Indian School Science Education

Anu Joy

This dossier on Indian science education aims at initiating a dialogue on the issues and major challenges facing Indian school science education. It examines the present status of Indian school science education and reflects what exactly the present science education is contributing to Indian children and larger society. The Indian school curriculum and polices have forged a remarkable level of consensus that science education is important for all children attending schools. Science is a compulsory subject from elementary school onwards. What are the distinctive purposes of teaching science in schools? What knowledge is of most worth for school science education? The children who come to the Indian science classrooms belong to a heterogeneous socio-economic-regional and cultural backgrounds, who will continue to pursue science and technology related careers and who will not. How school science teaching can meet the requirements of all the students? What can one reasonably expect from a student in terms of his understanding of science after 10 years of study of science in school?

The dossier comprises of five articles each taking a differing and complementary themes and focuses on the questions – What are the fundamental aims school science education? Why to teach science in schools? What will create a meaningful and fruitful setting for teaching and learning of science in schools? What are the major issues and challenges facing Indian school education in general and science education in particular? Looking to the future what kind of a school education and science education we envision for our children? Do we propose any difference in the way we educate children in school and the way we teach science? If so, how can we conceptualise a different school education and science education? One of the important matters of concerns is the close link between science education and the notion of development proposed under the banner of economic globalisation. In this context, how can we develop a responsible science education? Whether there are alternate requirements for the content and process of school science education? This dossier is an attempt to explore these possibilities. It aims to reassert the importance of a responsible science education in schools and a responsible approach to formulation of science educational policies.

Aims of Science Education – An Analysis of the Science Curricular Policies

The subject matter of science takes a central place in school education. The most widely acclaimed views of teaching science in schools is that it can inculcate in children certain values and attitudes –scientific temper, rationality, reasoning, problem solving, methods of science and so on. – that are essential for an enlightened citizenship; also teaching science in schools can fasten progress and development of a nation by creating scientific and technological manpower essential for continued economic growth. A wide range of influences went into the shaping and formulation of science education of Indian school classrooms – the historical and colonial influence, the Nehruvian project of creating a modern independent India, the neo-liberal economic mandate of creation of scientific and technological manpower and production of skilled labourers, the way in which larger society and parents wish to shape the lives of younger children and so on. The objectives that figured most prominently and persistently in several of Indian science curriculum and policy documents is the role of science education in eradicating poverty, and emancipating masses from social ills of superstitions and illiteracy, and training and creating a cadre of scientists who will contribute to the nation building. Thus Indian school curricular aims ascribed a transformative and emancipative role to the subject matter of science, that teaching science in schools can address challenging social issues facing the nation and liberate the minds from irrational beliefs and practices. *"In a progressive forward-looking society, science can play a truly liberating role, helping people escape from the vicious cycle of poverty, ignorance and superstition"* (National Curriculum Framework - 2005). The underlying assumption is that science education can initiate social change by bringing about changes in the outlook and attitude of people as it is a subject that is directly connected with enlightenment values such reasoning, logic and rationality. Another aim that got significantly valued in the recent science curricular reform is the creation of a scientifically and technologically literate citizenry who are sensitive to societal and environmental issues, and who can understand how science, technology and society influence each other.

While several of the post independent science curriculum and policy documents reinforced the above aims for science education, the rise of global economies and neo liberal policies created new challenges and opportunities for science education (Hodson, 2003). It has had to rise up to the realisation that science education is critical for creating a skilled labour force who can function innovatively and flexibly in the new knowledge economy and who can use their knowledge and skills for an effective competition within a market place. In this new paradigm of education, the science curriculum, textbooks and classroom processes has had to respond to the call for shifting approaches in its content and method of teaching-learning processes. School science education came under the pressure of catering to the diverse requirements of economic policies, larger societal, parental and children's aspirations – to develop creative thinkers and knowledge workers, those who can participate in the world of work and productive labour market after secondary schooling and to the students who want to pursue higher studies in science and technology related courses. The curricular documents, for example the Kerala Curriculum Framework-2007, proposed diversification of curriculum and subject matter at the secondary and higher secondary grades as one of the solutions to address these requirements and challenges. Thus, an instrumentalist and vocational view of science education that premises its assumptions on the polarised notions of 'knowing' and 'doing' began to emerge in the terrain of science curricular and policy discourses.

Past few years had witnessed revolutionary reform measures taking place in the scenario of Indian school education with National Curriculum Framework-2005 espousing a teaching-learning process that is child centred and activity oriented. The purpose of these reforms ranged from radical restructuring of the content, pedagogy, and evaluation processes, efficient school management and governance, empowering teacher and teacher education, bringing in community participation and local resources for school learning. NCF approached children's learning in school on the cardinal phrase of 'children constructing knowledge' and premised its recommendations based on the theme of the active nature of child's learning – 'child as an active constructor of knowledge', 'child centred learning', 'joyful learning', 'child as a natural learner', 'knowledge as the outcome of the child's own activity', 'constant querying of children', 'participatory, interactive, and experiential rather than instructive', 'active learning through the experiential mode', 'child as an active participant rather than a passive recipient in the process of leaning', 'child's capabilities and potential are seen not as fixed but dynamic and capable of development through direct self-experience' and so on.

The objective that forms a keystone to this reform initiated by NCF-2005 is of making school learning closer to child's familiar everyday world and contextualising science learning in everyday world of child. Thus according to NCF-2005 school classrooms must be transformed to spaces where children actively engage with their everyday familiar world – physical, social and cultural – around them exploring, observing, solving problems, inventing and working things out, and making meaning out of it all. NCF 2005 regards this bridge i.e. between the everyday world of the child and school science learning, to be important cognitively, to make school learning meaningful. It also embraces the view of learning as a collaborative and situated process where learning and understanding are done within a community of learner. *"It is in interaction with the environment that the child constructs knowledge and derives meaning. This area has generally been neglected both in the conceptualization of textbooks and in pedagogic practices. Hence, in this document, we emphasize the significance of contextualizing education: of situating learning in the context of the child's world, and of making the boundary between the school and it's natural and social environment porous. This is* *not only because the local environment and the child's own experiences are the best 'entry points, into the study of disciplines of knowledge, but more so because the aim of knowledge is to connect with the world. It is not a means to an end, but both means and end. This does not require us to reduce knowledge to the functional and immediately relevant, but to realize its dynamism by connecting with the world through it"* (NCF-2005, pp30). NCF also placed a greater emphasis on the role of teachers, their autonomy and professional competence in implementing the new form of pedagogy and emphasised on the need to revamp professional development programs. It called for radical changes in teachers' knowledge and beliefs about subject matter, teaching, children, and learning. The different constructions of curriculum about the nature of children, their learning and pedagogy, can produce different construction of the science teacher. According to NCF-2005, the teacher is a facilitator who encourages and guide children to reflect, solve problems, analyse and interpret in the process of exploring their world and knowledge construction.

While the policies and curricular aims have been ambitious, there exists a wide gap between the curricular ideals and the actual practices of school science school science classroom and learning of children. These recommendations are differentially approached and implemented by different states of the country, and thus differentially experienced by teachers, children and science classroom processes. Also in the Indian case, the school science education and teaching learning processes majorly have tended to favour children belonging to high socio-economic background and it dominantly aligns with the urban middle class values and practices. The ethos and values promoted by science education such as meritocracy and competitiveness resulted in creating disproportionate and inappropriate learning outcomes from children belonging to different socio-economic backgrounds. The science curricular and policy documents are also in a persistent search for devising a universal content and pedagogy that structures its learning programs taking the view of 'universal mind' of a learner. The school science education that embraced a 'universalist view' of science was successful enough in equipping learners to perform well in standardised year end examinations, competitive tests and in preparing scientists and skilled scientific work force to participate in an economic regime driven by science and technology. The present system of school science education is successfully created scientists, IT professionals, engineers, doctors and a labour work force for the global economy; also a technocratic and managerial class of citizens who casts their major influence on shaping the nation's policies, larger societal thinking and cultures. The children from marginalised communities and rural backgrounds still find it a distant dream to secure the hope and social mobility that the school science education promises. After several years of learning science in schools they eventually find it irrelevant to their lives and livelihoods. Science education thus continues to remain elitist in nature, inappropriate for children coming from heterogeneous socio-cultural and economic backgrounds and whose aspirations and requirement of school education are diverse.

The dominant trends in science education that are apparent in the recent decade are the marketisation and vocationalisation of school science education. The growing nexus between the public institutions and the market have not only played a major role in pushing the directions of educational policies, but also the 'pedagogy market' (Kumar, 2012) have made significant inroads to science classrooms in terms of development of teaching learning materials, guides, project books, science experiments and lab kits, assessment tools and delivering software tools and digital resources. Science related professional courses being one of the most preferred choices for students, the competition for the entry to top institutions is high with parents spending lot of money to send children for additional tuition and coaching classes for science related subjects. This has resulted in mushrooming of large number of entrance coaching and tuition centres. Such outside agencies that devise a completely new content and pedagogy for teaching and learning of science have deepened its influence not only on student's success in entrance exams but also in shaping their understanding of science and of the nature of subject matter of science

With all its claims, the value that lie at the heart of these science curriculum and reform initiatives is an aspiration to pursue a model of developed proposed by western societies and science. The idealised western imagination of science as 'objective' is treated as a truism in curricular documents that presupposes teaching of science in schools can support faster economic growth, social development and human welfare. The teaching-learning processes of science classrooms guided by such curricular and policy rhetoric provided a factual account of the world to children. The Indian school science textbooks still derives its understanding of science and scientific method from an inductivist-positivist tradition, and structures its content on the assumptions that science is 'value free' and 'neutral'. Knowledge is valid only when empirically demonstrated and substantiated. The primary concern of school science often seems to be the transfer of universal scientific principles, laws and concepts. In the science classroom process, even those focusing on activities and demonstration primacy is given to teaching the facts, and the activity was treated as a tool for making these facts realistic and interesting. Although the influence of positivist science is diminishing in contemporary philosophy of science, its role is dominant in the school science curriculum and textbook making. A conventional method of science as observing, formulating hypothesis, deducting, measuring, accepting or rejecting hypothesis based on observation is the method followed and transpired by science textbooks and classroom learning processes. The overarching emphasise of the science curriculum and textbooks on frameworks such as "inquiry based learning" "learning by doing" etc. gives primacy to investigative methods of science and gives the image that scientific facts and principles are derived only from large amount of observational data and tested hypothesis. The science curricular aims of making learning ‘relevant’ i.e. connecting science to social context and everyday world, is achieved by the science textbooks by introducing topics related to Science, Technology, Society and Environment (STSE). What actually happens in actual cases is that the science textbooks and classrooms processes take a moralistic and prescriptive stand and succeed in only making children aware of the environmental issues, and social issues. Moreover while making science learning ‘active’ and ‘relevant’, the science curriculum and textbooks recognises the role of activities, experimentation and doing science. But little attention is paid by the school science on theorising in science, the nature of science, limitations of science and scientific methods, the role of history and philosophy of science, and the social nature of scientific knowledge. It often discards the numerous examples of creative thinking in science where basic ideas of matter, motion, Newton’s first law of motion, etc. were theoretical constructs and derived as a result of elegant speculation and answers to philosophical questioning regarding fundamental nature of the universe (Sarukkai, 2012).

In India, the kind of inquiry and activities happens in school classrooms are more often scripted by the textbooks, syllabus and teacher handbooks developed in accordance with the guidelines set by a centrally written curriculum. Science teachers are trained to follow these predetermined scripts and procedures. The actual science classroom processes gets confined to and dependent on the content of the textbooks, specific timeframe allotted by the curriculum and syllabus, i.e. the 45 minutes time allotted by the time table of a school day and specific time period allotted by the syllabus to complete portions; also the science teachers does not have any autonomy over the selection of content and choice of pedagogic processes. The science classroom processes implemented through the teacher within the limits of the centrally written curriculum guidelines, classroom time and through scripts of the science textbooks and teacher handbook offer limited provisions to draw children’s attention to the relevance of their everyday world and immediate context for learning purposes – as the curricular document envisages – and thus converting science learning a *‘decontextualised’* experience for the children (Kumar, 1997). This decontextualised science learning processes of school classrooms are at odds not only with the curricular ideals and aims, but also with larger societal and community’s ways of integrating children into its knowledge traditions and cultures.

Research studies from several countries and contexts bring out the differential participation and low achievement of students belonging to different socio-economic regional, cultural and gender backgrounds (Baker, 1998). Research studies also indicate the lack of participation and low achievement of women in science. There are fewer girls who opt for courses related to science and technology. The science curricular and classroom experiences, together with the invisibility and lack of representation and participation of women in the discipline of science contribute to this underrepresentation and underachievement of women in science. Undermining the voices, perceptions and lived experiences of several sections of societies by the science curricula and classrooms made science learning an alienating experience for children. It socially excluded and cognitively alienated a larger section of children from science learning processes, which surprisingly also went into conflict with the policy rhetoric of transforming societies though inculcating scientific values in all of its children and creating an enlightened citizenry through science education.

The development of a systematic strategy for bringing in fundamental changes in the teaching and learning of a subject like science requires meaningful curricular visions, innovation in course content, modes of instruction, teacher education, student assessment and situating the learning in child's socio-cultural milieu. What is more important is the support of a state policy, funds and resource allocation. The contributions of education and science education to the development of societies and individuals have been profound. Education is the fundamental right of all children, a means for economic, social and political advancement and for empowerment of marginalised and disadvantaged sections of the society. Policies are in place to improve education for all and several measures have taken to bring the disadvantaged and marginalised children their right to education and to empower them to meaningfully participate in educational processes. What the future holds for these children and what science education has to offer for them is still a big question.

References

Baker, D. R. (1998). Equity issues in science education. In B. J. Fraser & K. G. Tobin (Eds.), International Handbook of Science Education (pp. 869-895). London: Kluwer Academic Publications.
Hodson, D. (2003). Time for action: Science education for an alternative future. International Journal of Science Education, 25, 645-670. https://www.researchgate.net/publication/216458605_Time_for_action_science_education_for_an_alternative_future

Kumar, K. (1997):What is worth teaching? New Delhi: Orient Longman. http://www.orientblackswan.com/display.asp?categoryID=0&isbn=978-81-250-3752-1

Kumar, K. (2012). The Pedagogy Market.Economic and Political Weekly, Vol – XLVII No. 47-48, December 01 http://www.epw.in/commentary/pedagogy-market.html

National Council for Educational Research and Training.(1993).Learning without burden. New Delhi: NCERT http://www.teindia.nic.in/Files/Reports/CCR/Yash%20Pal_committe_report_lwb.pdf

National Council for Educational Research and Training(2005). The National Curriculum Framework. New Delhi: NCERT. http://www.ncert.nic.in/rightside/links/pdf/framework/english/nf2005.pdf

Sarukkai, S. (2012). What is Science? New Delhi: National Book Trust. http://www.jawahar-book-centre.com/cgi/prd-search-new.pl?ss=What+is+science%3F&prd_srch_col=PRD_SEARCH_NAME&opt=2&pcid=99003&smode=4&module=PCAT&tpl=3&srch_col_match_typ=LIKE&Submit1=GO