It is time to integrate science and technical education at the undergraduate level

In the present scenario of undergraduate education in India, after XII standard, it is customary for students of natural sciences to branch out into science and technical education. These students, thus enroll in engineering, medical or science colleges. In recent times, the tendency of students who have performed well at the class XII level is to take admission in technical colleges. Most often, students who do not make it to technical colleges join science colleges. The exceptions to this segregation are a few Indian Institutes of Technology (IITs) which offer integrated M Sc degrees for a small number of meritorious students.

This segregation of students into science and technical institutions is highly detrimental for both the streams. The absence of a good peer group in science colleges leads to lack of motivation for the students of science. Besides, a vibrant intellectual environment is necessary to challenge the students and expand their outlook. The absence of such an environment is hurting students of basic sciences, while technical students are suffering from a poor background in the much needed science subjects.

The divide between science and technology is artificial and is blurring each day. To be a good technologist, exposure to science is essential, just as to be a good scientist knowledge of technology is an asset. For example, in the present day, most experimental science requires facility with fabricating as well as tweaking equipment which benefits greatly from a knowledge of engineering. A good understanding of basic science is necessary, for example, in the development of advanced materials for technological applications. It is only when both science and technical education coexist in the same institution can we see development of a young student into a competent scientist or technologist.

Unfortunately, this trend of segregation of technical and science education has been reinforced in recent years by starting new Indian Institutes of Science, Education and Research (IISERs) and new IITs. The former was more a reaction to the emergence of the IT sector as a big employer leading to flow of talent towards this sector. It was envisaged that IISERs would help in stemming this flow of talent away from science by attracting meritorious students into premier science institutions. Regarding the new IITs that have been started, it is mainly due to the fact that the IIT system had stopped growing after the formation of IIT-Delhi in 1963. The next one to come up, IIT-Guwahati had to wait over 30 years and was started as part of the agreement to end the strife in Assam. Since then, no new IITs were formed until 2004, with the exception of Rourkee University which was upgraded to IIT status in 2001. Since 2008, eight new IITs have been formed to cater to the ever increasing demand for quality technical education, without giving thought to the integrated structure of undergraduate education in the country. Thus the first decade of the millennium which witnessed the establishment of new premier educational institutions was indeed a saga of missed opportunities to integrate science and technical education.

Arguably, the best undergraduate education is provided in the universities in the United States. Here, in almost all the universities, science and engineering undergraduates study together. They often have common courses, which leads to healthy exchange of ideas between students of different disciplines. The universities also provide an opportunity to interested students to graduate in more than one subject as majors. It is also not unusual to see double majors in seemingly as disparate subjects as music and mathematics, or biology and computer science. What appears as unrelated subjects may actually find some common thread because of such creative choices of majoring subjects.

It is time we remedy this situation nationwide by integrating science and technical education in all the universities and national institutions. As a first step, we should expand science education in all IITs by increasing the intake into science streams. We should include engineering education in IISERs, so that science students have exposure to engineering. We should bring science and engineering education at par by introducing four-year science degrees, and also include some basic courses in engineering as core requirement for students of science, as has been envisioned in the four-year BS programme set to start in the Indian Institute of Science, Bangalore, from the next academic year. Integrating medical education with science and engineering education should be taken up subsequently as this would require establishing infrastructure such as full-fledged hospitals.

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Fate of an Indian technology developed for mosquito control

Mosquito-borne diseases have been major contributors to the sufferings and mortality of billions of people, especially in the underdeveloped and developing world. They have been rightly termed as neglected tropical diseases (NTDs). NTDs such as filariasis (elephantiasis) and leishmaniasis, inflict severe social stigma although they may not cause mortality. The battle of mankind with their insect carriers has been going on for decades with the invention of chemical insecticides. But, these arsenals became undesirable and ineffective due to the resistance developed by mosquitoes and concerns about their hazardous effects on man, animals and the environment. This calls for the search for alternate tools

which are mosquitocidal, and safe to man and environment. The Vector Control Research Centre (ICMR), Puducherry, under the Ministry of Health and Family Welfare (MoHFW), Government of India, isolated an indigenous strain of a bacterium, *Bacillus thuringiensis* var. *israelensis*. This strain was found highly lethal to a variety of mosquitoes that transmit filariasis, malaria, dengue and other vector-borne diseases. The Pasteur Institute, Paris, a WHO collaborating centre for identifying and testing bioefficacy of biocontrol agents, rated this strain as the most toxic.

Over a period of two decades, the Centre worked on aspects such as bioefficacy against a variety of mosquitoes and safety to non-targets organisms, especially economically important insects such as honey bees and silk worms. The bacterium was found highly effective in killing the aquatic stages of mosquitoes and not harmful to any other organisms, except mosquitoes. Scientists continued their efforts towards developing cost-effective production and formulation technologies. The agent was tested in several distant geographical areas with different geoclimatic conditions for its mosquitocidal efficacy, shelf-life, etc. and was found to be fit for an efficient mosquito control operation in those areas. Thus, an indigenous bio-friendly mosquito control agent was developed. Further, the efficacy of this agent was tested independently by other national and international agencies and certified to be highly effective.

Based on these facts a few Indian entrepreneurs came forward to commercialize this product and take it to the public. But, to their dismay, they lost their money. While they struggled to obtain the Central Insecticide Board (CIB) registration, their greatest block was the approval of their product by the National Vector Borne Diseases Control Programme (NVBDCP), another body under MoHFW. This organization has approved a product imported from Russia, and turned down the product developed by Indian scientists. The reasons given for not approving the indigenous product by NVBDCP have been changing during successive years at the meetings of the Technical Advisory Committee that came out with the recommendations leading to blocking of the indigenous product from marketing. It is to be noted that this product has met all the requirements necessary for obtaining the clearance by the CIB, an apex body which gives approval for use of insecticides in the country. NVBDCP has been successfully blocking the sale of indigenous products because of reasons best known to the health officials of State and Central agencies, including the highest level of health authorities of the country. It appears that all this is to protect the interests of one firm, Biotech International Ltd, New Delhi. This company has been doggedly pursuing the prevention of not only indigenous products, but also other products of similar type, including those of multinational giants such as Sumitomo, let alone the small Indian investors.

It is thus one government organization with the responsibility of public health sabotaging the efforts of another government research organization committed to taking indigenous research to the health of the nation. If this is the fate of an indigenously developed technology by an institute of national importance, the fate of those technologies that are developed at lesser known institutions will end up on papers. When there is a lot of public outcry about public-funded research not reaching the common man, an indigenous product with immense use in combating NTDs is struggling to survive.

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Indian science is speeding up

Arunan[1] has focused on some of the pitfalls and burning issues of the Indian science scenario. It is true that India is lagging behind China in scientific research, but it has the potential to stand neck-to-neck with many developed countries, including France, Germany and the United Kingdom. Though India may take some more time to gain a prestigious position in the scientific world, data from many of our research laboratories already suggest that Indian science is ready to make a big leap.

Our scientific funding in S&T is rapidly increasing every year. We spent more than Rs 29,000 crores in 2010, which was about 16% higher than the S&T expenditure in the previous year. India can lead in the scientific world if expenditure on higher education is increased substantially. Institutions like IITs, IIMs and IISc have their own importance in professional education, but the vast majority of the younger generation should derive benefits from higher education.

We must ensure that all science subjects have good laboratory manuals and more emphasis is put on research methodology and training skills, so that a skilled and dedicated 'science force' may be developed to take up challenges of the new millennium.

1. Arunan, E., *Curr. Sci.*, 2011, **100**, 21.

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