

Is Indian science too theoretical?

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Disclaimer: I have nothing against theoretical science or scientists and my own research uses theoretical, computational and modelling aspects extensively, almost always to enhance our understanding of the problems we study with home-built experimental facilities. I respect and admire all the theoretical scientists mentioned without naming them here and their contributions to science. Here the word ‘theoretical’ is used with the broadest sense, including ‘science of no practical use’ and I also discuss the ‘lack of adequate experimentalists building indigenous experimental facilities’.

When I was a Ph D student at the Kansas State University, Robert Hammaker who was teaching a course on group theory used to start his course with a statement, ‘Theory guides, experiment decides’. The current and past leaders of India seem to have ensured that we will not have any decisive leaders in Indian science. Experimental science has not been encouraged adequately. An emphasis on quantity rather than either quality or the nature of work has seen to it that people who publish more have been encouraged and rewarded. I have pointed this out earlier in this journal^{1,2}.

Recently, following the initial invitation to Gautam Desiraju, four of us wrote an essay about Indian chemistry in *Angewandte Chemie, International Edition*³. This essay came out in a special Jubilee issue of *Angewandte Chemie* in January 2013. Another author in this issue was the eminent experimental physical chemist, by now well known to the readers of this journal, Richard Zare from Stanford university. He had written about the status of university education in USA⁴, and these two articles, by some coincidence appeared back to back. Our essay had a graph showing that the number of papers in chemistry published from India is growing and we are now fifth among all the nations, recently overtaking the UK. We were well aware that the numbers alone do not mean much, but it was a feel-good thing to point out in an essay on Indian chemistry. On reading our essay, Zare responded: ‘Is world research output measured

simply by number of papers? I believe that the papers from the UK are more influential in chemistry. The increase in number from India is more symptomatic of writing too many “me-too” papers. *I also sense a distortion in Indian chemistry toward theory over experiment, which was hardly touched upon.*’ I could not agree more. However, for India it is also important to increase the numbers, not necessarily at the cost of quality. India should find ways to support those who publish more and simultaneously support those who are willing to work on challenging problems.

Another renowned experimental physical chemist came to India the following month as part of the Royal Society road show. He had visited a sister institution in Bangalore, well funded in India, and was quite impressed with the facilities available. On a private conversation, he mentioned to me, ‘but everything there was commercial equipments, imported’. Fortunately, on that busy day, I could show him around our laboratories with home-built equipments^{5,6}. He had come here after visiting the Indian Association for the Cultivation of Science, Kolkata and was on his way to the Tata Institute of Fundamental Research (TIFR) and Indian Institute of Technology, Mumbai, and he had seen laboratories doing experimental physical chemistry in India with home-built facilities. Our academies would not know many of them as they appear keen on ensuring that the average *h*-index of their fellows is high. Bruce Alberts⁷ has pointed out the danger of using such numerical indices in evaluating individual scientists. The application for the coveted Swarnajayanthi fellowship given by the Department of Science and Technology (DST), New Delhi asks the candidates to list the names of the journals in which they have published along with their impact factors; its impact factor, a practice specifically detested by Alberts.

Just last month, I had an opportunity to meet A. V. Rama Rao, whose Avra Laboratories is a rare success story in Indian chemical industry and it has started a foundation to support Indian science⁸. During our conversation, Rama Rao

mentioned that as the Director of the Indian Institute of Chemical Technology (IICT), he did not allow any of his scientists to submit a research project to DST. The mandate of IICT was to solve problems of interest to chemical industries in India. The Council of Science and Industrial Research (CSIR) had founded many such institutes or laboratories all over India to help the Indian industries and also provide technical solutions for India. Another laboratory established with a focus on chemical industry is the National Chemical Laboratory, currently headed by an eminent theoretical chemist. Perhaps, this sums up the skewed priority our science leaders have had in the past. Now CSIR, Defence Research and Development Organisation (DRDO) and Indian Space Research Organisation (ISRO) all have their own institutes and academies, to offer degrees and perhaps publish more papers and one hopes they will not add to the ‘me-too’ papers pointed out by Zare and also by Alberts⁷. Are we rewriting the mandates of these institutions as we cannot find scientists to carry out the original mandates? Or have we been systematically ensuring that we do not produce scientists to carry out such mandates?

The committees involved in choosing scientists for awards and fellowships in India have to do a difficult, often perceived, task of balancing different subjects (for example, physical, inorganic and organic in chemistry) and regions (north, south, east and west), institutes of national eminence and the neglected universities, etc. Often they have to put up with uncharitable remarks as ‘committees without credibility’ even by persons who have enjoyed all the awards and fellowships in the past. Recently, one such committee decided to give the only two awards available in chemistry to two theoretical chemists, both from the south. That the committee did this shows the conviction they had. Both awardees were of course well qualified based on their credentials. It also shows that theoretical chemistry has been encouraged and is flourishing in our country. The current and past Chairman of the Programme Advisory Committee in Physical

Chemistry chosen by DST are both accomplished theoreticians. TIFR has historically been a place where difficult experiments could be carried out as it is internally funded, which reduces the burden of showing some output in a typical project duration of 3 years. Often building your own experimental facilities could take longer and without output (read publications) your chances of getting the next project are dim. Moreover, TIFR has remained a research institution even after IISc and ISRO have started UG programmes.

A typical western University having 20 faculty members in a department is likely to have one or two theoreticians. In India, one can see this number to be about 5. This may not be unique to India and the funding situation may force most nations to do the same. As Freeman Dyson⁹ pointed out brutally one of the reasons we have more string theorists is 'Because string theory is cheap. If you are the chairperson of a physics department in a remote place without much money, you cannot afford to build a modern laboratory to do experimental physics, but you can afford to hire a couple of string theorists.' The pity in India today is that, even when the funding situation is getting better, we have not produced and encouraged enough experimentalists who are willing to do experimental physics/physical chemistry with indigenous facilities.

Experimental groups in India, trying hard to build their own facilities work in a not-so-friendly environment. One cannot find fault with the accountants and auditors for raising objections. Auditors have gone through a rigorous training and have learned one thing well. When $n_1 > n_2$, both n_1 and n_2 being integers numerically equivalent to the local or

foreign currency, n_2 is better than n_1 . One cannot fault them for their acquired knowledge and wisdom. This is why academic institutions are led not by auditors and accountants, but by academicians. When these academic leaders do not appreciate the difficulties involved, they can only be expected to pass on the audit objections back to the faculty members and not find ways to help researchers. They are unlikely to be sympathetic to the struggle of those who develop indigenous facilities, occasionally publishing in low impact journals, with an impact factor less than 5. This number has been specifically quoted by Alberts in his commentary⁷: 'And in some nations publication in a journal with an impact factor below 5.0 is officially of zero value.' While I can hope this is not true for India, the fact that the recent Swarnajayanthi fellowship application asks explicitly for the impact factor suggests that my hope is against what is printed and practised.

Often there is a perception which has been perpetuated by the self-serving few, that India is known for scholars (loosely translated to software) and not for skilled workers (loosely translated to hardware) and that is why we have succeeded in the IT industry but do not produce/manufacture anything. This is wrong on two counts. Our IT industry has largely been responsible for the economic boom we have had. However, the hard fact is that our IT industry is more of a service industry and has produced little intellectual output that can do us proud. India has built temples (Thanjavur) and cities (Madurai) which remain examples of marvellous design and execution to this study, several millennia later. Taj Mahal was built in India nearly two centuries before the USA got independence.

Clearly, we had talent in every field and it was not limited to philosophy. If we do not appear to have talent in every field today, it can only point out the skewed priorities we as a nation/society have had in the recent past. At the cost of repetition, I must quote John W. Gardner again as I did in my earlier commentary²: 'The society which scorns excellence in plumbing as a humble activity and tolerates shoddiness in philosophy because it is an exalted activity will have neither good plumbing nor good philosophy: neither its pipes nor its theories will hold water.'

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