

Today's scientific scenario and tomorrow's challenges: The case of India

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It is instructive and useful to examine the state of science in the country after 60 years of independence. What one sees is a curious mixture of successes and disappointments, and yet, one cannot but marvel at the great imagination of Pandit Nehru and the Parliament for having committed India to the path of science in the very early years. India is probably one of the few countries where a science policy resolution has been unanimously adopted in the Parliament. We have also had the advantage of sound traditions in modern science, with stalwarts leading scientific research in several areas in the pre-independence period. Since gaining independence, the country has established many agencies and institutions, and some of the mission-oriented agencies have been able to fulfill the objectives and goals set for them. The number of higher educational institutions has also increased enormously over the years.

In the 1950's and 60's, one had great difficulty in obtaining chemicals and equipment and there was an acute shortage of foreign currency. Some of us, who have worked in those hard days, cannot forget how we had to struggle to do reasonable experiments. There were hardly any sophisticated instruments in most laboratories. In spite of the many odds, outstanding research came out of our universities, the percentage contribution of the universities to research publications in the country being well over 50% in the 60's and 70's. Although the development of science was somewhat uneven, with some areas

such as medical and health research receiving less attention, the general feeling by the 1980's was that we were catching up with the advanced countries.

Research facilities have improved significantly over the years in many of our institutions, but our universities have generally suffered from the lack of sufficient investment in infrastructure facilities and faculty development. They have also faced undue pressures from various quarters which have not been conducive to carry out high quality programmes in higher education and research. Although the education provided by many of our institutions may not have been altogether satisfactory, we cannot ignore the fact that we have produced a large number of engineers and scientists. These very people have contributed to our accomplishments in science and technology. The big boom in IT has been possible mainly because of the large number of engineers available, although some of our bright young people have served science and technology elsewhere in the world. Whatever has been accomplished in the country has been possible with a modest investment in education (~3% of GDP) and in science and technology (~ 1% GDP).

In the last few years, there has been a major change in the geopolitical as well as the industrial and technological scenarios in the world. Globalization has had an extraordinary impact on the way we do things. The very objectives and the goals that we had for many of the scientific and technological institutions have changed. Competitiveness has become a more important word than self-sufficiency or self-reliance of the early years. In the mean time, the way we do science has also changed. There are newer areas in science, and newer technologies required to carry out frontier research.

We are facing serious competition not only from the advanced countries in the West, but also from our immediate neighbours in Asia. We have a big giant in China where investment in people and institutions has been very high. China is producing research at a high rate and training a large number of scientists and engineers. South Korea which gained independence around same time as India, has blossomed in science and technology and industrial development. The investments of South Korea in higher education and science are some of the highest in the world. Even smaller countries like Taiwan and Singapore are investing heavily in science and higher education in recent years.

Asia has emerged as a major contributor to science - next only to Western Europe and the US, each contributing roughly one-third of the world's research. Within Asia, the contribution from India is, however, coming down drastically. Today, India's contribution to world scientific research is less than 3% and the contribution from China is soaring. The contribution from India is roughly equal to that South of Korea. The number of Ph.Ds produced from India is small (~4000) compared to that produced by Brazil (~10,000) or China (~16,000). We often hear statements from the IT sector and the industry that the manpower we produce is not of sufficient quality. In scientific research, the problem is even more acute. If one takes the top 1 percent of the research papers in the world, the percentage of Indian contribution is less than 1%. A mighty country like India has to produce more science and of better quality. I would say that we should be contributing at least 15% to the world's scientific research and 4 – 5 % of the top 1% of the research papers. Individuals and institutions are nowadays evaluated in

terms of the impact index based on research publications. A new index (H-index) is being employed to quantify the impact of the contributions of individual scientists. It is unfortunate that the number of our scientists with a high H-index is rather small. All in all, the status of basic science in the country is not encouraging. One of the main reasons for the present situation is that our universities are no longer able to produce as much research as they used to. In some of the crucial areas such as biomedical research, our effort is marginal. Furthermore, even our leading scientific institutions are performing below par compared to similar institutions elsewhere. And then, the number of talented young people taking up science is decreasing. They are whisked away to other areas before they are old enough to make up their minds. There has also been a continuous demand for our Ph.D's and graduate students not only in Europe and America, but even in some of the Asian countries.

Clearly, we have to do many things on a war footing to improve the situation. If we have to produce more and better science from here, we have to invest more effort and money in higher education to bring up the quality of at least some of our institutions to a level prevailing in some of the Asian neighbours and in Western countries. The private sector should partake in this effort in a significant way. In addition to supporting Universities, we will have to create better institutions to provide high-level education for our scientists of the future.

We are facing an unusual situation today. Money may be available, but not minds. We have to, therefore, do more than increasing the investment in higher education and

science. It is only when there is unison in our national goals and objectives, that we can make a determined effort to solve the pressing problems facing us and make up for our deficiencies in science, engineering, agriculture, medicine and other areas, and at the same time, compete in certain chosen sectors. While there is some recognition of such issues in the government and elsewhere, we need a greater commitment from our scientists and other colleagues, policy makers and administrators and the society as a whole, to uplift our educational and scientific institutions as a matter of national priority. If such a commitment does not come forth, I foresee a bleak future. There is already an acute shortage of high-quality scientists and engineers, particularly leaders who can take up major tasks. It is likely that a major hurdle to our scientific progress, at least in the short or intermediate term, will be the shortage of talented manpower, particularly in the public sector.

I do not want to end this article on a pessimistic note. Although things may get worse before they get better, I feel that we can really circumvent most of problems by consciously devoting ourselves to the training of a large number of young people with high quality education and research experience. Being a young country, we have extraordinary responsibility for the future of science in the world as a whole. With the strong support of the government and the society, we can create a situation in another 10-15 years when bureaucracy would be minimal and intellectual effort high and cater to the needs of the entire world besides taking care of our own. We can then hope to become a major power in the world because of our strong science base.

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