CURRENT SCIENCE

Volume 108 Number 10 25 May 2015

GUEST EDITORIAL

What ails physics education in the country?

I have been actively involved in physics education from 1962 till date. I have seen, with concern, the deterioration in quality of physics education in colleges and universities across the country. There has been a large increase in the number of colleges and universities in the country since independence, and one should expect some deterioration in quality. But there are other important reasons. I would like to highlight some of these and also suggest a few steps that should be taken, in my opinion, to remedy the situation.

From 1900 physics has seen explosive and revolutionary developments in all its sub-areas. Established ideas in classical physics, which could be understood in terms of mental imagery, have been overthrown. The subject has become more and more dependent on advanced mathematics, which a common student finds difficult to understand. Elsewhere in the world, rapid advances in electronics and instrumentation have kept pace with theoretical advances in physics, making experiments more elaborate and sophisticated. While researchers in theoretical and experimental physics from well-recognized institutions in the country have kept pace with these developments, the average teacher in a college has been left behind. In their eagerness to update the physics curriculum periodically, boards of studies in universities have made changes in the curriculum based on the cut-and-paste model without giving any thought to building a firm foundation in basic physics. If you look at the curriculum for M Sc physics of any university you find highly advanced theoretical courses, often taught by teachers who have had little exposure to these subjects. At the same time courses on experimental techniques, like measurement and instrumentation techniques, vacuum techniques, low temperature and spectroscopic techniques are not included.

The situation in the laboratory programme is even worse. An impression has gained currency that one needs costly electronic and other equipment to conduct advanced experiments in physics, and colleges do not have enough funds to procure them. The instrument manufacturers in the country are still producing commercial equipment for physics experiments which they had designed several decades ago. They have made no attempt to incorporate improvements in design. Colleges have found it easier to dispense with laboratory experiments than to improve them. There is an apology for practical laboratory programmes in which neither the teacher nor the student shows any interest. The old equipment often gives faulty results and the student is unable to see the validation of the theoretical ideas taught to him through experiments in the laboratory. In the absence of a solid practical learning, graduates from colleges and universities have a shallow understanding of the subject and cannot solve even basic practical problems. They become unemployable.

To improve education in physics, the most basic requirement is an improvement in the quality of teachers. It is not enough to employ a person with a Ph D degree as a member of the faculty. The teacher should have a good understanding of basic physics and should be able communicate well. A Ph D degree alone does not guarantee these qualities. A person with a Ph D degree has highly specialized knowledge in a restricted area of research. Often such a person continues to publish some papers in this area and does not have the breadth of outlook required to teach effectively. In my long career I have often met good teachers who had only a Master's qualification and who were discriminated against because they did not have a Ph D degree.

It is acknowledged that the role of a teacher in society is important as he/she is the mentor of many generations of young students who will shape the future of the country. As such, great care should be exercised in the selection of teachers. The existing selection procedure is too casual to locate teachers with a depth of knowledge, ability to communicate, and motivation to inspire young inquiring minds. These should be the important criteria involved in the selection of a teacher. However, in the existing political climate in the country a change in the selection procedures may not be possible.

A teacher once appointed should be evaluated periodically. This should be done both by the students and by a group of peers. Procedures must be worked out carefully to carry out a fair and unbiased evaluation by students. I believe unbiased student evaluations, done by a large batch of students over 3–5 years consecutively, will give

a good idea of the ability of a teacher. In addition, there should be periodic evaluation by peers of a teacher's performance in the classroom to assess how the teacher communicates and if he/she has kept abreast of new developments. These evaluations must count for promotions. The suggestion of student evaluation of teachers may be opposed by many. But as the consumer, the students' opinion of the teacher is important.

Any professional is expected to keep himself informed of the developments in his field. Since developments in science come at a rapid pace, it is all the more important for a science teacher to be well informed of these developments. The Academic Staff Colleges have been conducting three-week refresher courses to update the knowledge of teachers. This is a laudable idea. I have given lectures in some of these courses. I feel that in many cases the courses are not properly planned; they lack focus. The lectures by different academics do not dovetail and are not connected by a common thread. Linking participation in these courses with promotions is a bad idea. Teachers attend the courses only to fulfil the mandatory quota for their promotions, but seldom show any interest in the lectures or ask questions. There should be an audit of the performance of Academic Staff Colleges to see how the courses conducted by them have improved the quality of teaching.

A committee of knowledgeable physicists should plan model curricula for all courses starting from the PUC up to M Sc level. The curriculum must be balanced both in theoretical and practical content. The curricula must spell out the syllabus for each subject to be taught and must list out the experiments to be performed in the laboratory. At the Bachelor's level more importance should be given for laboratory training than what is being done today. At the M Sc level there should be a few core courses and many optional courses. The student may choose combinations of interest to him/her. Universities should be free, within certain limits, to adapt this curriculum to their needs.

Autonomy has been given to select colleges of repute to frame their own syllabus and conduct their own examinations. But it is disappointing that many such colleges have not used this autonomy effectively.

Physics laboratories need to be upgraded. It is possible to make drastic improvement in the laboratory programme at moderate expense. Equipment at moderate cost to carry out good experiments is being produced under license from the Indian Academy of Sciences, Bengaluru. In the 68 refresher courses in experimental physics that I have conducted since 2001 all over the country, I have taken pains to explain to the teachers that it is possible to design simple electronic circuits and mechanical items to conduct good and advanced experiments which produce reliable and good results. An improvement of laboratory programmes at the B Sc and M Sc levels is an urgent necessity.

These are some points on which action needs to be taken. There are several others as well, which could not be mentioned due to limitations on length of this column. What I have stated above represent my considered opinions based on my experience as an educator of physics. I do not expect everyone to agree with the points I have made. There will be other distinguished teachers who may have other points to make. If this editorial serves to bring about a useful discussion on the problems of physics education in the country and how to solve them, then it will have served its purpose.

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