

Improving the STI landscape through an augmented and revitalized postdoctoral fellowship programme

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In the emerging knowledge driven world, India will require individuals with sufficient skills, professional agility, and technical acumen to serve as its development engines for science and societal well-being. This contribution intends to begin a discussion about contemporary post-doctoral research programmes, the possibility of establishing a national cadre for a planned and careful intake of quality students, as well as broad basing their training. Synergies in sciences for resource optimization and, accountabilities in the science, as also in its administration including finance, will be critical to Indian science.

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WILLIAM H. Press, in a thought-provoking article¹, talked about Solov's residual which suggests that the economy of any nation is determined by two kinds of resources – finite and infinite. Finite resources include land, labour and natural wealth, which can only be optimized and realized up to a point. The infinite resources accrue through knowledge-based technology development, which provides positive feedback for exponential growth. Press refers to the number of scientists and engineers per million people and investment in research and development (R&D) as a percentage of GDP, being key to knowledge generation and thereby national prosperity.

Currently, India has about 250 scientists and engineers (STP – science and technology personnel)/million. By contrast, more innovative and technology-generating countries like the US, Finland and Germany have 3000–7000 STP/million. Even a small country like Israel has close to 2000 STP/million and it spends around 4.5% of its GDP on R&D. It is therefore no wonder that Israel is a net exporter of technology – be it water resources utilization for agriculture or electronics, armaments and medicines. The GDP outlay for R&D spending in high technology-generating nations is in the range 3–4.5% compared to India, where it is around 0.6–0.7%. Therefore, in the context of national aspiration for self-sufficiency, both the human and financial resources need judicious augmentation by almost an order of magnitude. This has been repeatedly highlighted by a large number of experts and is worthy of repeated reiterations².

A recent report suggested that India produces more than 15,000 Ph.D.s in science annually. However, its capa-

city to retain them in active academia with reasonable jobs and adequate funding for research is less than few per cent. This is despite multitude of institutions in both public and private sectors which are coming up. Such a poor absorption rate indicates a colossal waste of national effort and resources in developing thousands of Ph.D.s, whose talents cannot be used owing to a lack of acceptable routes and the quality of their training. As of now, there is no obvious and substantive mechanism or plan that can help improve the number of STPs/million without creating a deluge of people with degrees, but without commensurate skills.

Agashe *et al.*³ discuss the aspirations and plight of young early-career researchers, who are in academia and are keen to carry out cutting-edge research. The message of this article adds to the nation's concerns about its future health in the knowledge space, especially when it aspires to be a global leader. Is it not worrisome that such an article had to be written in the first place? The inferences of this article would have created more worries had the survey included the trials and tribulations of researchers in state universities/private institutions, and then scaled them in proportion (to the number of scientists in state universities and the institutions of lesser eminence) to the total scientific pool. These researchers are paid sub-optimally and have limited opportunity of exploring science and perpetually get exploited without reason. Many of them are indeed talented, but they are unable to express themselves because they are unable to find an outlet for their abilities. McDowell *et al.*⁴ discuss in detail the aspiration of younger scientists – being the engines of research. Several contributions have articulated similar concerns in India and elsewhere^{5–10}.

Meagre data that are available suggest gross mismatches between supply and demand for research scientists in all disciplines. This highlights the absence of any realistic

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long-term planning with a national vision. There is no denying that the national talent pool for science must be expanded within the contours defined by scarce resources. We need a constant supply of innovating minds, but with a caveat that we guard against mushrooming of Ph.D.s without requisite merit. There is a need to dispassionately evaluate the economics of our postdoctoral programmes, -of demand, -of supply and -of quality.

Limited avenues, as at present, imply that several bright young minds (who would have otherwise contributed to knowledge and technology generation) stand compromised and the country loses out on its potential riches. More damaging is that this talent pool of young minds finds itself demoralized and demotivated, and at times takes to methods, including unethical, to somehow qualify for jobs and other academic openings. It may perhaps be sensible to judiciously reduce the intake of doctoral students, so that frustration of seeing 5–7 years of sleepless nights of their most productive years leading to unemployment is avoided, and that they have more time to explore alternative avenues, beginning at an early age. It is equally necessary that those selected get an enabling ecosystem to perform optimally. To assure a continuous supply of well-skilled workforce, significant planning and dynamic and self-calibrating mechanisms based on robust data must be developed.

That said, it is heartening to note that senior scientists of the country are seized of this matter and this offers hope³. Anticipating an affirmative action, a few suggestions are made here with a conviction that a strong post-doctoral/early career researchers programme is cardinal to improving India's position in the knowledge/technology/innovation space (and thence towards self-reliance). To begin with, a minimum, fivefold increase in STP/million is needed to create critical volumes of skills in each area of development. Although the suggestions that follow may already be known, the fact that India still does not count in the global knowledge and innovation space, reiteration of a possible framework comprising a few simple steps within the confines of limited financial resources and rigid administrative procedures, may be timely.

At a minimum of 1000 STP/million, India needs over a million skilled STP to serve its 1.5+ billion population. And, all those in this million will have to be gainfully employed in a meaningful scientific activity. For this, it is necessary to ensure that a larger number remains active in science to provide the critical mass to deliver new science. Current reliance on a couple of thousands in faculty positions in institutions of eminence to deliver, is misplaced due to their small numbers. The entire ecosystem, the universities and the institutions which provide this manpower will have to change. The success of India's space programme can be attributed to the achievement and empowerment of a local-scale criticality in volume of skills. This model should be followed in a variety of different disciplines.

Suggestions

Given that no proper scientific study can be conducted and published in two years, it is very intriguing that in general Indian postdoctoral programmes are just two years long. This is particularly too short for field and laboratory-based work, especially in the areas of natural and geosciences. Added delays due to financial and administrative procedures coerce postdoctoral fellows (PDFs), to take up programmes that are built on incremental, rapid-fire data gathering in well-established research areas, where the concepts are fairly well established by the group leader(s). The present two-year postdoctoral programmes are therefore self-defeating, as by definition they compromise on the very purpose of the postdoctoral tenure, being a period of growth of a young Ph.D. graduate – a bubbling youth with motivation, enthusiasm, skills and the confidence of exploring uncharted horizons to mature as an independent scientist. In the Western world, post-doctoral students are treated with respect and at par with a young faculty. They are provided the freedom and encouragement to develop independent and new lines of research. The supervisor plays only the role of a mentor and facilitator. Numerous deserving PDFs do get full support for up to 7–8 years, by which time they can perform good work with results of fundamental importance. The Indian system should offer such possibilities and have requisite flexibility for its bright PDFs.

There is also the need of flexibility in recruitment age of scientists and academicians. If merit exists, rules must permit recruitment, including enrolment in a Ph.D. programme, at any age. Of course, any such effort will succeed only if there is honesty, transparency and a sense of purpose in the entire process. It is annoying to see that a year can be spent in hiring a PDF for two years – largely because of administrative trivia and to ensure equal opportunity to all. We rarely realize that such response times compromise on the contemporaneity of the proposed science and takes a year off from a younger colleague's career. That said, a flexibility in choice, as happens in the West, would call for a responsible academia.

A change in the mindset towards PDFs is called for. They are not cheap labour, but professionally skilled assets, competent colleagues and potential future faculty members, with proven competence and track record. A debate is on in advanced countries on the tenure of postdocs and the fate of perma-docs. Still, it is possible that a bright PDF is supported beyond five years. After this long post-doctoral tenure, PDFs feel qualified for a faculty position. And then, the PDF as faculty gets another five years of support during his tenure track, before confirmation. We perhaps appoint our faculty members rather too soon and perhaps do so, on compassionate grounds, as there are no alternatives on the table. This must change.

The INSPIRE programme of the Department of Science and Technology (DST) has been a step in the right direction

with an assured five-year support, but has been largely focused on absorption of selected candidates as faculty members in some institutions, and to a lesser extent towards building a sustained and innovative scientific activity and a skilled scientific cadre. Also, the intake has been too limited to be of any substantive impact at the national level. It currently operates at 50% with respect to what was originally envisaged. The scope of the INSPIRE Faculty Programme needs to be expanded with an added focus towards creating a National Science Cadre with a mechanism to extend continued support to competent post-docs to do science and improve their career. And, from these, some could be picked up for faculty positions. Such a scheme was in place in the University Grants Commission under its Research Professors scheme.

There is a need to empower our younger colleagues with space for intellectual play, and their minds should be freed from worry of unemployment. They should have assured sustenance so that they retain their excitement and aspirations for new ideas. Only after an extended and demonstrated performance, one should get mature enough to be on faculty. The foregoing outlines the advantage of extended postdoctoral fellowships. It is noteworthy that in recent years the INSPIRE selection had 65–75% candidates with postdoctoral experience at the international level. This will change if Indian PDFs also have the same facility of an extended tenure and a suitable ecosystem.

It is worrisome that post-COVID, many of the existing postdoctoral programmes have been on hold, delayed or curtailed, sending a wrong signal that there are limited/no avenues for many of the fresh Ph.Ds. Such a situation will discourage students from opting for Ph.D. programmes and therefore, it is likely that in a few years from now, we will find ourselves compromising on the standards due to a limited supply from a truncated catchment.

Some trivial issues that distract young minds often is the compensation for inflation and stagnant fellowship amount. And, every few years when they feel the pinch of inflation, a lot of effort is expended in writing letters of protests and thereafter committees meet multiple times and eventually a delayed increase occurs. It will make sense to link the fellowship to an inflation index, so that like Government employees, student and postdoctoral fellowships get an automatic increase such that their creative time is not distracted by trivia.

Currently, far too many postdoctoral schemes exist under many agencies. These make the system unwieldy in terms of deployment and management, as well as keeping track of redundancies, duplication and potential compromises on ethics. It is better that a single national postdoctoral-Early Career Research (ECR) cadre (with levels a, b, c) is implemented effectively (e.g. N-PDF), wherein after an assessment through multiple interviews (for objectivity transparency and fairness), one becomes eligible for a five-year grant, at a place of her/his choice and with approval by the host, and that this grant is delivered in real

time. The success of the Indian National Science Academy with the INSPIRE programme suggests that the science academies can provide a robust and fair mechanism to implement such an initiative.

As much as there is scientific audit of the work done by a PDF and Intellectual Property Rights (IPR) created by him/her, a system for audit of administrative efficiency and finance disbursement is called for. This will examine the timeliness of grant administration, approvals and disbursement of funds. It must be recognized that finance and administrative services are created for science, and the existing practise of scientists pursuing the contours of administrative and financial procedures just undermines the core goal of nurturing science. The current milieu of scientists spending much of their time on issues other than their science leads compromises on the basic objective of enhancing scientific enterprise in the country. Administration and finance are created to serve the cause of science and not to impede its development. The only golden rule should be to facilitate good science. All other rules must follow this rule.

Having worked in a model scientific institution created by Vikram Sarabhai, where everyone willingly assisted our work, I feel appalled to see the difficulties faced by the present youth – from multiplicity of approvals needed by them. Most of their creative time is expended in waiting and worrying about these approvals than for actual science and in the end, we create bonsai scientists denudded of their creative faculty and confidence of independent work and waiting endlessly for a financial or tour approval. Stories on grants not being implemented by the universities due to administrative trivia for years on end compromise the spirit of these schemes. There is need to mandate universities to hosting ECRs and provide performance credits for enabling such research fellows. Universities and institutions must appreciate that good science results will bring to them added glory and global goodwill.

To support 1000 PDFs @ Rs 100,000/month and Rs 50 lakhs research grant, we need a budget outlay of about Rs 120 crores annually, which compared to the size of India is reasonable given that such an outlay holds the potential to change the landscape of research in the country. Everyone in the gamut of administering science would do well to read two books, viz. *The Usefulness of Useless Knowledge* by Flexner¹¹ and *Science: The Endless Frontier* by Bush¹². Discussions and concrete actions at various levels are needed.

A significant part of this resource could be generated through prohibiting the use of public funds for the payment of publication/open-access charges in fancy journals and by according formal recognition to publications in journals from Indian academies, in all academic review processes. Developing a national programme will also eliminate duplication of effort and hence save money on manpower and resources to conduct these activities. Why should each Government department run a postdoctoral or similar programme?

Special tax rebate for Corporate Social Responsibility (CSR) contribution to the development of this cadre, will attract more funds. The national cadre approach will also save money by reducing the number of instruments and pooling resources, while simultaneously ensuring the desired quality for faculty in all institutions.

For the young academics also, there is a need for a change in the mindset from the ownership of instruments to leadership in science. The current trend of seeking credits in the purchase and setting up of commercial instruments must give way to new developments in-house. Never ever, have new concepts evolved through commercial systems. Any instrument not used effectively on 24 × 7 basis should attract a serious scientific scrutiny and this fact be used as a determinant in future funding to that institution/individual. Synergies in experimental programmes and shared resource will bring in considerable savings, and improve interaction and communication between scientists.

At the end of five years, a new cadre of Research Professors may be considered wherein based on performance and science plans, active researchers get support on a continuing basis. The grant should include a salary, something that is not possible at present. In the US, many of the Research Professors have been doing excellent work and are regularly invited for plenary lectures. In fact, it is likely that in the years to come, many may eventually prefer to use such an engagement, to gain freedom from other duties of a regular faculty position.

Eventually there could be a National Cadre for Education and Research, on the lines of IAS or IFS, but this will need another discussion. It is essential that all appointments in all institutions and universities are based strictly on merit and that, there is no room for any extraneous considerations in such appointments.

Our fixation with age limits for research must end so that we do not lose brilliant minds whose education may have been delayed for reasons other than academic merit.

At the Ph.D. level, there is a need to expose students to various aspects of scientific research. These should include training in management of science, issues of policy, finance and economics, history of science, instrumentation and coding, so that they are equipped with various other possibilities and may be able to identify alternatives at a young age. In the US, an initiative of Integrative Graduate Education and Research Traineeship is being run by the National Science Foundation, which promotes multidisciplinary Ph.D.s.

In summary, it is my firm conviction that the future of India will not be served by few centres of excellence/eminence carrying out good work on account of abundant facilities. Our need to become a scientifically advanced nation will only be served when the entire ecosystem for research, from a college to the state university to an institution of eminence, changes. The baseline of education

must evolve via competency in teaching and collaboration in research for those at smaller universities, bringing everyone at the cutting edge.

The level of science funding in the universities needs to increase substantively, as it is only when first-rate science research is carried out in university departments, that teaching will be of a higher level, so that the enthusiasm of science will rub on a larger set of young minds. We need to think of the scale we want to work with and the scale of skills that India would need to cope with the technological and scientific advances, let alone develop some of its own.

Finally, I reckon that we need to treat young scientists as drops of water on a leaf. And, it is up to us to provide an ecosystem that permits them to shine like a pearl, or be lost in the vastness of an ocean of mediocrity or simply evaporate into thin air. The choice is ours and the time is limited.

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