2. RESEARCH PROMOTION IN OUR TECHNICAL INSTITUTIONS

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Summary

This paper discusses the nature and scope of the paucity of research culture in our technical institutions. Some suggestions are advanced to remedy this situation.. Some of the important considerations for graduate students and researchers to take into account during their professional careers are highlighted.

1. Introduction

Over the past few decades, technical education in India has witnessed massive growth in terms of number of institutions (3241 engineering colleges, currently) and admission capacity (1,324,246). However, informed academics are deeply concerned about the poor quality of education dispensed by the great majority of technical institutions. This growing concern has been amplified by a recent NASSCOM (National Association of Software Services Companies) study which indicates that only 25 percent of India's technical graduates are employable in the IT industry.

2. Lack of Research Culture in our Technical Institutions

A root cause of the poor learning outcomes of our technical institutions is a conspicuous lack of research culture. Neither managements nor faculty of the great majority of technical institutions regard R&D – academic or sponsored – as an important activity. They are satisfied if the institution gets enough reasonably good quality students to fill up admission capacity, and if their graduates are able to secure placement in industry in adequate numbers. They seem to be blissfully unaware of the multiple roles of technical institutions and faculty, and of quality and performance parameters.

The requirement of the All India Council for Technical Education (AICTE) that Ph.D is a prerequisite qualification for assistant professors and professors was driven by a need to encourage faculty to engage in research (because writing an original research thesis is the pre-condition for the award of a Ph D). In a similar fashion, AICTE's National Board of Accreditation (NBA) criteria stresses institutional collaboration with industry, continuing education, research publications, and other features to build academic institutions of good quality. The NBA accreditation system demands that the technical institutions engage in R&D, and that faculty are active in publishing research papers in high-impact peer-reviewed journals.

Unfortunately, quite a few academics, question the need for possessing a Ph D qualification to teach undergraduate and often,

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even postgraduate students. Not only do they regard research competence as unimportant, they seem unaware that for knowledge transfer from teacher to student to occur, new knowledge needs to be continuously created through sustained research activity.

Therefore, it's hardly a matter of surprise that in the list of the of the top 500 universities worldwide, announced a couple of years ago, by the Jiao Tong University, Shanghai, only three of our institutions (IISc and two of the seven IITs) were listed, at all. That's because research capability and achievement was given heavy weightage in the study. According to the ESI Essential Science Indicators Database, for the period 1994 – 2004, India's position is 13th in terms of number of papers (China 9th), and 21st in terms of number of citations (China 18th).

A common excuse advanced by college and university faculty for not engaging in R&D activity is paucity of time. On analysis, several facts come to light. Most academics devote too much time to 'low-value' activities such as routine testing and consultancy assignments, coaching classes, and even non-academic activities. In metros, they have to travel long distances to and from their institutions. Furthermore, most faculty are unaware of research funding opportunities and the criteria adopted for assessing research proposals. Even those, who write research papers, tend to have at best, a hazy idea of where to present/ publish them — the quality of conferences / journals and the concepts of citation / impact factors.

3. Some Suggestions to remedy the situation

How can this untenable situation be rectified? What steps do we have to take in order to produce large numbers of Ph.Ds who have to discharge the important roles of mentors, motivators, guides? These are questions in need of urgent answers.

Firstly, we need high-quality research infrastructure - experimental (equipment, diagnostic instrumentation) and computational. Secondly, we need to develop a research culture with focus on quality and rigour in Indian academia. Simultaneously, we need to promote opportunities for peer-to-peer interactivity, and provisioning generous funding for deputation of academics to international conferences. Moreover, faculty and research scholars should be encouraged to publish only in high-impact journals.

In short, we need a national R&D movement, as significant, for example, as our economic reforms kick -started more than a decade ago. We need university research policies which are supportive and promotional. They should motivate, incentivise, enable and reward research excellence. However, it should be borne in mind, that we can not mass-produce Ph Ds, nor enhance Ph D capacities overnight. Good Ph.D theses takes a minimum of three years to complete and requires a great deal of hard work, commitment and perseverance. Therefore, it is of vital importance to acknowledge that development of R & D capability in our institutions of higher education requires sizeable investment in terms of finance and manpower.

In this connection, corporate sponsored R&D sources offer great development opportunities to our technical institutions. The funds required for creating research infrastructure, for supporting research scholars, engaging in research activity providing relevance and utility to end-users, and contributing to solution of nationally significant problems, need to be actively solicited. India's academic community seems largely unaware that within our national borders, we have a large number of funding agencies offering substantial grants to academic institutions.

In short, for sponsored R&D to build world class research capability, institutional managements need to actively solicit the growing R & D budgets of government and corporate India. This requires preparation of detailed R & D project proposals with clear

definition of outcomes. It is high time, Indian academia realised that the drive for transforming teaching institutions into Centres of Excellence must come from within.

4. Some Serious Issues of Concern

It is also to be pointed out that during interviews for selection or promotion, the primary performance parameter relates to research output, even though there are inherent difficulties in assessing its quality and impact. It is necessary to have in place a research promotion policy with clear guidelines on the preferred journals for publication in, and the acceptable conferences for presentation at. The latter is particularly useful in making decisions relating to financial support for attending international conferences. Our research recognition system attaches more importance to publication of papers than to technology development, which is much more relevant in Engineering and Technology than in Science.

It is also worrisome that the majority of faculty and research scholars prefer to pursue computational or theoretical research rather than experimental research. There are reasons for this, of course : Experimental research is dependent on the availability of equipment and instrumentation; in the Indian context, import takes time, whereas the spread of high-performance computers provides a convenient platform for undertaking computational research. Experimental research is often dependent on the availability of skilled technicians to fabricate precision apparatus; it is often time-consuming, whereas in computational research, time is under the control of researchers. In experimental research, the workplace may be noisy, hot and humid, whereas computational research is conducted in air-conditioned workspace. The impact of Murphy's law is more prevalent in experimental research, making it all the more difficult.

It is also a matter of concern that the manpower opting for Ph.D.s and the manpower becoming available to our national R&D establishments, such as DRDO, AEC, ISRO, CSIR, etc. largely comprise those who could not make it to the other more attractive sectors, such as the corporate sector, and outside the R&D system, such as, management, consulting, etc.

5. Some Issues in Choosing the Research Topic

Professor Richard M. Reis, Director for academic partnerships at the Stanford University Learning Laboratory, and author of Tomorrow's Professor: Preparing for Academic Careers in Science and Engineering, has written a series of articles in The Chronicle of Higher Education, dealing with issues commonly encountered by Research Scholars and Supervisors. The essential points made by him are summarized here.

He quotes Professor George Springer, chairman of the aeronautics and astronautics department at Stanford University:

"It is really important to do the right research as well as to do the research right. You need to do 'wow' research, research that is compelling, not just interesting."

He identifies the importance of identifying the right research area, and in particular, the right research topic, which should be 'interesting, complex, and compelling'. He quotes Cliff Davidson and Susan Ambrose of Carnegie Mellon University: "The most successful research topics are narrowly focused and carefully defined, but are important parts of a broad-ranging, complex problem."

Richard Reis again quotes the chemistry professor and author, Robert Smith, who in his book Graduate Research: A Guide for Students in the Sciences (ISI Press, 1984), lists 11 points to consider in finding and developing a research topic:

- "Can it be enthusiastically pursued?

- Can interest be sustained by it?
- Is the problem solvable?
- Is it worth doing?
- Will it lead to other research problems?
- Is it manageable in size?
- What is the potential for making an original contribution to the literature in the field?
- If the problem is solved, will the results be reviewed well by scholars in your field?
- Are you, or will you become, competent to solve it?
- By solving it, will you have demonstrated independent skills in your discipline?
- Will the necessary research prepare you in an area of demand or promise for the future?"

6. Considerations in choosing the Research Guide

Richard Reis quotes S. E. Widnall, past president of the American Association for the Advancement of Science: "The adviser is the primary gatekeeper for the professional self-esteem of the student, the rate of progress toward the degree, and access to future opportunities."

Different Research Supervisors have different philosophies: at one extreme, some professors want to follow the progress on a day-to-day basis. At the other extreme, the professor holds the scholar fully responsible for the thesis, except to provide feedback and advice, when sought.

Richard Reis quotes Robert Smith in listing the considerations that should govern the choice of the Research Adviser:

- "Accomplishments in teaching and research.
- Enthusiasm for advising students.
- Experience in directing graduate students.
- Management and organization of his or her research group.
- Reputation for setting high standards in a congenial atmosphere.
- Compatible personality".

He classifies Research Advisers into three types: authoritarian, coach, and laissez faire.

Richard Reis quotes Paul Humke, professor of mathematics at St. Olaf College :"I treat my research time the way I treat my class time. It is high priority and I don't cancel my research time unless I would cancel a class for the same reason."

He also quotes John L. Hennessy, provost and incoming president at Stanford University: "You need to keep your creativity cycles free, and the best way to do this is to have something to work on in your head when you are walking across campus, sitting in a dull meeting, and riding in a car. Doing so also keeps you from thinking about a lot of trivial, negative stuff that isn't helpful anyway."

7. The Importance of Interdisciplinary Research

Richard Reis quotes Mark C. Rogers, vice chancellor for health affairs, Duke University : "The best institutions of the future are those that can reorganize themselves to address scientific and educational questions in an interdisciplinary way. The institutions that will have difficulty are those that keep the same rigid structure that prevents pollination among disciplines."

Richard Reis points out that "discipline-based research continues to provide the core of our knowledge about the universe and has led to many fundamental breakthroughs in science and engineering. Departmental-centered research also provides the structure around which academe is organized and is the

established way of assessing faculty research quality and productivity".

Yet, as Steven Chu, a Nobel laureate in physics, noted recently: "Our strength and our weakness is the departmental structure. The department is the guardian of its field. It trains students and promotes intellectual excellence. But the departmental structure means that we must carve up all intellectual pursuits into quasi-well-defined segments."

Reis takes the example of the emerging field of "smart," or "intelligent," materials and structures. "Here, investigators with backgrounds in chemistry, materials science, biology, mathematics, computers, and engineering cooperate in developing human-made artifacts which, like their creators, sense and respond to their environment by learning, adapting, and repairing themselves".

Other examples are the efforts in Stanford "to combine the work of investigators from physics, chemistry, biology, engineering, and medicine in such areas as tissue engineering; single molecule analysis and molecular structure; cognitive and systems neurosciences; imaging from molecules to humans; and bio-computation".

8. Ethics in Scientific Research

While Ethics in all aspects of human endeavour are important, there are special implications for scientific research. There are instances when "knowing and doing the right thing" are fraught with difficult decision-making.

Richard Reis points out that Robert E. McGinn, a professor of management science and engineering at Stanford University, engineering has generated a list of 15 "ethically problematic behaviors in science." This list includes: "plagiarism; falsifying (e.g., "cooking" or "trimming") data obtained from a genuine experiment; fabricating experiments to "obtain" or "generate" data; deliberately misleading research competitors to improve one's chances of getting there first". One other contentious area is co-authorship - allocation of importance to the different co-authors.

Reis points out that "different norms exist within institutions as well as among various disciplines". "In genetics and microbiology, for example, credit tends to be "shared," and the director of the laboratory is almost always on the list of authors even if, he or she, did no direct work on the project. In population biology it is the people who actually did the work, usually graduate students, whose names are the only ones on the paper".

Reis suggests that "for many experienced researchers, there is a simple test: Can every one of the co-authors give a talk on the paper at a scientific meeting and defend it publicly in a question-and-answer session? If not, then some attribution other than co-authorship, for example, "with technical assistance of," should be used".

9. Concluding Remarks

It is axiomatic that Research is an important activity and responsibility of all faculty members in higher education institutions. However, this realization is yet to percolate to all higher education institutions in our country. This is reflected in our poor performance in global league tables. In fact, it is being increasingly pointed out that for not only global competitiveness but also for national development, Innovation is the key, and R&D is the crucial basis of Innovation.

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