

A CHALLENGE IN THE SPHERE OF HIGHER EDUCATION

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In 1994 I wrote an article¹ (Narlikar 1994: 47) in the Kothari Memorial volume in which I paid personal tributes to the late Dr DS Kothari. This occasion of a centenary volume gives me an opportunity of looking at the area of higher education to which Dr Kothari had made such important contributions. In particular, I would like to discuss the problem of declining interest in basic sciences in higher education.

We can compare the present situation with that prevailing in the 1930s when a student such as Daulat Singh Kothari was planning his higher education. He had at Allahabad University no less a person than Dr Meghnad Saha to encourage him to go to the Cambridge University for higher studies in astrophysics. There he met another bright young Indian, S Chandrasekhar who had likewise come to the Cambridge for higher studies in astrophysics. Both Kothari and Chandrasekhar had been motivated by the galaxy of scientists at the Cambridge such as Fowler, Eddington, Larmour and Smart. And, astrophysics was just one part of what was going on at the Cambridge, where the new science of nuclear physics was taking birth, mothered by Rutherford and Kapitza. Another Indian to be attracted to nuclear physics at the Cambridge during that period was Homi Bhabha.

BASIC SCIENCE : URGE TO KNOW

All these examples, drawn from an earlier era, share a feature that is common to all basic sciences, namely *the urge to know*. Chandrasekhar and Kothari were interested in the structure of a white dwarf star. Bhabha was probing the interactions between electrons and positrons. It is this urge to know the *why*, *how* and *when* about natural events taking place around him that drove man from primeval times to become a scientist. In basic science, one is driven by curiosity as the prime motive. In any society, this curiosity is an energizing and refreshing

trait that keeps it intellectually alive. It prompts creativity that is on the same high level enjoyed by the creativity of the artist, the musician or the litterateur. Indeed a society needs to carry out serious introspection if this creativity seems to be dying out. The examples cited above are drawn from the colonial era revealing that even in bondage, our country was able to generate students motivated by curiosity and the urge to create.

A Nobel laureate of the subcontinent, the late Abdus Salam, had drawn an interesting parallel between the development of India and the Europe in the 17th century. He mentioned that the Taj Mahal in Agra and St Paul's Cathedral in London are contemporary masterpieces of architecture showing that creativity in this field was at its pinnacle in both the countries. However, within a few years, England and the rest of the Europe enjoyed the first important revolution in science, initiated by Isaac Newton. There was, alas, no parallel development in the Indian subcontinent. The urge of scientific creativity simply did not seem to exist. Or, if it did in a latent form, the social ambience certainly did not encourage it. While the arts, architecture and music enjoyed royal patronage, science had no foothold either amongst the creative intellectuals or their patrons.

That India did have such an urge a few centuries earlier is seen by the golden age of science starting from Aryabhatta in the 5th century and extending to Bhaskara in the 12th century. It was the period when Europe was nowhere on the intellectual scene. The Arabs who had earlier acted as conduit for transfer of knowledge from the ancient Greece to Asia, were now looking to India for new ideas. Thus it was that Alberuni translated Sanskrit works by Brahmagupta and others on astronomy and mathematics. This was when the Hindu decimal system of writing and manipulating numbers became popular, to say nothing of the important concept of the number zero.

A resurgence of the old spirit of scientific enquiry took place in the beginning of the 20th century, when even under the colonial rule, Indians began to assert their intellectual potential in science. Names such as Srinivasa Ramanujan, Jagadish Chandra Bose, Meghnad Saha, Satyendra Nath Bose, Chandrasekhar, Venkat Raman are examples of this new resurgence. Alongside these names from mathematics, physics, chemistry and botany, I may also mention the gynaecological genius, the late Dr V N Shirodkar, now very often remembered by the 'Shirodkar-stitch' named after him.

These people were all distinguished as teachers who inspired younger generations of students with their examples. Even poorly funded universities with very basic facilities could boast of a few inspiring teachers. So succeeding generations of students in the 1930s, 1940s and 1950s were motivated by them to take up research and teaching in basic sciences. I have already mentioned the name of Chandrasekhar. Let me go into further details about him.

Subrahmanyan Chandrasekhar, as an undergraduate, was inspired by the work of Ralph Fowler in Cambridge to work on the state of matter at very high density in the white dwarf stars. He wrote a paper on this work and after some correspondence with Fowler, it was accepted for publication in the proceedings of the Royal Society of London. Later Chandrasekhar met Meghnad Saha, the doyen of astrophysicists in India. Here is a brief account of how his meeting with Saha proceeded, as narrated by Kameshwar Wali in his biography called *Chandra* (Wali 1991).

A few months later, 2–8 January 1930, Chandra attended the Indian Science Congress Association meeting held in Allahabad. The host and the president of the physics section of the Congress was Meghnad Saha, the eminent Indian astrophysicist, whose theory of ionization a decade earlier had unlocked the door to the interpretation of stellar spectra in terms of laboratory spectra of atoms of terrestrial elements, providing information about the state of stellar atmospheres, their chemical composition, the density distribution of various elements, and then about the most important physical parameter — the temperature.

Chandra had learned all this from Eddington's book *The Internal Constitution of Stars* and was aware of the high esteem Eddington had accorded to Saha and of Saha's election to the Royal Society in 1927. But Chandra was not aware that Saha was acquainted with his own work; so when he met Saha at the Congress and introduced himself, he was pleasantly surprised by Saha's compliment on his paper in the proceedings of the Royal Society. Saha said that that was very suggestive and that one of his students was working on extending Chandra's ideas. He introduced Chandra to his student, who also seemed to know about his work, and he invited Chandra to his home for lunch with a small group of research workers all older than Chandra. The small lunch turned later into a dinner invitation with such distinguished senior Indian scientists as JC Ghosh, DM Bose, and JN Mukherjee. Saha persuaded Chandra to extend his stay in Allahabad so that he and his

students could discuss more with him. Chandra, so young, did not expect to be treated almost as an equal by an internationally renowned scientist of Saha's stature.

The account is illustrative of how even a senior and well-experienced teacher can learn from a talented student! Not surprising that with such responsive *guru's* new *shishyas* felt inspired to excel them.

My father (Vishnu Vasudeva Narlikar) was similarly motivated to take up higher mathematics at Cambridge in preference to the lucrative Indian Civil Service. Hearing of his achievements in Cambridge, Madan Mohan Malaviya, the founder of Benaras Hindu University, while on a visit to the UK for the Round Table Conference personally contacted him in Cambridge and invited him to join the BHU after completion of his studies. And he followed it up with the offer to professorship and the headship of the mathematics department. My father accepted the offer in preference to visiting Caltech under an international fellowship, and he stayed in this capacity at the BHU for 28 years during which his teaching inspired countless students. Can a vice chancellor today exercise the same initiative in attracting a highly talented young man to a senior post in his university?

These examples reveal the kind of atmosphere prevailing in the Indian universities in the pre-Independence era. I caught the tail end of this era in the 1950s, when after my standing first in the Intermediate Science Examination at the BHU, I was motivated to opt for the B.Sc. stream in preference to engineering, despite the existence of a nationally famous college of engineering on the BHU campus.

I should say, however, that the trend for preference for engineering amongst the bright boys had already begun and my decision was seen contrary to the trend. Nevertheless, the trend had not yet developed into an avalanche that it is today. Today, it will require extraordinary courage to resist peer and parental pressure to take to pure science in preference to engineering or medicine.

What has brought about this change? Probably, the decline of interest in basic sciences and temptation to opt for applied side, little realising that to be a good scientist one must have solid foundation of basic sciences.

DECLINE OF INTEREST IN BASIC SCIENCE

At the time of inauguration of the new building of the Tata Institute of Fundamental Research (TIFR) in Mumbai in the year 1962, Homi

Bhabha had this to say vis-a-vis basic sciences (TIFR Archives):

...By fundamental research I mean basic investigations into the behaviour and structure of the physical world without any consideration regarding their utility whether the knowledge so acquired would ever be of any practical use. Nevertheless, the support of such research and of an institution where such research can be carried out effectively is of great importance to society for two reasons. First of all, and paradoxically, it has an immediate use in that it helps to train and develop, in a manner in which no other mental discipline can, young men of the highest intellectual calibre in a society into people who can think about and analyse problems with a freshness of outlook and originality which is not generally found. Such men are of the greatest value to society, as experience in the last war showed, for many of the applications of science which were crucial to the outcome of war were developed by men who, before the war, were devoting their time to the pursuit of scientific knowledge for its own sake. Radar and atomic energy are two examples of two fields in which a vast body of known basic knowledge was developed into technology of immense practical importance, largely through the application in war time of the efforts of those who might be called 'pure' scientists.

Secondly, the history of science has shown that 'there is no genuine knowledge of the universe that is not potentially useful for man, not merely in the sense that action may one day be taken on it, but also in the fact that every new knowledge necessarily affects the way in which we hold all the rest of our stock.'

Firmer advocacy of basic sciences than this cannot be found. Ironically in retrospect, the manner of establishment of institutions like the TIFR (the TIFR was established in 1946, during the twilight of the British Raj) has been largely responsible for the present decline in the following of basic sciences amongst the students of the day. This is not a healthy development.

Following TIFR, soon after independence, the trend to establish specialized autonomous research institutes or laboratories started. Different agencies of the Government of India like the Council for Scientific and Industrial Research (CSIR), Department of Science and Technology (DST), DAE, Defence Research and Development Organisation (DRDO), Department of Science (DOS), DBT, etc. have set up their own autonomous research institutions in specified areas. These institutions enjoy a measure of autonomy and are generally well-endowed both in cash and in facilities.

Moreover, to make the life of a typical research scientist 'hassle-free' these institutions were decoupled from the universities so that teaching undergraduate or postgraduate students should not come 'in the way' of the researcher. This means that researchers were decoupled not only from the universities but from the students also.

At the same time, the universities by revisions of their acts and statutes evolved to a state where a faculty member was required to do more teaching and less research. Consequently, research occupied the back seat in the universities while the teaching became noticeably absent from the research institutions.

I had the opportunity of attending lecture courses delivered by the best scientists of the premier institutions in the world. At Cambridge, I had Dirac lecturing on quantum mechanics, Hoyle on cosmology, Davenport on number theory while at Caltech I heard Feynman lecture on his path integral approach. These were Nobel laureates or of comparable class. Yet, they never thought that teaching was below dignity, or that it came in the way of their research. Rather, they expected that their interaction with the students would improve their own perception of the subject. Students like us on the other hand felt inspired that these teachers who had shaped contemporary science were able enough to establish a rapport with our level to share their excitement and understanding of the subject.

That a similar academic ambience existed in the best departments of our universities in the 1920s and 1930s was shown by the extract I read out of Chandrasekhar's interaction with Meghnad Saha. A few years ago I was invited to deliver the Meghnad Saha Lecture at the Allahabad University and once again I was very disappointed to see a lethargic atmosphere in the department with hardly any students at all. The change is regrettable but understandable also. On the one hand we have separated the students from a research ambience, where they could meet and listen to those who 'create' new science, for these people have set themselves in the ivory towers of research institutions. On the other hand, we have also made it difficult for a university faculty member to carry out meaningful research by (a) depriving him of suitable facilities, and (b) over-loading him with teaching. I have come across vice-chancellors who openly denigrate research on their campus saying that the teachers should only teach. If the evaluation process of a university teacher is to assign very low weightage to research, why should he be so motivated?

The feedback of such experiences has been that the typical student, howsoever bright, does not see interesting research being done around him, something that would excite him/her through the challenges it poses. So he does not see much scope for a career in research. Those few who still feel the urge to do so, take a look at the scientific establishment in the country. As I mentioned before, research opportunities lie remote and inaccessible to him. What little he gets is a picture of a bureaucracy-ridden hierarchy conscious community that does not attract him. *Ergo*, he opts for a career abroad where he sees science practised more as an intellectual pursuit rather than as a chore to be performed during office hours. Or, back home, he goes for a professional career that is financially more rewarding although not intellectually so.

It is not surprising therefore that the autonomous research institutions are finding it increasingly difficult to attract young talent as a consequence of which a vacuum is slowly but steadily being created at the younger age group. Since it is this age-group that eventually grows to take up higher responsibilities, scientific projects, which proceed in a mission mode like atomic energy, space, industry-oriented research, defence research etc are experiencing serious human-power shortage.

Thus, while scientists such as Homi Bhabha and Shanti Swarup Bhatnagar created the institutional structure to boost basic sciences, this happened at the cost the universities. There was no parallel growth in the universities; rather what existed was slowly allowed to wither away. Consequently, the very lifeline of science graduates from universities that fed young scientists to these research institutions got more and more tenuous and it is now close to extinction. Thus, what is needed is a change of mindset vis-a-vis basic sciences.

REJUVENATING BASIC SCIENCES

The difficulties perceived above tell us that conditions have to be improved on the basic sciences front not only in the interest of higher education, but also in the interest of future development of science and technology in the country. There are several possibilities that need to be explored in real earnest if the situation is to be retrieved in time. The internet has already shown that information transfer proceeds fast, painlessly and at insignificant cost. Keeping such developments and

facilities in view, the scenario that emerges for the future of higher education is encouraging. Some of the positive features are as under:

1. In an extension of the open university system one can have an interactive classroom where pupils singly or in groups scattered in different places listen to lectures, lecture demonstrations and panel discussions while interacting with the resource persons. The resource persons may be distinguished scientists who can convey their excitement of doing science to their audience.
2. In the era of shrinking library budgets and escalating prices of books and journals, the networking of resource libraries with electronic transfer of information can supply the needed browsing facility to the student and the teacher, as well as the facility to access the book or journal remotely. If science courses and questions are so designed that the student feels the urge to search for information that would provide the answers, these data-mining systems can be very effective in motivating him/her.
3. The electronic mail will gradually replace the conventional "hard copy" mail, often called snail-mail for its comparatively slow speed. It also allows two or more persons to "converse" on their computers, to access database in different parts of the world to operate telescopes remotely, etc. By saving physical travel and money it can make the future educational system much more efficient and cost effective. Through such e-mail dialogues, students from different colleges, in different cities even, may exchange views. Indeed, the whole sphere of higher education has to adjust itself to such rapid information transfer. No country planning for the future of its education can afford to ignore this potential. For a country like India with its far-flung and difficult-to-access areas this is a boon. It will indeed be a tragedy if our planners fail to cash in on this mode.
4. Technology provides new instruments in different scientific disciplines. The astronomers have their telescopes, the nuclear and particle physicists have accelerators, for example. In each discipline there are sophisticated facilities. These are expensive and providing such expensive a facility to each and every university is economically unviable. Even where some instruments have been provided, the experience to date has not been very encouraging either, with the expensive equipment lying underutilized or even inside the unopened crate. How do you solve this problem?

Even in advanced countries with greater prosperity, the shrinkage of available funds in relation to the cost of the required research facility and the low utilization factor per institution of such facility, have forced universities into a sharing mode. Thus expensive facilities like telescopes or accelerators are shared by many institutions. For example, the National Optical Astronomy Observatory in the United States is run by the Association of Universities for Research in Astronomy. A similar culture needs to be popularized in India. A beginning has been made by introducing inter-university centres (IUC) in areas inadequately covered by universities. A typical IUC would act as a nodal point providing access to advanced and expensive facilities to all universities interested in that field.

5. It is still not too late for bringing the autonomous research institutions closer to universities. In a typical case there may be a university and such an institution (or several of them) in the same city. A memorandum of understanding between the university and such an institution should allow the use of the laboratory facility of the institution to the university and it should be made mandatory by the institution that each of its scientist staff members will give at least one course in the university. Although with their present mindset, most staff members may initially think lecturing a burden, but soon they will come to appreciate it when they begin to get good students wishing to do research in their field. Let me recall one episode in the University of Cambridge, which I had observed personally.

While the proposal for setting up the Institute of Theoretical Astronomy (IOTA – hereafter) was being discussed in the university in a public debate of its academics, a view was expressed that the research scientists at IOTA should not be allowed to teach the mathematics undergraduates at the university. As a young post-doctoral fellow who aspired to be one of the staff members of the proposed institute, I thought that this was a great blessing, since those who research at IOTA would then be spared the burden of teaching and examining.

Fred Hoyle, who had been the prime mover of the proposal to establish IOTA, however, interpreted this view negatively. He mentioned to me that if you lecture to students, you can motivate them to do research and with luck attract the bright ones to the

institute. If you are prevented from lecturing, you may find talented students being diverted elsewhere. Indeed, in the early years, it did become hard for IOTA to attract good graduates coming from Cambridge's prestigious Mathematical Tripos Examination. Later, the situation improved when more of the IOTA staff began to teach in the university. Perhaps, I should record here that I myself had been motivated towards opting for my career as an astrophysicist because of Hoyle's inspiring lectures when I was a Tripos student. Indeed, what Hoyle foresaw in 1965, has come to pass in the Indian context today.

6. The UGC may try an experiment of its own on setting up a centre for science and technology wherein students are admitted after the XII Std on the basis of their performance in an entrance test and interviews, with the aim of studying for a 5-year programme leading to the master's degree. I believe that three such centres are being set up and I hope that they will be run without compromising the criteria of strict merit and achievement.
7. Finally, let me return to the medical field, currently popular amongst students. It is not enough to study medicine and surgery up to the degree level and then acquire experience followed by established practice. Like all other scientific fields, those of medicine and surgery are rapidly evolving and it will reflect badly on a practising doctor if he does not move with time. While frequent reading of literature and attending workshops on special developments help, it is like being given a ride in a motor car, with yourself having no control as to where you are going. A real sense of being in the driving seat comes only when you participate in research and are an active member of the forward moving juggernaut of science. With genetic mapping a reality and the prospects of understanding the complex but marvellous machinery that we call the human body that much closer, medical science is on the threshold of revolutionary changes. Micro and now nanotechnology are likewise bound to revolutionize surgical techniques and non-invasive methods of correcting body-defects. It is more fun to be part of this ongoing urge to 'understand and improve' than to simply watch as a spectator what it delivers.

Research is possible not only in futuristic applications of technology or the basic genome-project type studies of the human body, but also into our past. *Ayurveda*, the ancient Indian science of medicine and

surgery, which had doyens such as *Charaka* and *Sushruta*, is expected to contain valuable and as yet untested information on drugs and treatments. As the episodes of turmeric and *neem* have shown, the information can command intellectual property rights for whosoever finds it. It is time that our own medical scientists found this information through their researches rather than have someone from the West find it.

Indeed, while I have used this occasion for paying my tributes to Daulat Singh Kothari, I feel that his pioneering spirit would certainly have been uplifted by the host of opportunities for improving higher education that are available to us today.

REFERENCES

1. Narlikar, JV. 1994. "An All-Rounder." In RC Mehrotra and Ramesh K. Arora, eds. *Education, Science and Human Values: Essays in Honour of Professor DS Kothari*. New Delhi, Wiley Eastern.
2. *TIFR Archives*. Tata Institute of Fundamental Research Library.
3. Wali, Kameshwar. 1991. *Chandra*. Chicago, Chicago University Press.