Three Challenges Facing Indian School Science Education

Padma M. Sarangapani

A serious lack of adequate equipment, of trained teachers and most importantly, a consensus on what should be taught in school science impede any positive movement on expanding quality education in science. We have still not had any national discussion or debate on critical issues in science education, much less a review of the possibilities to build a national consensus of what science should be taught in schools, particularly in a curriculum of compulsory schooling.

Science education in India is faced by three practical challenges today. The first is the most basic problem that has persisted and resisted solution since Independence. This is our inability to provide schools with labs and equipment to be used while teaching science.

Science is knowledge about the material, natural world. It is knowledge produced from systematic observation, measurement, experimentation, exploration, and speculation and theorisation about natural objects, their properties and their interactions. Whether the topic of forces in Physics or the solubility of substances in water from Chemistry, or germination in Biology, the science curriculum directs attention to the material world, to things and processes in it, about which it would like children to learn—to notice, name and think about things based on concepts and theories that characterise these disciplinary approaches. However, this material world is conspicuously absent in the Indian science classroom and the school.

The science classes are no different from history or geography or language. They are also taught by teachers from textbooks. The textbooks talk about things, experiments and processes and show pictures. They often take the route of not only describing the experiment, but also telling children what they will observe and what they should conclude!—an implicit acceptance by those designing the textbooks that children will not actually get to do or see the things that are to be learnt about. So tell all.

Nehru had dreamt of the day when every science classroom would have a microscope and children would have the direct experience of viewing the microscopic world. All of us have studied about the paramecium in our school biology textbooks, which told us that it was a slipper shaped single cell organism. Yet how many of us have viewed

a drop of ordinary water through the microscope, learnt to adjust the focus and see this for ourselves? We have all seen pictures in our book of Saturn and its rings. But most likely we have never been asked to look and spot Saturn in the sky and watch it through a pair of ordinary binoculars to see its rings.

It is not just a problem of providing infrastructure in schools. Even in private schools which could afford the infrastructure, few school managements actually make this provision. Of 85 schools that we visited in one education block of Hyderabad as part of a recent survey, we found labs or at least some lab equipment in only five of them. We were more likely to find virtual computer based lab, and short videos to be projected during the class. It seems that as a country, although we boast our large numbers of science graduates, we are not really serious about how they learn their science, considering that we have not yet equipped our schools with labs and nor ensured that children have practical experiences.

The second challenge we face is a shortage of science teachers and elementary school teachers who have studied science at least up to the 12th class level. No doubt there is regional variation in this, but everywhere with more lucrative and higher status jobs available for science graduates, we find a disproportionate number of young people from the arts and social science backgrounds rather than mathematics and science coming to be trained as teachers. While primary school teachers are expected to teach all subjects, most are not confident about their own knowledge of mathematics and science. This has serious implications for the mathematics or science that they can teach in turn. Elementary teacher education programmes need to be adapted so that they can address this problem. Students need to have additional curriculum inputs in these domains. At the secondary education level, neither states nor private management are able to find suitable trained science and mathematics teachers to employ. An option being considered is to directly employ those with science degree qualifications and undertake teacher education on the job, although it is unclear if such post appointment education will be taken seriously and bring about desired professional development. Following the NCERT's model of B.Sc., B.Ed., many Central Universities are considering offering this programme—this has found endorsement in programmes such as the National Mission on Teachers and Teaching with the argument that such early commitment to teaching will strengthen professional formation. While not discounting the higher quality of teacher education that is achievable through such an integrated degree, in my view this does not adequately factor in the need for the teaching option to be made available later rather than earlier in the person's life-cycle. It is likely that young people will seek admission to this programme as a way to study science rather than education/teaching. And it is very possible that many of the graduates with dual degree will go into science related streams rather than into science teaching. There is need to provide channels into education at later stages where people with science degrees, after having

pursued other careers shift into education because they are now interested in working with young people. It is also necessary to consider stipendary programmes for science teacher preparation, making it more financially attractive. We may also need to consider adding another year of study of science in teacher education programmes and allow such graduates to be employed starting at a higher salary.

The third practical challenge facing Indian school education is with regard to what should be included in the science curriculum. Following the Right to Education 2009 we are much more aware of the diversity of children entering our classrooms, to whom the curriculum must address itself "constructively". I use this last word deliberately to emphasise the need of the curriculum to make sense to those who are learning it, so that it is not just learnt to be remembered now, with the hope that it will finally make sense. This requirement could be approached in different ways.

One interpretation is that this means we should move away from a 'subject approach' towards the 'discipline approach'. This emphasises the need to teach science as a way of understanding the world, and comes with the view that knowledge of science—both the content and the method—is important as it informs our understanding of the everyday physical world which would not be available to us through common sense and everyday experience alone. Such knowledge is important for everybody and hence such disciplinary science would be a part of a compulsory school curriculum. It would, include 'big ideas' of science which deeply influence our understanding of the world and our relationship to the world—such as the human immune system and causes and treatments of diseases, or of photosynthesis, or evolution, or projectile motion. A combination of the specific ideas and concepts and ways of reasoning, thinking, proving and discussing science, would be the focus of such as curriculum.

A second interpretation could be that this requires science to be made 'relevant' to the students from the point of view of their lives and their futures. This could take the direction of being 'functional' with useful science being the focus—understanding the human body and its wellbeing, sanitation and public health, reproductive health and those relative to vocational contexts such as agriculture or animal husbandry, could potentially take centre-stage over the traditional disciplines in such a curriculum.

A third approach could be to review the disciplinary strong hold on the curriculum and move towards the inclusion of new areas of science such as the environment studies, engineering, technology and design, material sciences, animal behaviour, medicine, sexuality and gender, and science and society.

There is a fourth possibility that is relevant in the Indian context, which is that of local knowledge and indigenous sciences. Admittedly this a difficult terrain to navigate with claims being asserted to the scientific status of 'Astrology'. But clearly systems of health and wellbeing whether Ayurveda or Yoga are strong contenders for inclusion in a curriculum. Alongside, particularly knowledge of habitats and environments from

systems of non-western science are alive and rich repositories of valuable knowledge which is even more at risk of being obliterated through universal spread of schooled knowledge. Only the first of these four possible responses has received serious and systematic efforts over many decades and in some ways refers back to the earlier two challenges as well. The other three possible approaches all exist in the discourse on curriculum and its revision, but have not received systematic review and response. Nevertheless, we notice that in some states, notably Kerala, the government school curriculum has increasingly presented a vocational and applied version of science, while the NCERT has moved towards the disciplines and to some extent now includes newer disciplinary areas such as the study of environment. However, we have still not had any national discussion or debate on these issues, much less a reviewof the possibilities to build a national consensus of what science should be taught in schools, particularly in a curriculum of compulsory schooling.