of nations.

Secondary to these mainstream concerns, we have also witnessed a growing interest in understanding the nature of the scientific enterprise in the less-developed as well as scientifically peripheral societies of the world.

Unfortunately, the scientific establishment in India came to realize the significance and need for such studies rather late. And it was left to a few individuals to carry out such studies as were possible with limited or no funds at all. Leaders of Indian science seem to be content with mere perceptions unsupported by quantitative evidence—something they dare not do in their own chosen fields of science. Let me illustrate with two statements I came across recently on the quality of India's scientific manpower. Both were made by eminent academicians and were made at important forums in all seriousness. In a talk on the issues and priorities in S&T planning, a leading Indian scientist drew attention to the fact that Indian students who fail to clear the GATE examination for admission to the masters programme in the Indian Institutes of Technology and the Indian Institute of Science do get admission in decent American universities. Unsupported by data, this statement does not say much. Is the standard of admission higher at IITs and IISc than in some of these US universities? Or is the GATE examination system defective? What is the percentage of students who fail at the GATE examination and still get admission in US (or other overseas) universities of standing? Another Indian researcher of standing, in an invited article on Indian science contributed to a special issue of *Daedalus*, feels that not more than 5% of scientists in Indian laboratories should have been admitted to graduate courses in the first place! While my own perception agrees with his, I wonder how he arrived at this number.

It is common knowledge that such quantitative studies owe a great deal to the pioneering efforts of the late Derek de Solla Price (of *Little Science, Big Science* and *Science Since Babylon* fame) and Eugene Garfield, the creator of *Science Citation Index*. Not so well known is the contribution made by the late Michael J. Moravcsik, a scholar-activist, who, despite his European–American background, had an exceptionally good understanding of the realities of the Third World. The US National Science Foundation and OECD, Paris, have a strong interest in the development and use of quantitative techniques and their use in science policy formulation. CNRS in France, the Royal Society, the Hungarian Academy of Sciences and the European Commission are among the several national and international organizations with strong groups in this area. The Ciba Foundation organized a major symposium on

evaluation of science in 1988. The Universities of Amsterdam and Leiden in the Netherlands also organized advanced-level workshops in the past two or three years. 4S—the Society for the Social Studies of Science—devotes more and more time to seminars on quantitative studies of science in its annual meetings. Ton Van Raan of Leiden edited the first handbook in this field and the essays he commissioned have set high standards.

In India the only institution devoted to such studies is NISTADS in New Delhi. NISTADS played host to the Commonwealth Workshop on 'Science and technology indicators for development' in 1985. Rajeshwari and colleagues of the Department of Science and Technology produce *R&D Statistics*, in some ways similar to NSF's *Science Indicators*. INSDOC (under CSIR) and ICMR have small groups devoted to bibliometric research but their impact is yet to be felt. My colleagues and I have looked at the citation impact of work done at three physics laboratories (NPL, IISc and Banaras Hindu University); the impact of Indian work in the fields of catalysis, superconductivity, holography and liquid crystals; and the links between work published in Indian journals and world science. The September 1989 issue of *Scientometrics* (of which I was guest editor) was entirely devoted to research papers from Indian authors working in india. On the whole we have just started to scratch the surface.

In a vast country with a fairly large investment in science, especially when the investment is going to be hiked from the current 1.1% of GNP to about 2.2% within the next five years or so, it will be unwise to decide on policy questions without carrying out adequate quantitative studies.

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