Abstract

Scientific activity is measured and evaluated through two categories of indicators: research inputs and research outputs. The complementarities and proportionality of these two measures are fairly obvious. Like all measures, these measures also have inherent limitations. These two categories of measures of 'science' are grouped under the rubric 'Scientometric' and 'Informetric' indicators (SII). Given the complementarities of the two measures, factoring input measures as well as output measures is expected to give a more balanced view of the measurement.

An attempt is made here to measure and evaluate the productivity and impact of Indian science publications published during 1993-2000 and citation analysis of 1993 and 1994 publications for the subsequent six years period using SII. The dataset is derived from Science Citation Index (SCI) database. The findings of our study is presented in terms of the following: Macro level analysis of publication counts in terms of growth and trend; Comparison of Indian science with other countries in terms of publication counts; Micro level analysis of the composition and constituents of Indian science factoring Indian science publications using the two variables: State and Discipline; Micro level analysis of Indian scientific publication in terms of institutional productivity and scientific collaboration; Citation analysis of Indian publications: Studying the impact of Indian publications (1993-94) for the subsequent six years time frame using diachronous counting method; Comparison of the publication patterns vis-à-vis referencing patterns. Referencing pattern is derived from synchronous counting method of references in the publications. For analysis and interpretation of the results apart from using ordinal metrics with ordinal scale, interval scale and classification, correspondence analysis which is a multivariate analysis is used. Correspondence analysis is carried out using Data and Text Mining software. Since the dataset is very large, the process is automated wherever possible. The dataset is mounted on a MySQL database as backend and PHP is used as front end. For retrieval of citing references terminal resident program, STAYKEY is used.
According to this study, there appears to be no fall in productivity in absolute terms, but the fall is in terms of India’s share in the world of science. A comparison of publication productivity of a few first, second and third world countries indicates that China and Brazil are the two countries with more than 100% increase in share. USA, Russia, Canada and India are the countries that have witnessed a negative growth in share. From a comparative study of GDP, publication productivity and journals included in JCR for a few selected First, Second and Third world countries it is noted that only in case of a few countries the journals covered in JCR published by a country and number of publications by a country has direct correlation and so also with GDP and publication productivity. This indicates that scientific productivity is a complex process and rise or decline in productivity depends on several factors such as socioeconomic development, science culture, educational system, political system and information infrastructure.

An analysis of Indian publications indicates that among the Indian States Maharashtra, West Bengal, Uttar Pradesh, New Delhi, Tamil Nadu and Karnataka have more than 10% contributions. Out of 22 subject categories, Chemistry and Physics are the two disciplines with more than 20% contribution and Clinical Medicine has more than 10% followed by Engineering, Biology & Biochemistry and Materials Science with more than 5% contribution.

Analysis of Indian institutional publications indicates that in all the disciplines, universities’ contribution is more. The institutional output is highly skewed, a few major institutions contributing a large percentage of the output. It may be said that the activities of these institutions constitute the core of Indian science. However, this analysis is based on journal publications as reported in SCI. Literature based indicators are appropriate only for institutional settings that reward publication and only for those activities that produce written knowledge. The fact that cultural and socioeconomic aspects, as well as cognitive determinants influence the role of written knowledge that varies between fields
of science and between different institutional settings, is considered their main theoretical constraint.

The ranking of top five institutes based on productivity and impact has minor variation. The top five institutions in terms of publication counts are Indian Institute of Science, Bhabha Atomic Research Centre, Mumbai, All India Institute of Medical Sciences, Banaras Hindu University and Tata Institute of Fundamental Research, Mumbai. The top five institutions which received maximum number of citations for the publications published during 1993-1994 for the subsequent six years period are: Indian Institute of Science, Tata Institute of Fundamental Research, Mumbai, Bhabha Atomic Research Centre, Mumbai, National Chemical Laboratory and Indian Institute of Technology, Mumbai. However, variation in ranking is seen when more number of institutions in different disciplines is taken into consideration.

International collaboration as indicated by multi-authored Indian publications have increased almost three fold from 1993 to 2000. The top five countries with which India is collaborating is: United States of America, Italy, Germany, France and England. Top five disciplines are Physics, Chemistry, Clinical Medicine, Astrophysics, and Engineering. According to multi-authored publications analysis, Chemistry, Physics and Clinical Medicine have more number of multi-authored publications. According to multi-institutional publications analysis, Physics, Chemistry, Clinical Medicine, Engineering, Biology & Biochemistry and Material Science have more number of multi-institutional publications.

Discipline wise ranking of the citation per paper for 1993 and 1994 publications to the total number of citations these publications attract for the subsequent six-year period indicates that Immunology and Astrophysics top the list. The top five source journals are Physical Review D, Physical Review Letters, Tetrahedron Letters, Physics Letters B, and Journal of Chemical Physics. Most of the top cited publications are multi-authored publications. This indicates that potential impact increases with more authors per paper
and more addresses. Increased potential impact is partly through greater international co-authorship, and also through indigenous papers.

There is a considerable difference in the rankings of journals based on journals used for publishing and journals used in references. It is observed that Indian scientists prefer to publish in domestic journals whereas they refer to foreign journals in their publications, indicating the difference in the reading and publishing patterns. The disciplines with more number of cited references are Astrophysics and Geosciences; and the disciplines with very less number of cited references are Social Sciences, Engineering and Material Science.

The study has shown several interesting patterns of Indian science publications. SII could be used successfully to measure and evaluate Indian science. This study is limited to the publications covered by SCI. Since publication is a multifaceted activity, many factors affect the publication process. Hence science evaluation based only on publication productivity reveals bibliometrically limited view of a complex reality. Therefore our measurements are to be balanced, developing and taking into consideration more variables. Measurement needs to be carried out based on comprehensive datasets and also more robust tools and methods. The focus of bibliometrics and bibliometricians aught to be on enhancing the quality of our datasets, adding value to datasets, databases, and metrics - there is a need to move from 'what of Science' to 'why of Science' studies - from descriptive SI studies to analytical SI studies - more sophisticated better honed metrics of science.