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EDITORIAL

Should We Produce More Ph Ds?

A doctorate, a Ph D degree, confers on its recipients an aura of academic accomplishment that is prized. Honorary doctorates are sought after by men and women in public life; at times, leading to unseemly controversies at the annual convocations of our universities. Ph D degrees are generally acquired after several years of research, whose outcome is documented in a thesis or dissertation; often a document of considerable size. Students, who choose to plunge on towards a Ph D after graduation from college, face a long haul, which requires commitment, concentration and resilience. Research can, at times, be slow, unpredictable and frustrating, requiring students to deal with long periods when no fruitful results appear forthcoming. Ph D research also ties students to supervisors ('guides' is a term favoured in India), whose temperaments and commitment to the task at hand can be widely variable. In large research groups or in surroundings where an academic ambience is fostered, as in many research universities, Ph D students often learn more from their peer groups than from their faculty advisors. The student–supervisor relationship can be delicate; easily shattered when personal differences arise. In the best of cases, students bond to supervisors in a manner that can be heartwarming; there is indeed one debt that can never truly be repaid – the intellectual debt that students forever owe their teachers. In retrospect, most middle aged and aging academics look back on their Ph D days, with a degree of wistfulness; a period when youthful enthusiasm infected everyday research. For experimentalists 'working at the bench', directly observing the unexpected is a pleasure that can rarely be experienced, with advancing age and extraneous responsibility. For the theoreticians there is undeniable satisfaction when a calculation yields a result that provides a new insight into a nagging and recalcitrant problem. Ph D students often lead a life that is almost completely tied to their laboratories. Time can pass almost unnoticed as the years tick by.

In Indian institutions, Ph D students are the foot soldiers of research. Post-doctoral fellows and technicians are relatively rare; a marked contrast to Western laboratories. Graduate students (and post-doctoral fellows) in US laboratories have often been viewed as cheap labour, advancing research agendas of professors who run very large groups, with little time for individual mentoring. The period of a Ph D degree can stretch to several years. European and British Ph D degrees are somewhat less time consuming than American degrees. In our own institutions national scholarships can run up to five years, but the time taken for a Ph D degree is even longer in many institutions. As the head of an institution which has on its rolls the largest number of science and engineering Ph D students on a single campus in India, my attention has been repeatedly, and sometimes forcefully, drawn to the excessive lengths of time that appear to be needed to complete a doctoral degree. A mean time of about six years seems to be a somewhat uncomfortable norm. Even while being asked to reduce the time taken for the award of the Ph D degree, the institution has been repeatedly exhorted to increase the number of Ph Ds produced annually. In an environment where there is a growing reliance on quantitative metrics for assessing science, the number of Ph Ds produced appears to be gaining ground as a measure of national scientific activity. An article entitled 'The Ph D Factory' noted that 'the world is producing more Ph Ds than ever before. Is it time to stop?' (*Nature*, 2011, **472**, 276). The growing cry for 'more Ph Ds' is based on the unstated, and possibly unfounded, presumption that employment opportunities readily beckon the newly minted doctorates. In most discussions of institutional performance, I have usually played the role of the defendant in the dock, responsible not only for the inordinate length of time required to obtain a Ph D degree, but also for the less than satisfactory number of Ph Ds produced. In an arena where strong personal opinions and prejudices far outnumber hard facts, I have always found it difficult to counter the 'shorter Ph Ds, more Ph Ds' argument, with statistics to bolster my defence. Suggesting that the problem of Ph D timescales may be harder to solve than commonly imagined, appears to be an admission of both incompetence and ineffectiveness. Are there facts available which might help to provide some insights into the problems of doctoral education? Mark Twain famously remarked: 'Let us first collect the facts; then proceed to distort them'. I was therefore hugely encouraged when I chanced upon a marvellously compiled 'Survey of Earned Doctorates' produced by the National Science Foundation (NSF) of the United States. The prefix 'earned' is intriguing, suggestive of the fact that there might be a fair number of 'unearned doctorates'.

The NSF report on Science and Engineering Indicators 2012 is a treasure trove for analysts of science and technology. The chapter on doctoral education is replete with statistics, carefully collated and presented. The US research university system has been the gold standard in higher education for over half a century; the envy of other nations attempting to race along the path of development. There may be hidden in this mass of data, valuable lessons that might be learnt by other countries aiming to build an ecosystem of productive research universities. The growth of academia in the United States is clearly reflected in the rise in the number of doctorates from 8611 in 1957 to 49,010 in 2011. Inspection of the numbers over this period reveals two spurts of growth. The first occurred in the decade between 1960 and 1970 fuelled by the post-Sputnik thrust in American science and technology. The second, somewhat less dramatic surge is observed between 1988 and 1994, presumably a consequence of the electronic and biological revolutions. Is the United States producing too many Ph Ds? A recent report at the February meeting of the American Academy of Arts and Sciences (AAAS) appears to suggest that the job market for Ph Ds is poor, with the post-doctoral position becoming an increasingly uncertain road, which does not always lead to a suitable job in academia or industry. Six broad areas in which doctorates are awarded are identified (figures for 2011 in parentheses): Life Sciences (11,467), Physical Sciences (8678), Social Sciences (8120), Engineering (8004), Humanities (5214) and Education (4691). The top 50 institutions ranked by the number of Ph Ds produced are listed. The University of California at Berkeley (878), University of Michigan (767), University of Florida (762) and University of Illinois – Urbana-Champaign (750) lead the pack. Stanford (703), MIT (609) and Harvard (573) come in at positions 8, 14 and 16, respectively. Some feeling for the scale of the academic enterprise in large universities can be obtained from the figures for a single institution, the University of California's Berkeley campus. The 2011 figures for the Ph Ds produced are: Life Sciences 166, Physical Sciences 177, Social Sciences 161, Engineering 173, Humanities 128. The emphasis on research in the area of education is striking, with as many as 151 Ph Ds graduating from the Teachers College of Columbia University in 2011.

Foreign students constitute a considerable presence on US campuses, entering the country on temporary visas but often staying on after graduation. Of the 49,010 Ph Ds awarded in 2011, 14,245 recipients were foreign nationals on temporary visas. Of these, China accounted for 3978, India contributed 2161, South Korea's score was 1442, while Taiwan completed the top four with 693. South Asia watchers (and hopefully there may be some with a South Asian University coming up in Delhi) might be intrigued by the fact that Pakistan, Sri Lanka and Bangladesh contributed 91, 88 and 77 Ph Ds to the US figures. The diversity and number of foreign students is an enormous source of strength to US science, with as many as 40 countries contributing at least 50 degrees to the list of 2011 doctorates. Foreign students overwhelmingly receive their degrees in science and engineering. Amongst Indian students, 2033 received Ph Ds in science/engineering in 2011, whereas only 128 graduated in other disciplines. For China the corresponding figures are 3640 and 338. The NSF survey goes on to poll the foreign students regarding their future intentions. For the period 2005–11, 86.4% of Chinese and Indian students indicated a desire to stay on in the US; the highest amongst all the countries from which students were drawn. The figures for Japan 50.4%, UK 62.8%, Brazil 45.3% and Taiwan 57.2% are revealing; China the emerging (or emerged) superpower and India (a country actively wooing expatriates) do not seem attractive destinations for recently graduated US Ph Ds. Only two countries outranked India and China in this dismal statistic; Iran at 89% and Nepal at 86.7%, albeit with a very much smaller sample size. The gender ratios (M/F) for Ph D recipients in 2011, across the fields are: Life Sciences 45.2/54.7, Physical Sciences 71.4/28.6, Social Sciences 40.5/59.5, Engineering 77.2/22.2, Education 30.6/69.3 and Humanities 48.5/51.5. In patiently ploughing through systematically organized data tables in the NSF report, I finally found the numbers I was looking for – the average time taken for acquiring Ph D degrees and the age of the recipients. Across the fields, the median time to a doctorate is 7.7 years from the start of graduate school, while the median age at the time of the Ph D award is 32 years. The shortest median times are in the physical sciences, engineering and life sciences (6.7–6.9 years), while the humanities and education degrees appear to take substantially longer (9.3–11.7 years). Clearly very short Ph Ds, four years or less, may be the outliers.

Indian policy makers are now engaged in developing strategies to dramatically enhance the number of Ph Ds produced in India (20,000 annually is a number often heard as a target) and in boosting the quality and quantity of scientific output, largely measured by the number and presumed impact of research publications. Maximising quality and quantity of the Ph Ds and papers produced is hardly likely to be an easy task. It may be necessary to survey the employment opportunities for Ph Ds in our academic institutions and industry. Despite loud protestations about the shortage of faculty, recruitment is severely constrained by a multitude of factors. State government institutions are beset with difficulties in recruitment, while central institutions rarely find many of the Ph Ds graduating from our vast university system suitable for appointment. Industry is rarely seen as a significant employer of Ph Ds. Maybe the cry for more Ph Ds must be muted, while facts are gathered and interpreted.

P. Balaram