

Refresher Courses at the Indian Academy of Sciences

The Science Academies of India are involved in conducting programmes aimed at improving science education in the country. These programmes are focused at three levels – college and university teaching, and research. One key activity is the Refresher Course, mainly meant to help teachers improve their background knowledge and teaching skills.

Genesis of Refresher Courses

In July 1994, the Indian Academy of Sciences, Bangalore, under the Presidentship of Roddam Narasimha constituted a Panel to study the state of university science education in the country¹. This panel, chaired by N. Mukunda, prepared a document that included several recommendations to improve the quality of science education and teaching, and to attract students to careers in science. The panel, comprising 11 members, submitted to the Academy in December 1994, a document titled 'University education in science'². Of the several significant recommendations made, one was the institution of sustained teacher training programmes. To achieve this goal, two kinds of activities were later recommended by the panel – two-week Refresher Courses for Teachers and short-duration (two or three days) Lecture Workshops for Students and Teachers at the M Sc and Ph D levels¹.

The suggestion made regarding Refresher Courses, as one of the panelists, R. Srinivasan reminisces³, was that Fellows of the Academy would conduct these courses in various areas of science. It was also suggested that lectures be delivered by distinguished scientists, including Fellows of the Academy at a level familiar to teachers. These courses were meant to update teachers and students with recent advances in the scientific area dealt with in the course³. Accordingly, in 1999, Lecture Workshops were started and the first Refresher Course in Mathematics was held at Panjab University, Chandigarh. As of December 2010, 84 Refresher Courses have been held. Of these, the series in Experimental Physics, designed by Srinivasan, deserves special mention.

A decade of Refresher Courses in Experimental Physics

In the first few years, Refresher Courses were mainly theoretical in nature³. It was in 1999 that Mukunda discussed the idea of a course in Experimental Physics with

Srinivasan and K. R. Rao. Both Srinivasan and Rao were receptive to the idea and searched for a young and committed person to help them conduct the course. When Rao attended the annual meeting of the Academy in 2000 at the National Institute of Oceanography in Goa, he came across K. R. S. Priolkar, a physics teacher at Goa University. The first course in experimental physics was held in Goa in 2001, with 20 participants selected from across India³.

The Refresher Courses in Experimental Physics were aimed at improving laboratory programmes in physics at the B Sc and M Sc levels⁴. In December 2010, the 25th Refresher Course in Experimental Physics was held (Box 1) in a laboratory set up in Bangalore. According to Mukunda and Srinivasan, members of the 1994 Panel, these courses

have had a beneficial impact across the country. This is supported by the fact that about 20 universities in southern India have included these experiments in their M Sc syllabi¹.

Till 2006, these courses were not popular. In 2006, about 25 teachers nominated by the Indian Association of Physics Teachers were invited for a three-day meeting at Bangalore, where the experiments designed for the course were demonstrated and suggestions were sought from the teachers to get the experiments accepted by colleges. The valuable feedback then stimulated Srinivasan and others to think of a low-cost teaching aid kit³. Ajay Sensors and Instruments of Bangalore, involved in making scientific equipment for DRDO, ISRO, etc., was considered suitable to make these low-cost kits. Srinivasan decided that Academy

Box 1. The 25th Refresher Course in Experimental Physics⁴ (December 2010).

The 25th Refresher Course in Experimental Physics was held in Bangalore. Twenty-five participants selected from all over India attended the course. This included 11 students of M Sc and B Sc courses, and 14 teachers.

At a brief function on 15 December 2010, A. K. Sood, President of the Indian Academy of Sciences, inaugurated the course. Mementos were presented to K. R. S. Priolkar (Goa University), S. M. Sadique (Goa), J. B. C. Efrem D'Sa (Carmel College for Women, Goa) and Manohar Naik (GVMS Higher Secondary School, Goa) for the help rendered in developing and conducting these courses over the last 10 years.

The first four days of the course were devoted to lectures on experiments. This was followed by 18 laboratory sessions in which the participants carried out 27 experiments. Four special lectures were delivered by R. Nagarajan (Tata Institute of Fundamental Research, Mumbai), V. A. Raghunathan (Raman Research Institute, Bangalore), H. L. Bhat (Indian Institute of Science, Bangalore) and T. G. Ramesh (National Aerospace Laboratories, Bangalore). There were two discussion sessions. K. Rukmani, B. N. Meera and Sarbari Bhattacharya of Bangalore University and S. B. Gudennavar of Christ University, Bangalore, were resource persons at the course.

The participants showed considerable interest and worked 12–14 hours in the laboratory and made full use of this opportunity to carry out all the experiments and analysis of results. It was encouraging to see the enthusiastic response of the students.

The course concluded on 31 December 2010 with distribution of certificates to the participants by N. Mukunda.

R. Srinivasan

would ask the company to make one kit for evaluation³. This was found to be quite satisfactory. This company has been licensed by the Academy to make all the circuits and set-ups required for carrying out nearly 27 experiments since 2008. The set-ups are simple and the experiments use unsophisticated electronic circuits for measurements. The experiments are highly reproducible. Each experiment verifies a physical law or principle⁴ and yields results accurate to within 5% of physical values.

In December 2008, when the kit became commercially available, the demand for courses also rose³. Since 2008, several courses have been held in various universities in Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, Goa and Maharashtra. About 80 kits have been sold to institutions, including University of Hyderabad, University of Mysore and University of Mumbai–DAE Centre for Basic Sciences for the five-year integrated MSc programme. Others who bought the equipment include IISER-Kolkata, IISER-Thiruvananthapuram and IISER-Pune. Some of the IITs have also introduced these experiments, including IIT-Madras. In addition, about 25 universities and other colleges have bought the kit^{3,4}.

The duration of each Refresher Course is 14 working days, one-third of which is devoted to a series of 15 or 16 lectures on the experiments, and three special lectures from active researchers not necessarily connected with the course. There are two discussion sessions, where Srinivasan not only answers questions raised by participants, but also suggests new projects or describes how to go about designing an experiment. The remaining duration allows 18 laboratory sessions that participants spend conducting experiments, taking readings and analysing the data. A detailed manual prepared by Srinivasan and made available to the participants includes the theory behind an experiment, the procedure, a sample set of data³, method of analysing the data, and the expected result^{3,4}. Participant feedback is taken after every course. Though the course has been found useful, one concern is that circuit diagrams are not made available. This is because the norms of the licensing agreement between the Academy and the company do not allow this³.

Until 2007, only nine courses in Experimental Physics were held. Since 2009, Srinivasan has been conducting six

or seven courses every year. In 2011, nine courses are planned. Participants have found the course useful^{5,6} and, undoubtedly, Srinivasan is the driving force behind it⁵. They have also learnt how to improve old and existing experiments and design new ones.

Refresher Courses in other areas of science

Table 1 indicates the popularity of Refresher Course in Experimental Physics. But there is the opinion that the relative success might be because the approach of carrying laboratory requirements to different places is feasible in experimental physics, but not in other areas of science, particularly biology and chemistry.

Mukunda says: 'Experimental courses have been conducted in chemistry as well. Two experimental chemistry courses were held in November–December 2006 and in June 2009 at the University of Hyderabad. To run them on a recurring basis is easier in physics because chemistry requires storing possibly hazardous chemicals, special precautions in the set-up with hood, etc. As for biology, again maintaining living organisms brings its own problems. So physics is definitely easier to manage⁷.'

Srinivasan is of the view: 'Chemistry needs a lot of glass equipments. Physics doesn't need that but this does not mean

Table 1. Refresher Courses held up to 2010

Subject	Number of courses
Biology	17
Earth Sciences	8
Engineering	2
Mathematics	10
Chemistry	
Experimental	2
Others	7
Total	9
Physics	
Experimental	25
Theoretical	5
Others	7
Total	37
Mathematics and physics	1
Total	84

Data extracted from http://www.ias.ac.in/php/refresher_all.php3?status=archive.

the requirements for physics are less; we can build electronic equipment ourselves – they are durable and can be carried from place to place. This is difficult with glass equipment. Therefore, it is more difficult to set up a chemistry experiment when you have to go from place to place. But if you designate a place in Bangalore, it will not be difficult to run chemistry Refresher Courses. What is required is commitment and effort. In biology also it may not be very difficult; you may need a few microscopes which could be bought and the course can be conducted³.

Role of Refresher Courses in science education

With the growing concern over fewer students taking to science each year, it seems relevant to ask if such courses could help retain the interest of students in science. Srinivasan replies: 'The number of students taking science going down is a cyclical phenomenon. But we should make science interesting. The way science is taught and the way experiments are done will drive any student away from science! We should kindle the interest of students first by showing that one can do experiments in simple ways and get results that verify theory, and then encourage them to ask questions. This is never done in any college!'

Mukunda believes there is no quick cure to the problem of falling numbers but 'improving the quality of experiments at college and university levels may help bring back the numbers⁷.' He also adds that in 1999 and 2000, when the courses began, four or five Fellows of the Academy in each broad subject were requested to plan a course, which worked well in mathematics in Chandigarh, and also in chemistry in the Delhi–Kanpur region. As long as this practice was followed the response was good, but when the responsibility was left to host institutions, the number (of courses) came down. The numbers have now begun to go up again⁷.

Current status of Refresher Courses

UGC recognition

The Academy Refresher Courses were initially not recognized by the University Grants Commission (UGC) because they are of two-week duration. UGC has now agreed to approve two-week courses as

well. A request for UGC recognition of the Refresher Course was filed by the Academy, some years ago. A decision on this is yet to be taken by the UGC. Srinivasan points out³, 'The UGC wrote to Mukunda notifying that if it is made into a 21-day course, the UGC will accept it and promote it like any other UGC course, but the Academy had its own reservations and maintained that the courses will only be of 14-days duration. Now the UGC has modified this requirement. Participation in a two-week course is also acceptable for consideration for promotion. But many Government organizations and collegiate education directorates are not aware of this.'

Refresher Courses at Academic Staff Colleges

In a letter to the UGC Chairman, dated 17 June 2010, Srinivasan and Mukunda wrote about the successful activity of the Academy and its efforts to improve laboratory education in physics. In the same letter, they requested UGC to suggest to Academic Staff Colleges (ASCs) of all universities to introduce a Refresher Course in Experimental Physics based on the kit developed by Srinivasan. This information reached ASCs in August 2010. The first such Refresher Course by an ASC was conducted by the Ranchi University in February–March 2011, which was welcomed by the participants.

Refresher Courses as a nation-wide activity

Though many Refresher Courses have been conducted successfully thus far, a majority of these courses have been restricted to the southern part of the country. When asked about the plan to make these courses a nation-wide activity, Srinivasan replied: 'This was the main problem we faced when we wanted more universities to accept these experiments. I knew people in the southern universities, especially in Karnataka, Tamil Nadu and Kerala, and thought of introducing the experiments there. The idea was to begin with already existing contacts and then spread the news. So, till last year the only State outside these southern States was Goa, where the first course in experimental physics was conducted. From there I could reach Kolhapur University, which agreed to accept the experiments. At Kolhapur, I met a retired



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Even at the age of 80, Srinivasan goes throughout India to conduct Refresher Courses in Experimental Physics. Ask him where he gets his motivation from at this age and he promptly replies: 'Motivation has nothing to do with age. You can be young and be unmotivated, and you can be old and be motivated.'

R. Srinivasan on science education in India

'Our Government has been developing science in this country in a top-down manner. It should have been bottom-up. They should first put emphasis on higher education in colleges and help universities build good laboratories, good infrastructure. Then they should have built high-level research institutes around the universities. The present high-level research institutes have taken away good people from universities, and have starved the universities of basic infrastructure, and this has completely demolished our education system.

'At least now the Government can make amendments. I will confine myself to physics. The Government has set up IISERs. In addition to taking top-grade students and training them, IISERs must also develop low-cost equipment that can be made in India for all areas of science, and they must run regular courses to train college teachers. If IISERs cannot do it, the Government must set-up four or five centres which should be fully devoted to this. In Germany and the US, there are companies which make low-cost kits that are used in schools and colleges. In India there is no company doing it; therefore it is necessary to build up the laboratory experience in basic physics or chemistry by conducting refresher courses for teachers. In other countries, a Nobel Prize-winning experiment immediately becomes a laboratory experiment; we are 100 years behind. Whatever experiment we did 60 years ago, is being done the same way and probably with the same equipment!'

IIT-B professor, the Director of a nanotechnology centre, who asked me to run a course in Mumbai. Similarly, we wrote a letter about the course and how it has progressed, and sent it to the Fellows of all three Science Academies – Indian Academy of Sciences (Bangalore), Indian National Science Academy (New Delhi) and National Academy of Sciences (Allahabad) – who work in the area of physics. This letter also found its way to a

Deemed University in Bhubaneswar which then requested the course³.'

Coming together of the three Science Academies

Since 2007, the three Science Academies of India have worked together to conduct the Refresher Courses¹. Mukunda adds: 'Such courses where quality is maintained should become more common so

that motivated teachers, though in small numbers, are given all possible help to teach better. The courses organized by the three academies do ensure maintenance of quality. However, looking at the numbers involved, other bodies too should take up this work⁷.

What lies next in experimental physics?

Srinivasan has plans to set up experiments in low-temperature physics, high-vacuum physics, optics and condensed matter physics in the coming months in Bangalore. If this materializes, he also plans to conduct an advanced experimental physics course and a basic experimental physics course alternately in Bangalore. In 2011, only four courses are planned in the city, as there is a prior commitment to have five courses – in Chennai (two courses), Bhubaneswar, Mumbai and an institution in Banga-

lore – till August 2011. From 2012, more courses will be held in Bangalore^{3,4}.

Mukunda¹ says: 'Refresher Courses are generally on an all-India basis, and cover all areas of science and mathematics. The main purpose is to help improve the quality of teaching, stressing fundamentals and finer points of pedagogy.' The need for Refresher Courses that are topic-based, such as experiments based on mechanics, and waves and optics, has been expressed by the participants. Experiments based on modern physics and material physics have also been suggested⁶. As of now Srinivasan has tutored about 500 teachers and students, but he believes this number is too small. He hopes that more ASCs will follow suit in incorporating the experiments in college and university courses.

1. Mukunda, N., Seminar on Higher Education, Centre for Contemporary Studies, Indian Institute of Science, Bangalore, 15 January 2011.

2. University Education in Science, Academy Papers No. 1, Indian Academy of Sciences, Bangalore, 2 December 1994.
3. Interview with R. Srinivasan, 11 February 2011.
4. R. Srinivasan's note to *Current Science*, unpublished and incorporated as part of this article.
5. Telang, P., e-mail to Richa Malhotra, 5 March 2011.
6. Jain, D., e-mail to Richa Malhotra, 4 March 2011.
7. E-mail interview with N. Mukunda, 12 February 2011.

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