

Reflections on Science and Physics education in India

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Learning/teaching of Science/Physics has always been endowed with several attributes which reflect the difficulty associated with the subject. This has been made more frustratingly so by our own approaches to the teaching of these subjects. To be able to evolve strategies which will help in making the science/physics education better require a deeper understanding of highly complex parameters. This article intends to give a brief overview of science/physics education in India and attempts to discuss pertinent factors that probably have implications in developing a comprehensive understanding of the relevant issues.

Science Education at School Level.

Children in India begin formal schooling between the ages of 5 to 6 years. A uniform 10+2 structure is adopted by all the states. Schools follow curriculum developed by the respective states, CBSE (Central Board of Secondary Education) or ICSE (Indian School Certificate Examination). The content in the curriculum is not same among these, learning of Science (Physics, Chemistry and Biology) and Mathematics is mandatory for every year till 10th grade. As a result, among students having completed the 10th grade, there is no marked heterogeneity of knowledge base. Differences may exist in the knowledge state of individual students. After 10th grade, students may choose not to study Science during their 11th and 12th grade. Languages in different states are different and hence learning may have taken place in the language specific to the region and not necessarily in English. Socio cultural aspects do have a definitive influence on both the attitude and effectiveness of learning.

Education in general and Science Education in India in particular probably has the following dichotomy. All efforts on the education front are attempting to bring homogeneity in terms of structure of education, commonality of curriculum, commonality in evaluation methods, and equal opportunity for all sections of society. However, the system is inherently highly heterogeneous on several accounts. The divide between urban and rural India is huge. There are several languages in use and learning is not simply learning of the content – it has to accommodate language cognition. Social contexts are different in different regions. All efforts to bring about change have to reach out to huge numbers. Homogeneity in certain aspects and heterogeneity in terms of some others render a complexity to the education scenario in India. Probably the difficulty to overlap a massive heterogeneous system to a homogeneous pattern is not a straightforward process. No single attempt will do the needful. An integrated effort from all fronts is expected to yield noticeable results. However, with the redrawing of national priorities strongly in favor of school education, several initiatives have been taken up both by Government and Non-Government Organizations (NGO) to evolve and

implement strategies for improving quality of Science Education in India. Some of the initiatives on different aspects of Science Education at school level are discussed below.

a) Curriculum development initiatives: A major shift in science teaching was initiated by way of curriculum reform. A notable beginning in this direction was realized when Department of Education in Science and Mathematics (DESM) addressed issues and problems in the education of science and mathematics and involved in research and development of prototype curriculum and instructional materials, and designing and developing of science equipments. The need for the activity based learning approach was the basis for several of these curriculum reforms. There has been a paradigm shift in the approach to science teaching with the development of activities that can be used to make science learning more effective. Though the efforts have not percolated to majority of schools in India, there is a growing awareness and tendency towards this new approach to teaching and learning. In addition innovative curriculum for Science teaching are being tried and tested at several schools to study its effectiveness.

b) Teacher training: School teachers in India are required to obtain a degree in Education in addition to their training in specific subjects. Upgrading the competence level of teachers has been the aim of teacher training programs and is perceived to play a major role in influencing the interest and effectiveness of teaching/learning. Government Organizations like Nation Council for educational Research (NCERT) and National Council for Teacher Education (NCTE) have been conducting both pre-service and in-service teacher training programs. More recently, novel teacher training programs have been developed and implemented. Intel piloted the Intel Teach to the Future teacher training program and companies like Infosys and Wipro support several teacher training programs in the country.

c) Talent nurture: Identifying talented students and nurturing them is imperative for the strengthening of the knowledge force. Several organizations like the Science Olympiad foundation, National Science Talent Search Examinations and Intel Science Talent Discovery Fair are a few of the programs that work towards the identification of young talent. With a view to identifying a nurturing talent in Mathematics, Physics and Chemistry at school level, the International Mathematical Olympiad (IMO), International Physics Olympiad (IPhO) and International Chemistry Olympiad (IChO) is held every year. India has been participating in these Olympiads since 1989, 1998 and 1999 respectively. However, it is highly desirable that these efforts reach the majority of the intended population.

d) Reaching out : Discussion of various aspects of science education in India is never meaningful unless an effort is made to reach out to a large number of students residing in rural parts of India. Majority of schools in rural India are run by the Government and funding is scarce. Infrastructure is poor in many places and teaching is barely adequate. Various NGOs have taken up highly commendable initiatives to support the efforts to upgrade the facilities to schools in rural India. Libraries are being upgraded by NGOS. Asha is an organization that works with many schools that attempt to provide quality holistic education to children from poor economic backgrounds. Science

education is a capital intensive activity. Good laboratories are an essential requirement for effective learning. Organizations like Vidnyanvahini, Agastya foundation are some of the few who provide mobile science laboratories to children in rural areas thus helping children learn science through laboratory experiments. Several organizations are devoted to developing low-cost experiments so that activity based learning may be implemented in schools with weak funding. Intel® Learn program is a technology learning program designed to improve digital literacy and critical thinking skills among youth (ages 8-16) that may have little or no access to computers at home or school.

e) Science popularization : Motivation to learn science and to pursue a career in science can be greatly influenced by making the hard to understand concepts of science more exciting. This probably is the most widespread activity in India with numerous efforts to popularize science by popular science articles (both in local language and in English), organizing lectures, through the development of science centers etc. Efforts in this direction have come from both individuals and from institutions. Homi Bhabha Center for Science education also has a major program to popularize science. National Council for Science and Technology Communication (NCSTC) has played a pioneering role on the Indian science popularization scene.

Physics education at undergraduate and graduate level

The undergraduate study begins after 12th grade. Students who studied science in 11th and 12th grade choose to opt for professional courses like engineering and medicine or continue graduation in science. In most of the states, matters of technical education are separated in terms of process and procedure from the other branches of graduation study. The University Grants Commission (UGC) set up as the apex monitoring body of the higher education in the country. Though majority of funding for universities come from UGC, a small fraction is borne by the corresponding state. Though the UGC lays out general guidelines for operation, the logistics of implementation and actual running of the university is the responsibility of the state. The university mostly runs the graduate courses whereas the under graduate courses are run by individual colleges. Majority of these colleges come under the banner of University and are guided by the University procedures, some colleges function autonomously. Though discussion below are relevant for science education in general, focus if on the Physics education.

The crisis in the domain of higher education in Physics is probably a more serious one than the school education and need to be a subject matter of immediate concern. The knowledge force that drives the development of research and technology of a country is expected to come from this sector. The major problem in this domain has been the dwindling interest as reflected by the quality and quantity of students perceiving a career in Science. The nature of the problem is not very different from the ones experienced globally but the magnitude is. Major research organizations in the country have been sending warning signals regarding the poor quality of Science graduates produced by the universities. Barring graduates coming from some institutions, nearly large percentage of graduates coming from most of the universities reflect very poor learning. The laboratories are poorly equipped and are conducted in a very unimaginative manner.

Evaluation methods neither test learning nor challenge the abilities of students. Acknowledging the need for efforts to improve the situation, the following initiatives are being undertaken.

a) Curriculum development : Universities revise curriculum periodically and incorporate newer advances in Physics. Majority of the universities train a large number of graduate students who show a weak understanding of the content and poor training on application abilities. The curriculum is robust in structure – but is very weak in implementation. Curriculum reforms/upgradation has focused entirely on what is learnt rather than how it is learnt. There is a need for enhancement of training in problem solving. The universities appear to be able to produce physics graduates rather than future Physicists. The examination scores appear to show no correlation to their understanding. In the absence of any tool to probe the understanding of student learning other than the examination performance, students have very faint understanding of expectation levels which needs to be addressed and rectified.

b) Teacher training : For teachers both at the undergraduate and graduate level, UGC has made it mandatory to participate in periodic orientation and refresher programs to help teachers keep abreast of research in frontier areas. Indian Academy of Sciences analyzed comprehensive views on the problems of education in science in India as well as spelt out the action that can be taken. Their report on Science Education made strong pertinent recommendations – an important recommendation is the necessity of properly implemented continuous teacher training programs. Several research organizations conduct short term teacher training programs that provide an opportunity for teachers to be exposed to frontline research carried out in major research institutions.

c) Talent nurture : Though there have been programs to identify and nurture talent at the school level, development of nurture program for undergraduate students has been more recent. Acknowledging the importance of attracting and nurturing good graduate and undergraduate students, several premier leading research institutions in the country are offering summer programs, student visitorships. The Homi Bhabha center for Science Education has initiated a large scale, comprehensive and sustained program encompassing all basic sciences which aims to identify and nurture talented students.

d) Reaching out : The reduction in the number of students pursuing Physics has been a matter of concern for both policy makers and scientists. The choice of a subject or a career is decided by several factors depending on the dynamics of processes globally and locally. Students who decide to pursue technical education do not find Physics uninteresting! Not giving too much importance to statistics of students pursuing studying physics, the matter of concern is the effectiveness of the imparted training. The majority of trained future physicists are bound to come from the large number of universities spread all over the country. Loosing out on them is not a desirable proposition. In majority of the institutions, the training and the evaluation processes does not necessitate thinking – students do not show the ability to think. Enhancing the learning outcomes of students need a deeper understanding of how students learn better. Research in Physics Education as an area of research with the involvement of more and more Physics teachers

and researches is expected to provide necessary inputs. There must be enhanced investment both in terms of human resource and funds towards this.