Reformation of science education in Indian universities

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In the developed countries, various discoveries in science have come through scientists working in the universities, which play a significant role in the promotion of science and scientific culture. People in those countries understand that new discoveries in science give them a better quality of life. Such an awareness about science does not exist in our country. In the pre-independence period and even up to the late sixties, our universities were producing world class science. In the beginning of the sixties and thereafter, the emphasis has been to establish institutes of technology and research laboratories. In this process, the universities which are the training centres for young graduates and which are also the interaction centres for a large cross-section of the population were ignored.

The number of universities did not grow proportional to the growth in population. Financial resources did not increase in the ratio of increasing prices. The continuous increase in the number of students and decrease in the financial resources created a frustrating atmosphere in the universities which led to all the maladies presently existing in the university system. Basic sciences became the first casualty. Students with competitive spirit lost their interest in basic sciences due to change in the socio-economic situation. Now the research laboratories are in need of bright young science graduates but the universities are not able to attract and train them for competitive utility. Hence the following reforms are immediately needed for the university education system and for teaching science subjects in particular.

Expansion of university education system

Rural development programme

Each university/engineering college must adopt at least 5 villages in its vicinity for a period of five years. Students and teachers must actively participate in the promotion of education, health and self-employment programmes in these villages. Computer networking and internet facilities should be utilized for this purpose. This programme will remove illiteracy and poverty in rural areas and promote awareness about science in the society. If 500 institutions participate, 5000 villages will develop in 10 years. This process must continue for national development.

Increase in the number of universities

There are about 240 universities and nearly the same number of technical institutes. Thus there is nearly one university and one engineering college for about 4 million people. This ratio is too insignificant for any kind of higher education in this country and science education in particular. The number of universities with emphasis on science teaching must be increased in a phased manner. Nearly 500% growth is needed to have a significant network of higher education in the country.

Admission of foreign students

At least 10 universities should be identified to admit foreign students on payment of full fee as in any developed country. Learned faculty should be appointed on attractive salaries. These universities will also attract those Indian students who go abroad for higher education on payment of full fees in foreign currency and will be financially self-sufficient and will create an international competition among Indian students.

Strengthening of university education

Change in the administrative structure

The strength of the non-teaching staff must be reduced to just one-third of the existing strength. One person, one responsibility formula can be adopted. The policy of continuous change in fee structures, rents, and other incomes of the university can be adopted. These measures will increase work efficiency and reduce budget deficit of the universities.

Interdisciplinary teaching and research

In modern research, there are no boundaries between subjects like physics, chemistry, mathematics, biology, etc. The experimental and computing techniques have much in common to study various problems in physical, biological and computational sciences. Therefore interdisciplinary teaching and research activities must be promoted in the universities. Graduate students must be allowed to study various combinations of science subjects according to their needs. Research projects involving various facilities existing in different departments of the university must be given priority. This will generate comprehensive and competitive scientific results with limited financial resources.

Research programmes in the universities

Universities–central laboratories interaction

The universities are the intellectual human resources centres. But the UGC does not have enough grants to create infrastructural facilities and to support worthwhile research projects in the universities. Most of the research work in the universities depends upon financial assistance from organizations like DAE, DST, CSIR, ICMR, ICAR and ISRO. This situation needs a change. The central research organizations must come forward to establish laboratories for specific research in the university campus. Teachers and students from the universities must be allowed to participate in research work in these laboratories. Scientists of these laboratories must be allowed to teach and train students who could be usefully employed in similar laboratories and industries. This arrangement will be beneficial to both the institutions and research workers. Mission-oriented research projects can be carried out very effectively and economically in this system.

Universities as resource centres for industrial development

Long-term industrial technology projects should be prepared in consultation with scientists and engineers. Scientific problems of these projects can be taken up by university rsearch laboratories in a time-bound programme. Engineering institutes must take up design and fabrication jobs. Thus a project indigenously conceived and designed by Indian scientists and engineers can be patented. A part of the financial gain by the industries should be given back to universities and engineering institutes. Such collaborative programmes will generate finance and provide employment opportunities.

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SCIENTIFIC CORRESPONDENCE

Indoor radon levels and inhalation doses to population in Punjab

During recent years, an increasing concern has been expressed over the presence of radioactive elements in the human environment and their health hazards, particularly radon and its daughter elements which account for nearly 60% of the total radiation dose received by humans from all sources[1]. Radon and its daughters emit alpha, beta and gamma radiations as they decay. Internally deposited alpha radiations are the most damaging as their relative biological effectiveness is about 20 times that of beta radiations. A high dose to internal tissues is delivered not by radon but by its short-lived daughters[2,3], Po, Pb and Bi. The main health hazard associated with radon and its daughters is lung cancer. This has been concluded from various epidemiological studies on miners[4,5]. Various case control studies in different parts of the world also suggest some kind of correlation between enhanced radon levels and lung cancer[6].

In the light of these facts, an extensive survey was conducted in Punjab, India for which no comprehensive data are available. This survey has been conducted as a part of the national coordinated radon project sponsored by Environment Assessment Division (EAD), Bhabha Atomic Research Centre (BARC), Mumbai. The authors' laboratory has been engaged in radon concentration studies in dwellings in other areas too[7–9].

A time-integrated track-etch technique using a plastic detector has been used for this survey. Cellulose nitrate, commonly known as LR-115 type II has been employed. Though the survey was performed with the twin chamber dosimeter cups (Figure 1), due to the problem of calculating the concentration of thoron daughters, it has been decided to present the data only from the bare card which records the alpha tracks due to both the gases and their alpha emitting daughters.

The survey was conducted in three phases. In the first phase, from March 1997 to March 1998, 90 dwellings in six districts, viz. Bathinda, Mansa, Moga, Patiala, Faridkot and Sangrur, were monitored. In the second phase, from August 1997 to August 1998, 69 dwellings were covered in three districts of Amritsar, Gurdaspur and Jallandhar. In the third phase, from November 1998 to November 1999, 39 dwellings in the districts of Hoshiarpur, Ropar and the Union Territory of Chandigarh were covered.

The dosimeters were generally kept in the dwellings at a height of 3 m above the floor. After exposure for the specific period, the detectors were collected and replaced by fresh ones. In this way data for the whole year were collected in the form of seasonal cycles. The exposed detectors were etched in 2.5 N NaOH at 60°C for a period of 80 min in a constant temperature bath (Tempo shaker water bath). After etching, the detectors were peeled off from the plastic base and counted using a spark-counter designed by the Radiation Safety Systems Division (RSSD), BARC. It is a specially-designed counter meant for counting the alpha tracks in pelliculable LR-115 detectors. The central 1 cm^2 area of the detector film was chosen for counting for all the detectors films. This instrument (Figure 2) consists of two electrodes between which the detector film is placed and suitable voltage applied, so that sparking takes place through the holes produced by alpha particles and is developed in subsequent etching of the film.

When an alpha particle is incident on the polymeric detector, it causes damage in the molecular chains and produces what is called a latent track. This damaged region is chemically more reactive than the other parts. So, during chemical etching, the damaged region known as latent track is converted to a through hole as the thickness of the detector is only 12 μm. Before counting, the samples are pre-sparked at a voltage of 900 V. The purpose of pre-sparking the detector before counting is to convert any partially developed holes into full ones if any residual thickness is remaining after etching, which is expected due to the difference in the energies of the incident alpha particles. For this, the film was placed on the electrode which has an area of 1 cm^2, then the mylar film