

## Our higher education – deficits and possible remedies

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*The substandard graduates and doctorates that India has been producing is a matter of worry. Analysis reveals that the causative factors are many and inter-related. Among them, the corrupted ways of recruitment of teachers and the pedagogic practice of rote learning are important. Apart from overhauling these, the main remedies suggested are directed towards developing intellectual independence, promoting curiosity and intensive rather than extensive teaching recommended for students. The lack of understanding of the real problems among the upper echelons of the government and its agencies is unfortunate and should be modified.*

Much has been written recently about the malaise in our higher education and the poor quality of our research (for example, see ref. 1). The deficits are spread over large swaths and the causative factors are complex. However, the root causes are to a great extent interconnected, making it amenable to analysis. Here our main goal will be pointing out some neglected aspects as well as some emerging research problems that challenge the style of education and research in India. The treatment will be restricted to science education and research, though much of it will be relevant to the humanities as well.

### Throttling curiosity and mental independence in our educational institutions

#### *Experience gathered from interviewing young Ph Ds and aspirants*

The comments below are based mainly on assessment of young Ph D aspirants and postdocs, supplemented by critical reading of many papers in my field published in Indian journals. My field is petrology (science of rocks) and geochemistry (application of physical and analytical chemistry, and the significance of chemical composition of rocks and constituent minerals). Previously the science of geology, like some other natural sciences, was by and large descriptive, to an extent empirical based on observation, but weakly analytical. But in the last six to seven decades, it has undergone revolutionary changes owing to application of physics and chemistry, both experimental and analytical, and mathematics. But this approach has affected an extremely small number of universities and institutes pursuing education and research in geology in India.

When we asked the candidate why he chose this topic for Ph D, majority replied that the guide had chosen it for them. The answers to what made chasing this problem worthwhile were unsatisfactory and in some cases in parrot-fashion. Ask about related problems or other tools for solving them – inadequate to poor response. Tell them that some trace element geochemistry could have improved the quality of interpretation as well as provide checks, silence and the excuse that they had not been taught trace element geochemistry in their postgraduate classes. We at IIT Kharagpur, started teaching many of these useful subjects around 1960. Even today, barring two (three) university geology departments, students are not exposed to these subjects or techniques. I have personal knowledge of one university where it was clear that most of the M Sc students had mathematics up to SSLC, a level much lower than that of the higher secondary level of today, and mathematics was avoided as a subsidiary subject in the B Sc programme. I hope that the situation has changed now.

But what is disappointing is why did not at least some younger faculty teach themselves some mathematics so that they can understand published research papers of the day and eventually apply them in their own research? The likely answer is depressing – laziness and enjoying the comfort of *status quo ante* as long as he can keep his job and get promoted.

The UGC and probably DST organized two summer schools in the 1980s for the young teachers and researchers in geology. The purpose was to make the young workers familiar with thermodynamics, its application to petrology as well as some useful methods of physical geochemistry which were in vogue. I took part

as one of the instructors in these schools. In the following years when I met some of the trainees to enquire whether they pursued the subjects further and even applied the methods, the responses were disappointing. Only one out of the 20–30 trainees tried to apply the knowledge gained in the summer schools. The riddle was solved when an honest participant told me that almost everyone in the group uses certificates for attending summer schools for promotions in their job.

So, how do you teach the teachers? This is a serious problem that should shake up the senior academics and administrators.

It should be clear by now what the main areas of deficit are. Our young researchers and teachers have been robbed of curiosity and mental independence during school (discussed later) and college stages, and are not eager to learn new concepts or methods even in this internet age. Of course, there will be exceptions, though their numbers will be small. Neither can they be picked up on the basis of their school and college scores. Most of them are unlikely to be good researchers, the past proficiency apparent from school records in all likelihood was achieved through rote and sticking to the ordains of teachers and tutors.

Recruiting the proper kind of science teachers for colleges and universities is a tough job – both caste and party politics have played havoc in this case. If the administration is run or dominated by a certain community, the candidates from that community shall have much higher chances of recruitment. This is worse than choosing mainly sons of the soil. In West Bengal, up until 2010–11, the determining criterion was that the candidate must belong to the communist (or leftist) caste. So how do we achieve the goal of

recruiting meritorious young men with enthusiasm for teaching and research?

### *The role of research guides*

Barring a few exceptions, the style of the Ph D guides here is feudal. They choose the research problem, method and approach familiar to them, as dictated to the scholars, and independent thinking by the student, barring rare cases, is rejected. But this is expected, since the student has practically no knowledge of research problems as his learning till then has been shaped by memorizing parts of textbooks. The new concepts and methods are seldom taught in the class. He cannot think on his own owing to the mental stasis caused by his school and college education. So it is better to follow the guide's wishes and learn to enjoy the intellectual serfdom.

For a guide this is a good deal. The number of publications would increase for him and another member will be added to his 'school'. The products of such schools seldom ripen into good researchers in the future. I have also seen heads of departments 'guiding' young faculty members and research scholars on topics which are beyond their specializations. When, after the degrees are obtained, papers would be published with the professor's name as the senior author, people will be impressed by his versatility. This is another benefit of the feudal system.

### *The roots*

All the deficits mentioned above relate to graduates and postgraduates in their early twenties. But before entering college/university, they have already gone through 12 years in schools. And the education received in school, starting from when they were 13–14 years of age is extremely important. This is the time when their minds start building infrastructure. So during this period teachers should abandon the style of teaching in the lower classes and adopt methods that enhance the students' thinking abilities, stoke their curiosity and create independence of their minds.

How? Have regular discussion and question-and-answer sessions; show them how problems can be approached and solved in more than one way; go beyond the textbooks and give them access to

materials which will heighten their curiosity and ask them to write on subjects relevant to what was taught but not adequately or sufficiently covered in the textbooks. In French high school programmes, philosophy is a compulsory subject, and students are required to write on rather difficult questions/problems regularly.

I dare say that most of the Indian school teachers are unwilling and/or incompetent to try out this style of teaching. The common excuse offered will be lack of time as a result of exhaustive syllabi. It is true that the volume of syllabus in schools has been growing over the years. Much of the material is marginal and can be picked up from the internet. The school boards or their college/university equivalents forget that a good education has to be intensive and not extensive. After all, what do the students gain by skimming through a lot of information? High-school graduates are not preparing for job interviews where such extensive knowledge is sometimes tested.

As far as I know, in the overwhelming majority of schools, teaching styles have not changed. Discussions and question and answers are *verboten* in the classrooms; after all, who is going to risk the anger of the teachers? Continuous evaluation of the students' progress may have started in some schools, but scores in the terminal examinations are the major deciders. And the 'ideal' answers to the questions set in these tests require memorizing, rote and responses as close to the minds of the teachers as evident in the classrooms and class notes. If you betray a different way of looking at the problem and express it in your answer paper, chances of scoring high marks in the exams are doomed.

It is relevant to mention open-book examination here. It is one of the best tests for judging the grip on concepts, clarity of thought and ability of solving unknown problems. This method is widely practiced in the US teaching institutions, probably elsewhere too. It was adopted in the first IIT in 1952 by several departments, but its lifespan was about 10 years. First, setting good questions for open-book tests often needed tough mental exercise and second, it was quite uncomfortable for students. After all, the mindset of these bright students had the impress of their earlier school education.

So how does a teacher promote the thinking ability and intellectual independence of the students? Do they assign them small essays on novel or out-of-the-box-topics? Do they learn to accept answers which are different from those expected? In other words, did they promote originality? Were discussions with students in the classrooms part of the pedagogy regularly? I am sure that the answers to these questions by honest teachers will be overwhelmingly negative. So in the age where students take long steps in developing maturity, mental independence, retain or reactivate their curiosity, the syllabus-ridden school education does not move in the right direction. How can you expect them to blossom as re-incarnates when they move to college? The college style of teaching will be a dampener again.

Is it then logical to expect emergence of a band of talented and motivated college graduates and postgraduates who will change the dismal situation that prevails in science research in India? Exceptional students will emerge, despite the hindrances, but only in handful.

### **Emerging challenges in scientific research**

We have explored the reasons behind the sub-standard preparedness of our young researchers. The deficiencies are increasing at a fast rate not only because post-war scientific research has been accelerating, but also because there are new research trends evident in the past two decades which require robust changes in the mindset of scientists. What I have in mind is the increasing emphasis on cross-disciplinary research. There are two prime movers behind the drive, solving the multi-faceted social problems such as water pollution, and improvement in our knowledge and ability through application of another discipline such as the progress in medical techniques through nanoscience. In the first example, we need collaboration of geologists, mineralogists, chemists, biochemists and engineers to tackle the problems of pollution of water and water supply. In educational institutions, such collaboration among scientists is difficult to build, I know of several university departments where intra-departmental cooperation is largely absent; inter-departmental collaboration is naturally a far cry.

### *Structures of universities – suitable for inter-disciplinary work?*

The current researches indicate that inter-disciplinary investigations will increase rapidly. On one hand, we will have to solve the problems of our environment and devise sustainability options; on the other, cross-disciplinary work has shown effective results in many problems. It is in this context that we examine the suitability of universities which are the major suppliers of research personnel. The structure of our universities promotes bureaucracy, inflexibility and feudalism. And most of the research-minded teachers will hesitate to give up work in their specialized areas and chase different techniques and ways of thinking required for inter-disciplinary work.

When we combine these two considerations, it becomes clear that the current set-ups are not congenial to inter-disciplinary research. Some drastic steps are called for. Break down the walls between the departments, let teachers from other departments teach and participate in research initiated in one department, and invite visiting professors. As Taylor<sup>2</sup> points out, this will cut down the number of departments, save money and result in less fragmented curricula. To my understanding, it will ultimately enlarge the minds of future scientists and they would move from reductionist to holistic approaches.

The Council of Scientific and Industrial Research (CSIR) institutes could have blossomed as ideal places for cross-disciplinary research. They were well equipped, employing scientists with various backgrounds and no teaching duties. But, by and large, the productivity of these institutions has failed us in terms of quality.

The reasons are many: poor leadership coupled with the usual conformity of opinions among the group working with him, which is a hangover from their college and university days and strengthened by our social mores. Add to this the bureaucratic practice of promotion by seniority ignoring merit or drive, dampening the will of hard and meritorious workers.

I do not agree with Desiraju<sup>1</sup> that the money and effort behind establishing the CSIR institutes should have been spent for upgrading the universities instead. First, in many countries similar institutes are doing well. Second, this was a good experiment where scientists have time,

equipment and the relative freedom to act and interact. Third, this was a fresh opportunity to build a research atmosphere free of feudalism, casteism and political interference. It can also be argued that 'applied' industrial research does not have many takers among the university researchers.

As long as we are on the subject of university and research, two more important issues can be taken up. The first one can be framed by a question – how many Ph Ds does India need? The production of Ph Ds in science per year was about 9000 in 2004. I presume that in the last 10 years the numbers have considerably increased. But the question is, do we have enough slots to employ such a huge number properly? The larger industries that can absorb a major chunk in research sections have seldom the will for establishing such sections and the smaller industries cannot afford it.

Some of the rest who are academically inclined will go for university and CSIR jobs, but every year the number of jobless doctorates will increase. The government, its agencies and the planners must devise solutions for this supply–demand process. If we cannot provide employment, cut down the number, restrict universities which produce them. No matter how optimistic we are, we do not expect industrialization on the scale of China or post-war Japan to bloom in India, and as a consequence the certainty of jobs for the Ph Ds. An alternative is provided by the Japanese way of recruitment for industries. Take in young B Sc graduates and train them intensely. Had the four-year B Sc course not been abolished by UGC, this model could have suited us well.

The second issue relates to the problems chosen for Ph D research. At least in my field the problems chosen are flat and outdated, often bearing the impress of guides' choices (cloning). Also, some Ph D problems are super-specialized, which may be of interest to a selected few. With so many potent problems in environmental science, materials science and biochemical sectors, should we not curtail such choices? It would be a good idea to discuss these issues in departments and frame a mechanism without hurting the freedom of choice. Exceptions must be granted in fields like abstruse theoretical physics, but only to workers whose abilities in the field are proven or to highly talented beginners whose potentials are evident.

### **Towards amelioration – recommended steps**

It is clear that education and research in science in this country are in dire straits; hence a major transformation is called for. Given below is a resumé of the steps that could be introduced in schools, colleges, universities and research institutes. As mentioned in the earlier sections, in schools (from the seventh and eighth grade) several practices are a must: classroom discussion, assignment of term papers where performance will be measured in marks to be added to the final grade and exposure to outside-syllabus topics like new developments in science and scientific logic, etc. (for students in the 10th and 11th grades). Obviously, computers will be a great help here. For college students open-book examination should be introduced extensively and seminar presentation with credits awarded in the form of grade or marks should be made compulsory for the M Sc students. The seminar topics should be such that it would require critical thinking and test the comprehension of the students.

For Ph D, the final go-ahead signal to the students should be given only after he publishes a single-author paper on his research topics, demonstrating that he is capable of individual research. This 'regulation' has been adopted in many American universities. Incidentally, the coaching schools for qualifying in NET examinations should be closed down. Is it not amusing that after 16 years of academic training, one has to go through coaching centres to learn how to be research-worthy? I would call it a shame.

There is a real need of training in modern facets of science, relevant to their disciplines, for teachers and researchers in the universities and research institutes. This needs summer schools like the ones organized by DST and UGC. Lecture courses by experts can also be organized by utilizing university funds. And there must be tough oral tests to check whether they have really benefited; if not, let them repeat.

The quality of recruitment of teachers in the schools, colleges and universities ultimately controls the quality of products. If we make mistakes here, mending matters will be very difficult. But we are often forced to make mistakes caused by political or caste-related interference and string-pulling. Only the Central and the

State Governments can solve these problems, education being a concurrent subject. The least the selection boards of institutions can do is to choose or recommend outside experts who are above political and caste pull, are beyond cronyism, are still in the game of research and impartial. This is a must.

### *The role of Central Government and society*

It is unfortunate that none of our education (HRD now) ministers at the Centre had any incisive knowledge of the problems of science education and scientific research. The former Prime Minister Manmohan Singh was conscious about the malaise and the fall in the quality of our researchers, but he had to prioritize many other problems, especially during the later phase of his tenure. The former HRD Minister M. M. Joshi was a physicist, but it was evident that lifting standards in science teaching and research was not important in his book; he had other agenda items of greater importance.

Looking at the record of the current government and its agencies like UGC, Union Public Service Commission (UPSC), can we regenerate hope? The answer is negative.

Look at some of the actions of UGC. They killed the four-year Bachelor's programme, which according to many was a progressive step. Now they are interfering with IITs, going against the statutes of the institutes. When I was a member of the Geosciences Committee of UGC, we found out that a college in Kerala was running a B Sc (Hons) course in geology with only one teacher. We brought it to the notice of the secretary, who was responsive and agreed to write to the college authorities about the matter. That was my last year in the committee and so I could not enquire about the result. As far as I know, nothing has changed; perhaps the letter entered the bureaucratic labyrinth of UGC and that was the end. This is but one example.

Neither are the State ministries helpful. UGC set up small committees in the late eighties for doling out grants generously to universities and colleges teaching postgraduate courses in order to strengthen their infrastructure. In our committee, demands were made for quick data-gathering and analytical machines which could produce results with high

fidelity. But a government college asked for glassware for its chemical laboratory such as beakers, flasks, burettes, etc. We were amazed and asked the representative – does your State Government not provide funds for the low-cost glassware, especially in view of the fact that you represent the most famous college in your state? He said 'no'.

UGC plays the role of both a watchdog and a promoter, but its impact has been by and large harmful. It was caused by a combination of manipulation by the government, the large bureaucratic web, indifferent leadership and other factors, but looking at the negative effects like making universities less free and robbing them of flexibility raises questions about the need for UGC.

Another important institution, the UPSC is responsible for screening applicants for government jobs and selecting the best among them. The main sieve employed for this purpose is written tests. But the quality of question papers, at least in geosciences is poor. I was shown one such paper set for the Geological Survey of India aspirants full of essay-type questions such as, 'Write an essay on metamorphism as a geochemical process'. This is the title of a chapter in an undergraduate and introductory-level book written six decades ago, and the examinees are all M Sc degree holders. So what are they testing – memory or merit? Obviously, the selection of paper-setters and moderators is not done properly, probably corrupted by cronyism plus mediocrity. It points out that real merit is of no concern for government jobs.

Apart from the mess created in the German versus Sanskrit issue, very few windows are available for knowing the HRD Minister's mind regarding higher education. In a rare statement she revealed that she was thinking of establishing many more IITs. Is having an IIT a talisman? Before going ahead, she should ask these questions and consider these problems. How many ex-IITians are working or had been working as engineers? Has the impact been such that development in engineering practice has acquired a new style or are they aping the styles of other countries? Research in engineering is even more backward than that in science; so interaction with scientists would be valuable. This implies that strong science departments will have to be built in the IITs, not merely as cater-

ing departments for the engineering students. One of the strengths of IITs was the good quality of students they admitted; the measure was their performance in tough admission tests. But a slew of IIT coaching institutes is going to affect the quality; they would be good 'examination technologists' and not necessarily meritorious students. The final question relates to finding enough teachers who will join only if there are good laboratories, good libraries and reasonably peaceful living atmosphere. It is obvious also that more IITs would have little effect on the decay of standards in our universities.

It is relevant here to record the vigour that this government has been spending in building and improving skills on a large scale. The kind of skill that will sell in the job market is innovative and advanced skill, where mental skills dominate over the manual skills. And for mental skill, honing by higher education is necessary.

Overall, the actions of the leaders in the present government do not encourage us to think that the long-standing problems in education will be solved speedily.

Worse yet are the vigorous pronouncements from some members of the BJP parivar. Our forefathers quite a few centuries ago knew travel by air, nuclear fission, plastic surgery, etc. The work of Susruta is documented, as are the calculations of astral paths by Aryabhatta and his guru, which are treated with respect everywhere by knowledgeable astronomers. But the rest are bunkum. The mindset of many ancient Hindus preferred mythical and supernatural causes; hence in spite of knowing the scientific truth behind solar eclipse, the Hindu astronomers preached that Rahu gobbles up the Sun during the eclipse. And Rahu is doing well even now, thanks to the astrologers. I do not understand what these people are aiming at. Is it to infuse pride in us or to suggest that we do not have to learn anything from the other countries, our span of knowledge includes everything worth knowing from ancient times. But one thing is for sure, these obscurantists and philistines, especially if they are close to centre of power are serious obstacles that can hold up progress.

### *The role of society*

People choose their careers often on the basis of the value system of the society.

Observations and family trends are determinants of the personal taste. To these are added their inborn talents. In Coorg, Karnataka, kudos is reserved for good fighters, so the best of the young choose military careers as evident from the large number of distinguished soldiers originating from the region. In Bengal, families seldom ask the young to prepare for going into business; they and the Bengali society's ethos would encourage scholarship as well as creative arts. This is why, at least until the fifties, Bengal has produced many notable scholars in humanities and sciences, significant musicians, poets and novelists, and film makers.

But value orientation has changed. Simple living is out and thanks to the media, especially TV, acquisition of fashionable goods, cars, electronic gadgets are deemed to be a must for a happy life. The aspirations have spread wide, even to the homes of people with low incomes.

Look at Gujarat, and there is a chance that the Gujarat model may affect the field of education also. There are many problems in Gujarat as the eminent Gujarati Mallika Sarabhai recently pointed out. Sixty thousand small industries failed, fits became fitter and near-fits withered during the Modi regime. The model of growth during the past 15 years was not inclusive and the growth of education as expected nil or negative. Many eighth grade students could not solve problems fit for third grade. *The Indian Express* (20 September 2014) published a report by two researchers on Ahmedabad Gyanshala schools and the AMC (Municipal Corporation Board) schools. In tests, the students of the former group consistently scored much higher than those of the latter. So, the AMC Chairman's diktat was to curb the spread and activities of the Gyanshala schools.

However, there is hope yet for our education system. First, ministers and

administrators also learn and an important part of learning is unlearning and shedding the previous prejudices. Second, using the penetration of computer in almost all fields as an example, the rapid advances and sophistication associated with computer use, jobs in this field will demand higher and progressive levels of education. In other words, before praying for blessings from Lakshmi one must obtain Saraswati's blessings. This could provide strong stimuli to improving the health of our higher education system.

1. Desiraju, G. R., *Econ. Polit. Wkly*, 2008, pp. 37-43.
2. Taylor, M. C., *Nature*, 2011, **472**, 261.

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