CURRENT SCIENCE

Volume 97 Number 1 10 July 2009

EDITORIAL

Teaching and Research: Inventing a Connection

Education appears to have been catapulted to centre stage in recent times with a great deal of discussion and debate on both school and higher education. On the one hand there is the suggestion that the 10th standard board examination be abolished or made optional in schools; on the other is the recommendation that the system of higher education be completely restructured, by the introduction of a new, overarching body that incorporates all the diverse commissions and councils, which are meant to police the vast network of colleges and universities, both public and private. Clearly, the sudden ferment, in the arena of education, is the result of a long felt need for change, catalysed by the pressures of privatization, globalization and expansion of higher education. Over the years there have been many committees, commissions and reports; most recommendations have been welcomed and then ignored. Even with the best of intentions, implementation of suggestions which may significantly perturb the existing system appears to be insurmountably difficult, with resistance to change being the determining factor. While a major expansion has been set in motion, with announcements of many new institutions to be created across the country, the need to rejuvenate and transform many old institutions is clearly recognized. In the many fields of science falling enrolment in B Sc courses, in many states, has been the subject of considerable discussion. There have been many seminars devoted to considering strategies for attracting young students to science. New scholarship schemes have been announced in the hope that money will entice students and parents away from professional courses in engineering or medicine. The situation in humanities and social sciences may not be much better, although public expressions of concern are muted. The debates about the content and quality of college education in sciences have thrown up many suggestions that merit serious consideration; most notably the introduction of a four-year Bachelor's degree program, with considerable flexibility in courses and a component of research. The 10 + 2 + 4 system would align with many programs the world over, reduce the time for entry of students into research programs and broaden the exposure of students to multiple disciplines, at the level of their college degree.

In all the discussions on higher education in science, one of the key issues has been the need to increase both the quantity and quality of research in science, emanating from Indian institutions. Research output is determined to a considerable extent by the number of graduate (Ph D) students and postdoctoral fellows in an institution and their quality. These in turn are determined by the size of the faculty, their quality and the level of infrastructural and research support. At the level of a research degree there are many areas of current interest where science, engineering and medicine merge seamlessly into one another. The scientific revolutions of the past fifty years in materials science, biology and computational methodologies have had a dramatic impact, emphasizing the need for interdisciplinary approaches. Unfortunately, the fragmentation of higher education in India is a reality, with the creation of separate universities for engineering and medicine in many states. The traditional university often has only a minimal core of humanities and sciences. In a majority of cases, undergraduate programs are localized in constituent colleges, with university science departments focused only on Master's degrees. The extent of research in university departments varies widely, with relatively few centres recognized as vigorous promoters of research. The barriers between the various disciplines of science are generally impregnable, leaving students with very little opportunity to acquire a taste for subjects which may help them enter areas of interdisciplinary research. Fragmentation begins early, with subjects like biology and computer courses becoming mutually exclusive even at the level of classes 11 and 12. Specialization is favoured in most programs, with the result that students are ill prepared to enter many areas of research, which involve the need to cross disciplinary boundaries. Overloading students with excessive syllabi at high school level is hardly the prescription for attracting students to science. Colleges have also struggled to maintain science courses as enrolments fall and the costs of running laboratories rise. For students who survive the course up to a Master's degree, financial support to continue on to a Ph D is available through national examinations. It is not uncommon to find research students in university departments struggling on without financial support. Can

meaningful research be accomplished when the level of preparation and support is so low?

The higher education sector in India is also dominated by the rise of the 'deemed university'. Many specialized, centrally supported research institutions which often have only one or two disciplines have been declared to be 'deemed universities'. This, of course, allows them to grant Ph D degrees to researchers. Many of these laboratories are too small in size and extremely limited in their scope, making the label of a 'university' meaningless. Their small size, high level of per capita funding and superior infrastructure make them attractive places for students seeking research degrees. However, there is no formal teaching in most of these national institutions, with students entering directly into a research laboratory. This situation may be contrasted with any American 'graduate school', to which many of our science students are admitted, where a mandatory course program must be completed and a qualifying exam hurdle must be crossed before entry into research. It is the course program that broadens a student's knowledge and outlook and allays fears about subjects which may be needed later. Very few institutions in India insist upon courses for Ph D scholars, thereby missing an opportunity to improve the level of preparation for research. Courses also introduce students to a wider cross-section of faculty; a bonus that can often prove to be useful. Why is there so little teaching in our research institutions? Is it because senior researchers believe that teaching is a distraction that takes away valuable time from research? Is it because that teaching requires a certain discipline that is constraining? Is it because teaching at the highest level requires a level of preparation and commitment that researchers find uncomfortable?

The segregation of teaching and research may be one of the most limiting and undesirable features of the Indian higher education scene. George Bernard Shaw once wrote, in characteristically dismissive fashion: 'He who can, does; and he who cannot, teaches'. However, Shaw was referring to creative writing and not to the practice of science. In science, teaching often benefits the teacher; sometimes even more than it does the student. For students an enthusiastic and knowledgeable teacher can be inspiring, catalysing their interest in subjects that may not be directly related to a narrow research problem. Excessive focus in a specific area during a Ph D program, can be limiting in a future research career. Good teachers can also train a new generation of teachers. An editorial in *Nature Chemical Biology* (Dec. 2007, p. 737) summarized the case for teaching succinctly: 'Those who can teach, should'. India now finds itself in a curious situation. There are a large number of national laboratories, well funded and well staffed, where there is research but no teaching. At the same time we have a large number of colleges and universities where there is considerable teaching, with little research. The IITs and the newly created Indian Institutes of Science Education and Research (IISERs) are examples of attempts to promote undergraduate and postgraduate programs in an environment where research is encouraged. The IITs have half a century of experience, while the IISERs are in their infancy.

Is there an academic case for promoting teaching in research institutions and to embed undergraduate programs in a research environment? I believe there is and that the present concerns on the state of science education are best addressed if scientists begin to fulfil their responsibilities as teachers. The imperatives of interdisciplinary research also demand a fresh approach to undergraduate education. Broad based programs in which the barriers between science and engineering are breached may allow us to nurture a new generation of students, who are comfortable with multiple disciplines. Exposure to research projects, conducted as a group effort, may provide the incentive to explore a future career in research. In many ways, research can be addictive and an early introduction to research may be a device that makes science more attractive. A flexible system of courses that includes exposure to social sciences and modules that enhance communication skills may be desirable. Implementing a transformation of undergraduate science education will be a formidable task. There is however a clear need to experiment and refine our approaches with experience. Maintaining the status quo will be comfortable, but it is an option that must be discarded if science in India is to grow and the requirements of research institutions and agencies are to be met. Despite many well meaning reports by committees and commissions, the burden of change rests with institutions and their faculties. The responsibility for engineering a transformation in the arena of higher education must fall not only on universities and governments, but also on research institutions. The time seems opportune to invent a robust connection between teaching and research.

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