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David A. Pendlebury joined the Institute for Scientific Information (ISI), now Thomson Reuters, in 1983, after graduate studies in ancient history. He began as a translator and an indexer and later worked with ISI's founder Eugene Garfield on personal research projects. In 1987, Pendlebury developed the research section pages of the newspaper *The Scientist*. Two years later, he joined the company's Research Services Group, under Henry Small, now chief scientist at Thomson Reuters, to launch the newsletter *Science Watch*, now in its 20th year. With small and other departmental staff, Pendlebury designed and developed Thomson Reuters' *Essential Science Indicators*, now the primary database for quantitative analysis of performance and trends in global research.

Tell us something about the citation process and its importance in the world of research.

Citations in the literature reflect the influence of many types. At high frequency, citations are good indicators of utility, significance, even the notion of impact. The late sociologist of science, Robert Merton likened citations to repayments of intellectual debts. The normative process in science requires authors to acknowledge relevant previous contributions. On the one hand, citations provide a means to search the literature by helping a researcher navigate through a network of associated ideas both backward and forward in time. On the other hand, they may also serve as a record of

research influence and performance, as indicated by Merton's description of their function as devices of peer recognition.

How did the inventive idea about predicting the Nobel laureates come?

It actually originated with Eugene Garfield, the inventor of the *Science Citation Index*[®], now in web-form at the Thomson Reuters *Web of Science*[®]. Only a few years after producing the first *Science Citation Index*, Garfield, in 1965 published a study showing the correlation between high citation counts and Nobel Prize-winners. His published lists showed some highly cited scientists who had already won the Nobel Prize; after the publication of these lists, many other names of highly cited scientists he had identified went on to win the Nobel Prize. Correlation is not causation: high citation counts do not produce the prize. The prize results from research excellence as judged by the Nobel committees on the basis of nominations they receive. However, citations in quantity reflect peer judgements of the type considered by the Nobel committees.

What is the methodology adopted to select the Award recipients – Thomson Reuters Citation Laureates? Is it credible?

Our approach is quantitative in the first instance. In the fields recognized by the Nobel Prizes in the sciences – Physiology or Medicine, Physics, Chemistry, and Economics – we search the scholarly journal literature over the past two, three and even four decades. We pay particular attention to highly cited papers – those cited 1000 times or more (although different fields do exhibit different average rates of citation and older papers will have had more time to collect citations than younger papers).

We explore the publication and citation record of the authors of such papers using many measures. But the production of one or more highly cited studies is the most diagnostic for us. Of course, then we read those papers and attempt to understand the substance and consequence of the research. That often entails exploring the history of the field – to identify the true pioneers and not just

those who later built on the work of the pioneers.

This procedure aligns with choices of the Nobel Prize committees in identifying the key discoveries of the science they wish to honour. Finally, having narrowed the field in this manner, we look for other markers of peer esteem, such as appointments at a leading university, election to one of the national academies, and also receipt of other prestigious prizes. Having done this, each year we suggest three possible prizes for each of the four Nobel Prizes in science, and the researchers whom we identify with these discoveries are named Thomson Reuters Citation Laureates.

We judge these people to be of Nobel-class, peers of those who have won the Prize. I think it is a credible methodology to the Citation Laureates who have gone on to win the Nobel Prize, and there have been 26 of them involved with 14 Nobel awards since 2002. I think it is a logical and credible approach to forecasting future Nobel Prize winners, but many have their own views, of course.

Is the calculation of impact factor the ultimate index of scientific productivity?

No, certainly not. The impact factor is a measure of short-term average influence for journals. It should not be used as a proxy measure or weighing for individual papers or for people. Garfield has made this explicit over more than four decades and Thomson Reuters continues to say this. Sadly, this 'quick and dirty' technique of evaluation is widespread. It does not represent good practice in citation analysis for the purpose of research evaluation. You'll note that this method does not actually measure anything – that would be achieved by looking up the citations for a paper or to papers by an individual.

Sometimes scientists seem to be fascinated into choosing journals on the basis of impact factors? Don't you think that the papers should be published in journals where they are noticed?

Yes, an author should submit his/her research publications to the most appropriate venue in terms of scholarly focus and appropriate audience for his/her work.

Having said that, there is nothing wrong in trying to target the appropriate journal with the widest readership, which is often reflected in the rankings of the journal by the impact factor or other measures of weighted influence.

According to you, where does India stand on the world map of scientific research? And what are India's research strengths?

Much improved and growing faster than other nations, but not as fast as China. Moreover, our measures of research impact for India are turning up. In broad terms, the physical sciences represent India's strongest areas, both in terms of the world share and in terms of citations per paper relative to world averages. Of course, as one drills down into the data, all sorts of different views emerge, including excellence in some areas of the biomedical sciences. Therefore, it is

always difficult to make blanket statements about a nation's research and its performance. In December 2011, Evidence, a Thomson Reuters business headed by director Jonathan Adams, prepared a report on Indian science covering the last three decades for the Department of Science and Technology (DST), Government of India. This report was recently made public and is available on the DST website. The report will repay readers in providing multiple perspectives on the landscape of Indian scientific research today (http://www.dst.gov.in/whats_new/whats_new12/report.pdf).

Any suggestions for young researchers in India?

Do not be diverted from your focus on research by chasing after this or that measure – even if you are being subjected to bad practice in research evaluation using single measures such as the

h-index or cumulative impact factor scoring. Instead, argue against such evaluations, as Thomson Reuters does. Citation scores should not be one's goal – the goal should be excellence in research, from which citations naturally flow – and perhaps Nobel Prizes! In short, don't put the cart before the horse, and if someone tries to do this, correct them.

What do you foresee as the future direction?

I see a future beyond mere rankings of performance built around one or a few measures. The next step should be for us to exploit technology currently available to put the data in a coherent context in order to reveal more about the substance of the research itself and its impact globally.

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