Higher education in science and a National Science University

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A proposal for a National Science University, made and actively pursued by Professor Swadesh Mahajan, a theoretical plasma physicist at the University of Texas, Austin, USA is being discussed in the higher echelons of government and educational support (UGC). The proposal suggests that such an institution can make a qualitative difference in the area of university level education and research in science. The present situation in this area, and our needs are described here after a brief outline of the proposal. Solutions are suggested and the Mahajan idea is looked at in their light.

The Mahajan proposal

The National Science University will combine undergraduate education, graduate education and research in the manner of the great universities of the world. This is unlike research institutes in India which have moved away from education altogether, or universities which have largely retreated from undergraduate education and for a variety of good reasons cannot generally pursue competitive research. To achieve this aim in the area of the basic sciences at the highest level of quality and interactive vigour, Mahajan suggests a small new university with a combined student strength (undergraduate and graduate) of about 1000–1500 and a faculty of about 200. It will have 'an independent charter, without quotas, without binding and suffocating rules', with a 'vibrant fundamental internal democracy, where the best of our youth are exposed to the best of our savants'. The University will require a capital of about Rs 400 crores, about three fourths of which will be kept in trust so that the income generated is used for the operating expenses, the remainder (Rs 100 crores or so) being the startup investment. About half of this entire amount, i.e. Rs 200 crores, or more is expected to come from the Government of India, and the remainder from industry and business sources as well as from non resident Indians. The financial and academic administration of the university will be decentralized. There will be an International Advisory Committee acting as an apex academic body, and a separate Management Trust. I will come to other details later on, but will now backtrack somewhat to put this proposal in perspective by sketching the Indian scene in higher science education, emphasizing the absence of quality undergraduate education and its consequences.

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Higher education in science

Nearly a million young men and women are enrolled for the bachelor's degree in science in our country. (The actual numbers are 1.27 lakhs for 1950–51 and 7.25 lakhs for 1986–87.) Nearly two thousand appear in an entrance test that the Indian Institute of Science conducts for its post B Sc integrated Ph D programme in physics. We find it hard to select the eight or so capable, well prepared and motivated students we need. Our experience with M Sc students is, if anything, more disappointing. Our standards for admission are not unusually high, say on the scale of IIT entrants. On the other hand, if we were to take students after school (the +2 level), and the programme were attractive, it is likely that we could get good students in the hundreds! Another statistic illustrates the situation even better. Out of the 750 students awarded the National Talent Search Scholarships in 1986, only 87 opted for science at the undergraduate level, and only 13 went on to do their postgraduate degree in that field. Finally, about 90% of the undergraduate courses are taught in affiliated colleges (nearly 2000 in number). The tale these numbers tell is easily pieced together.

Till higher secondary classes, a surprising number of boys and girls are educated nearly as well as their counterparts in economically better off countries, though there are deeply ingrained urban/rural, rich/poor and other social inequalities. The main (and serious) deficiency is the persistent discouragement of independent thinking and action. There are strong social pressures on the students to go into professions considered more marketable. The NTS numbers show how successful the pressures are. These exist in every country; the difference here is the lack of attractive alternatives (both in reality and in perception), and the sense of inevitability. Secondly, the quality of undergraduate education in science (B Sc or B Sc (Honours)) is generally poor, ranging from abysmal to reasonably good. Universities, with a few exceptions (these constitute the 10%), have walked away from undergraduate education, leaving it all to colleges. These are generally extensions of schools in mentality and structure. The student comes out mal-

nourished and often crippled at the most critical stage of his or her intellectual growth, and is now well behind contemporaries internationally. One has to compare this with the experience of the same person going, say to Princeton or even a less exclusive university. Such a person will be in a much brighter, larger world and will have opportunities to develop and know his or her capabilities. Closer home, a student at one of our IITs, or the best engineering or medical colleges mingles with practitioners and learns the basics of the profession in an environment which enables growth and demands professionalism.

What I have described above is just a small part of the crisis of quality in Indian higher education. As the Teshoo Lama, the wise old monk in Kipling's novel 'Kim' said: 'Education is greatest blessing if of best sorts. Otherwise no earthly use.' We however seem indifferent to quality, perhaps on the perverse grounds that in a large country, no matter what we do, the right people will turn up somehow. Some mistakenly perceive quality as a device for perpetuating social inequality, not realizing that in the absence of quality, our entire society is condemned to disadvantage in the larger world. Still others view it as a psychological threat!

The consequences for society are at least four:

(i) We do not have enough people with the unique intellectual and practical advantage of an excellent science education, persons with developed scientific abilities and values, functioning in other professions.

(ii) We do not have enough young people of the right type going into science and science-related professions.

(iii) We have a large science establishment which perforce is of low average quality, lacking independence and vigour; its efficacy is further reduced because of its structure.

(iv) There is a migration of motivated young people to more promising surroundings.

Most professional scientists tend to focus on the last three; I believe that the first is at least as important as the other three together. All these add to a serious and growing handicap for our society as it attempts to integrate with the science and high technology driven world.

Solutions

I briefly outline now a set of possible solutions to the root problem, namely the increasing and perhaps critical shortage of science graduates with the right training and motivation*. The problem is complex and deep rooted enough that all of these solutions, and more, will need to be tried together. In describing some, I have benefitted from a detailed grass roots report of a working group on undergraduate science education constituted by the Planning Commission in 1989 under the Chairmanship of Professor V. G. Bhide, formerly Vice-Chancellor, Poona University. The recommendations seem to have been accepted but not implemented.

Reintegration of undergraduate (science) education into universities

Some of our best universities, IITs and post graduate research institutions could open their doors to at least a small number of (science) students after the higher secondary stage. Some of the IITs could broaden out by including life sciences within their ambit. The students would be chosen nationally, for example, by a test or by a combination of criteria. The total number of entering students in all areas of science taken together may be less than a thousand per year. The students could be given incentives such as scholarships. There may be three or four institutions admitting undergraduates in a given basic science subject. These would be spread among universities, IITs and research institutes. The stress should be on the quality of the institution, students and the programme. The details should be left to different institutions according to their lights. This is obviously essential for the vigour and symbiotic growth of the venture. The terminal degree might be a three year B Sc or B Sc (Honours), or a four year B Sc as in the US, or a five year integrated M Sc. The first two leave many more professional choices open for graduating students.

The main hitch I see in this is that the likely institutions may not be interested. They are already overstretched, and the professionally active can barely do their work well given the infrastructure that we have, and the way our institutions have to function. For example, the Indian Institute of Science can do this very well in all areas of science, but I doubt if many of my colleagues would be enthusiastic. Much more support and changes in internal structure are needed to ensure that such places continue to do well what they are good at, and also teach undergraduates.

Improving colleges

Many colleges have a very good tradition of undergraduate teaching. Some others may want to develop such traditions. The best way would be to grant colleges an autonomous status so that they can innovate and experiment, set their own standards, etc. There has been such a provision for more than a decade now, but not

*My colleagues in the life sciences do not feel this so strongly. Perhaps here also, if one increases one's expectations greatly, the shortage is severe.

too many colleges have opted for it and implemented it. Perhaps the birds have been caged for too long, or there are cages outside cages. However, reactivation of this idea, and vigorous practical support for it (improved laboratories, libraries, support staff, better infrastructure, and even better faculty) seem to be the only steps pointing to high quality at low cost and with greater equity. For example, even a hundred such colleges throughout the country (out of a total of about two thousand) can transform the educational scene. I am sure that there are many colleges which would be willing and able to do this, and not just in the sciences.

Raising the average

The above two steps will perhaps affect 15% of the students going in for higher education in science. Unless the average level of the entire undergraduate education activity is raised, we will be practising (as we currently are) a cruel deception in the name of science education. Many traditional routes exist and have been repeatedly suggested with detailed plans worked out, e.g. a single national certificatory B Sc level examination or test; a better system of examination requiring analytical thinking, experimental skill and informed intuition; minimum acceptable syllabi; better textbooks. High technology routes are also possible such as video courses (e.g. a course of lectures on a given subject by an excellent teacher). Tried and successful open university or distance education methods may well be essential. The main bottleneck here (and elsewhere) could be inertia. The present undemanding state is one many are comfortable in, though in reality this means a lifetime disability for students.

New institutions

The suggestions above make use of what exists, and try to improve on them organically. There is a fourth, creative option, namely new high quality institutions such as a new (science) university. Considering that we do not have even *one* university which can be compared to the best in the world *overall*, this is not too much to ask. I am sure there are enough Indians both within the country and without to start and run two or more such universities. Also not lacking are the necessary imagination, organizational ability, and first hand experience as well as the personal commitment. Good partial examples and counterexamples also exist even within our country. A few such universities could have a large multiplier effect through their students, and add qualitatively new strengths in research as well as development if their areas of special expertise are properly chosen. The crucial ingredient is the choice of faculty who can make or mar the institution, and the conditions of working which can bring out the best or the worst. It is also necessary not to confuse quality with glitter or extravagance. A substantial humanities component is essential for any such university.

Prerequisites

We have sketched above some complementary suggestions. For any of these to work, a real commitment to education as perhaps the most valuable investment for individual and social growth is needed. Such a commitment becomes specially urgent in the present climate of economic globalization, where long term success and even survival require a broad, world class education and research base. This fact is being recognized, and needs to be emphasized by concrete steps. Various bodies, most notably the Kothari Commission in the sixties, have recommended with detailed arguments a nearly tenfold increase in investment on education. Most of this should obviously go to educationally empower all our citizens, e.g. by eliminating illiteracy and providing universal high *quality* school education. A small percentage, amounting to perhaps four or five hundred crores per year can transform the higher education scene. Private investment, as well as support from industry (through funding of research/development in specific areas, of scholarships and novel communication media efforts) could contribute uniquely.

As important as commitment to education and financial support is a change in mindset regarding how academic institutions should be run. Internal autonomy, relative freedom from want, and a supportive infrastructure are necessary if academic values and excellence are to flourish.

The Mahajan proposal revisited

Let us look again at the Mahajan proposal of a national science university. From what we have said above, it is apparent that this is *one* of the many ingredients necessary to resolve the crisis of quality in higher science education and its consequences. I believe it to be a very stimulating component. However, the actual proposal is a curious mixture of unexceptionable generalities with an undertone of specific inanities. Some of the generalities as regards structural reform are clearly of wide relevance.

Some of the specific suggestions are decidedly odd. An example is the idea of a permanent international advisory committee, '*in charge* of brainstorming and the creation and evaluation of various gameplans suggested by its members, other agencies, and of course, the faculty'. Another is the suggestion that the national

university be near a major airport, partly perhaps because of the idea (quotas?) that about 20% of the faculty will be mobile, consisting of short term (~two or three months) and long term visitors, primarily overseas Indian scientists. (This calls to mind the picture of a Joe (for Yogesh) Sarma squeezing an eight week course on photonics in between airport dashes and visits to folks back home in Coimbatore and Kanpur.) Such peculiarities run counter to the essential aim of a national university fostering self-reliant excellence. International participation is obviously welcome on the natural grounds of excellence, openness and mutuality. One might have also thought it positively bad to locate a university too close to a Mahanagar; the quality of life and dominant values could be major handicaps.

The preamble of the proposal vehemently inveighs against the Indian science establishment while grudgingly admitting the existence of a few exceptions. It is not worthwhile here to enter into a detailed analysis, but I would like to make one remark. Despite the exodus of many talented young Indians to the West, it is *not* true that in the basic sciences, 'Indians are doing so well abroad'. Two sets of tokens (of high level peer group recognition) bear this out. Two scientists of Indian origin working in the US have been elected Members of the US National Academy of Sciences in the last twentyfive years, out of a total strength of nearly 1700. In the same period, five scientists working in India have been elected Foreign Associates of the same Academy, out of a total world membership of nearly 300. The ten-year-old Third World Academy of Sciences has 43 Indian Fellows, and 8 Associate Fellows of Indian origin. It seems to me that while working conditions need to be better, and while many of our institutions may be too close to equilibrium with the surrounding ethos, scientists in India are not performing very badly. The really difficult question is, why is the Indian contribution to basic science so small, globally, especially at the highest level?

What is to be done?

The national science university is an idea which I understand is being discussed within the Ministry of Human Resources Development and in the context of the Mahajan proposal. This discussion needs to be broadened in many ways, e.g. the following:

i) A larger group of scientists and educators should be involved.

ii) Concrete alternate proposals should be invited for consideration by this larger group. These would share goals such as emphasis on undergraduate and graduate education as well as research, world class quality, internal democracy and assured support.

iii) Since the university (or universities) should preferably be strong in major areas of science education and research that are complementary to those being already pursued well, major funding agencies (DST, DBT, etc.) and ministries (such as MHRD and Environment) should see these as centres in whose creation and growth they have a real stake. Some positive involvement of these agencies could be explored.

iv) Reintroduction of undergraduate science education in some of our best institutions is an attractive possibility requiring much less extra investment and capable of broadly similar results as a new university. It must be pursued at least equally vigorously. The group considering the national science university proposal could also invite plans for such expansion. Clearly, the same necessary courtesies of structural reform and financial well being need to be extended to these institutions also.

Pursuing *only* the new university idea will quite likely further impoverish and demoralize the university/IIT system. Even at that, it may not succeed on its own terms, given our record with such attempts. Merely reintroducing undergraduate education into some of our universities/institutes will not make for the changes a well conceived additional institution of quality can. The two are complementary and must be pursued together as such.

The two other suggestions made earlier, namely improving colleges and raising the average, require a plan for action to be formulated by a somewhat different set of people. The MHRD, either directly or through the UGC, could constitute a committee which needs to consult a very broad spectrum of concerned and experienced groups such as college teachers and management, state education bodies, etc. and arrive at viable plans for raising the quality of undergraduate science education across the board. The Bhide Working Group has made detailed suggestions with financial estimates for both these categories of solutions (excluding the new university idea which it considered but did not pursue in detail, as being too expensive).

In sum, I do believe that this is the time to face and resolve the critical situation in higher science education. Some suggestions have been sketched above.