Some ailments in physics education in the country

Srinivasan[1] in his Guest Editorial has raised the question 'What ails physics education in the country'? In India, most of the undergraduate (UG) colleges where the bulk of physics teaching is done are still affiliated to one university or the other. The autonomous colleges that can frame its own curriculum and run the evaluation processes independently are much less in number. So the UG teachers put stress on teaching whatever they have been asked to by the affiliating university, irrespective of the quality and ability of the students they receive. Now we are talking about research right from the UG level. It is indeed a bit unkind to expect that the training and exposure or possibly even orientation for research for a UG student will come from the 'average teachers' in a college. We should not forget that the basic role of a UG college is to impart the right kind of general education to its students, who will fork out to a wide number of jobs in the service sector. UG classes do not make a specialist out of everyone.

Some of the physics students in the UG colleges do have a target to go for higher studies, may be research work, but most of the UG colleges do not have more than a handful of students of this type. Some students want to pursue higher studies in physics mostly because they target teaching positions in schools and colleges, but research as a career option remains a far cry. So, most of the UG colleges are not in a position to orient the majority of their students for research or similar activities.

I agree with Srinivasan that the UG teachers have not shown much interest in upgrading their knowledge. There is no objective evaluation process for the teachers in the UG level. Suppose the existing evaluation process indicates below-average performance by a teacher, what sort of step can the authorities take against him? There is no mechanism to check his contribution in classroom teaching or laboratory training. Srinivasan has mentioned about the good teachers without a Ph D and all of us are familiar with this. A good number of them are indeed excellent in classroom teaching or in imparting laboratory trainings. But what about the much talked about UG research? Can they motivate the students for this? Doing a routine work and exposing the students to new vistas are two different ball games.

With a few rare exceptions, a teacher in a UG college neither has a Ph D student nor a research laboratory. Often, a teacher is not the right person to motivate a student for UG research or even project work as part of the curriculum. On the other hand, UG teachers with Ph Ds often feel they are underemployed and should have been in a research institute or at least in a university department. Their attitude becomes a problem for the workplace. Most of the teachers attend refresher courses to fulfil the conditions for promotion. What are the learning outcomes of these courses? Have we ever bothered to evaluate them?

With the emergence of the IISERs and some other special institutes, we are possibly producing at least two distinct classes of physics graduates/postgraduates (PGs). Incidentally, those who are passing out of the UG and PG colleges or from university departments are found to take care of the teaching at the schools or in most of the UG colleges. The young students get their first exposure to the subjects through these teachers. There is no system worth mentioning for imparting periodic training and orientation to this section of teachers, which is the need of the hour.

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Regulated animal dissections in Indian curricula as a measure to control invasive species

Recent restrictions and regulations put on the animal dissections in academic curricula of life sciences at the undergraduate and postgraduate levels have met with a lot of criticism from researchers and university/college teachers[1]. Basic life sciences subject like Zoology have always depended on dissections for studying various aspects of animal morphology, anatomy and physiology. Such a ban will most certainly affect the quality of teaching, learning and research in these fields[2].

Invasive species are a serious threat to the native biodiversity and can lead to species extinctions and subsequent alteration in ecosystem function[3]. USA has already incurred a loss of about 120 billion dollars/year and nearly 42% of the threatened or endangered species are at risk due to such exotic species[4]. Strategies using biocontrol agents to curb invasive species involve risk of undesired impacts on non-target (including native) species populations, and their case studies have been debated[5]. To be on the safer side with regard to the environment, the simple logic that periodic and mass physical removal of any unwanted organism will control outbreak as well as its side effects. This action does not suggest halting any other control measures for invasive species; the advantage being that their side effects (if any) will be minimized and quantifiable.

India has its share of such invasive species, of which many were introduced as an alternative food source. Species like Giant African snail *Lissachatina fulica*, Tilapia *Oreochromis mossambicus*, Common carp *Cyprinus carpio* and the Mosquito fish *Gambusia affinis* are widely distributed in India. In the global context, these feature in the top 100 invasive species of the world[6]. Some

literature is available on controlling a few of these species as well[7,8]. The fact that they still position in the top 100, reflects the urgency to bring their populations under control. The species listed above are easily identifiable and substantial literature exists on various aspects of their biology.

Given this information, we suggest regulated use of these invasive organisms for animal dissections in different zoological research and study curricula. Such a substitution adheres to almost all of the University Grant Commission (UGC) recommendations (under Section B – Objective/Aim to be achieved). Dissection of invasive animals partly adheres to recommendation B.1.1, as none of the suggested animals comes under the Wildlife Protection Act currently enforced in India. This substitution does not affect B.1.2, since dissections of these animals would also be regulated. B.1.3 could be modified by substituting 'invasive species' in place of the native animal species. Due to this, the onus of mass captive rearing, especially in smaller colleges with limited facilities, will be lessened to an extent. B.1.4 could be modified on the lines of B.1.3. For recommendation B.1.5, a species selected for dissections in postgraduate curriculum could in itself be an invasive species. The syllabus could be amended accordingly, as there is a lot of literature on all biological aspects of these animals. Using the invasive species for dissection would not directly affect any long-term recommendations given by the UGC.

Public dissemination of such knowledge will definitely help governmental bodies to modify the regulations as is already being considered by the Ministry of Environment and Forests[9,10]. Use of such species will not only aid the students and researchers, but also help in controlling the damage caused by them on the native flora and fauna.

We completely agree that rampant use of animals caught in the wild for vivisection, especially the scheduled species[11], should be avoided at all costs. Substitution of exotic species for regulated dissections in the present curriculum can be a good strategy for both alleviating the pest problem and not compromising on quality of life sciences education.

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S&T R&D in Indian academia

The recent well-thought-out comments by Narayana Murthy[1] in his convocation address at the Indian Institute of Science (IISc), Bengaluru have elicited equally interesting comments by scientists, including Rao[2] and Mashelkar[3] among others.

I would like to focus on two kinds of R&D carried out in our academia.

The first is basic research which is curiosity-driven and is of a long range. The results can be major contribution to global knowledge and can receive worldwide recognition. The work of S. N. Bose, G. N. Ramachandran, etc. falls in this category, as noted by Mashelkar[3]. For India to make greater progress and impact in this direction calls for:

(1) Careful identification of the rare individuals who possess the intelligence and deep commitment for such research. These are likely to be found in a few of our leading academic institutions (IISc, IITs, IISERs) which have the proper ambience. They may constitute 5%–10% of the faculty in these institutions.

(2) Having identified such geniuses, support them handsomely with 5-year renewable grants instead of the usual short-term grants. The support comes basically from public (Government) funds. Rigorous selection of the awardees is essential because our Government funds for research are very limited by world standards.

(3) Once identified and funded, they should be left alone to pursue their chosen endeavours, as pointed out by J. B. Conant, President of Harvard.

(4) Administrative and bureaucratic obstacles should not come in their way.

(5) The progress of their work and publications are to be reviewed by a competent committee (with international participation) leading to support at an enhanced, or similar or lower (including none) for the next 5-year term.

(6) These steps, if implemented fully, will produce some Boses and Ramchandrans and maybe Ramans and Ramanujans.

The second area, which is of equal importance, is R&D to solve problems facing Indian society and industry. In this case, the first crucial step is to identify such problems by faculty members or the beneficiaries in industry or society, preferably jointly. Then a proposal is to be prepared, again with inputs from both sides to an appropriate extent, stating the