R R Koireng
karenkrr@gmail.com

Science Teaching: Recommendations and its Implications on Teacher Education Programme

Abstract

Policy statements suggest teaching of science as an integrated subject till secondary stage. This paper discusses about the recommendation of science teaching from upper primary to secondary stage. The recommended pedagogy and teaching learning materials including its implications on teacher preparation programmes prevailing in the country are discussed here.

Prelude

Introspecting the existing system of education prevailing in the country from policy recommendations to its final implementation will give us a good insight into science teaching at school. There is a general consensus at the policy level that science should be taught as an integrated subject from the upper primary to the secondary stage. Based on the ideas of National Curriculum Framework (NCF)-2005, NCERT has redesigned syllabi and textbooks for science starting from upper primary to secondary stage. Sincere attempts have been made by NCERT to teach science as an integrated subject till secondary stage and NCERT has been fairly successful in bringing out science textbooks based on integrated perspective from classes VI to X. It is important to note that the desired changes at the curriculum level should be backed by necessary reforms at the implementation level, particularly teacher education. Teachers are the ones who negotiate classroom processes at the ground level. They need to be equipped with the desired content and pedagogical knowledge. However, the existing teachers produced by the teacher education institutions in the country are ill equipped to teach integrated science. Usually the convenient way adopted by schools in the country is to divide science contents into physics, chemistry and biology sections among the prospective teachers in the school. These teachers are specialised in their respective subject areas. This may not be a problem for schools having many sections in a class and having senior secondary stages. However a school having only one section in each class and having only up to secondary stage may not have the subject teachers to teach the entire science content. However, teaching science as an integrated subject goes far beyond academic and administrative convenience. From the perspective of curriculum design, curriculum has pedagogical and psychological implications. Then, where does the problem lie? Is it because of the inherent traditional way of writing the books where authors tend to see science as a combination of segregated subject domains of physics, chemistry and biology? Or is there a problem with the teacher development programme existing in the country? Or is it the by

product of university education system which is a feeder source for B.Ed course in the country. This paper tries to reflect on these issues.

Science Curriculum

Let us turn to the recommendations of science curriculum and it's unfolding into syllabi to unravel the minds of framers of curriculum and syllabi. The National Focus Group on Teaching of Science (NCF-2005) supported by a large body of research on science education recommends a pedagogy that is learner-centred, hands-on and enquiry based. While this is widely accepted at the idea level, practice in India still tends to be dominated by chalk and talk methods. To attain the progress in the desired direction, changes have been initiated as per NCF-2005 as outlined below.

In learner-centred approach and 'hands-on' way of learning science, we start with things that are directly related to the learner's experiences and can be taken as concrete examples. To reflect the pedagogical approach, syllabi have to be reordered and rearranged. An example is the concept of electric current. If we think that the concept is abstract and needs the knowledge of movement of charge, then it should be treated at later stage only when the child is comfortable with the concept of charge. Charge is an abstract concept and is understood at a higher stage. However, we see that children can easily make simple electrical circuits and understand the concept of current. Therefore, concepts of *electricity and circuits*, *electric current and its effects* have been included at upper primary stage. The concept of charge is taught at a later stage after teaching electric circuit. It is a deliberate attempt to break the disciplinary mode of thinking by connecting to developmental principle. It means that there exists cross connectivity between concepts and developmental principles indicating the relationship between content and pedagogy. This also assumes significance as it reflects that syllabi is not merely a list of topics but also show the intended pedagogical processes to be followed while unfolding the content of the syllabi in the classroom. Thus pedagogy is inbuilt in the content right from the formulation of the syllabi. Hence a careful designing and sequencing of content is necessary for adopting a sound teaching strategy to be followed thereafter.

The National Curriculum Framework (NCF) -2005 also further recommended that science content for classes VI to X should be framed along integrated science and organised around themes that are potentially cross-disciplinary in nature. In view of this, a thematic approach was adopted to organise the content, and the syllabus was framed along cross disciplinary line. The themes included in the syllabus were *food, materials, the world of the living, how things work, moving things, people and ideas, natural phenomenon and natural resources.* These themes run from the upper primary to the secondary stages and there is consolidation of themes at the secondary stage.

Let us move further into the format of the syllabi presented. The syllabus has been presented in four columns titled as questions, key concepts, suggested resource and suggested activities. An example of science syllabus for class VI developed in 2005 is given below in table no.1:

Questions	Key Concepts	Resources	Activities/Processes
How do we separate the grains after harvesting the wheat/rice crop?	Threshing, winnowing, hand picking, sedimentation, filtration.	Talking to some elders about practices after harvesting the crop; kit materials	Discussion on threshing, winnowing, handpicking, experiments on sedimentation, filtration. Separating mixture of salt and sand.

Table no.1: A section of science syllabus for class VI

The syllabus starts with questions. These are key questions which are meant to provide points of entry for the child to start the process of thinking. The activity column lists experiment as well as other classroom processes in which children may be actively engaged, including discussion. Although the items are suggestive in nature, they are meant to give an idea of the unfolding of the content. If we read activity column together with the questions and key concepts; they give the intended depth and breadth of the content coverage. The syllabus also provides clues for teaching-learning strategies and choosing content for textbook writing. It also has space for learners to perform activities/experiment. The local context also finds place in this syllabus. The syllabus also takes into consideration children's experiences. In this example, the child is directed to the experiences he/she has gained about cleaning of food items. From there on they are being introduced scientific concepts such as sedimentation, filtration, etc. Thus, there is a deliberate attempt to connect their knowledge about their immediate surroundings to science concepts. However, to meaningfully pursue these processes, the learner also needs more time to reflect. This can be possible only if there is a reduction in content load. About 20-25% reduction in content load in science at upper primary and secondary stage has been made in the syllabi and textbooks prepared as per NCF-2005 as compared to syllabi the and textbooks prepared as per the National Curriculum Framework for School Education (NCFSE)-2000. This is being made to enable children to have adequate time for carrying out activities and discussions to arrive at a concept. This is also true for the teacher who engages the children. Thus, the syllabus of 2005 shows a paradigm shift from the traditional way of preparing a syllabus. NCF-2005 also recommends plurality of textbooks and relating science to everyday experiences of students.

NCERT has brought out an integrated science textbook for classes VI to X. If one looks through the lens of a science teacher, one can see a good integration of science concepts up to secondary level, though at some places the subject boundaries are still visible. This is because at the secondary stage though science is still to be taught as a composite discipline, the disciplines of physics, chemistry and biology are beginning to emerge. These steps by NCERT may be considered as a process in achieving our ultimate goal of seamless integration. Overall, it can be said that NCERT has been fairly successful in this regard. However, one might argue that the science content up to, secondary stage can still be delineated into physics, chemistry or biology. This might be true if one looks through the lens of a specialised subject expert in their own field. Can we think of how children of 11-15 years old will look at these contents? It is we

who have specialised in our own field tend to classify things from our own disciplinary perspective.

Implications on Teacher Preparation

Teaching science as an integrated subject requires a teacher who can teach science subjects. This gives us an opportunity for introspecting the present teacher education programme in the country. Are our existing teacher education programmes particulary, B.Ed able to prepare teachers to teach integrated science at school level? The answer lies in the course, the content knowledge provided and the pedagogical approach that we follow in teacher preparation programme. There was a time when content and methodology papers were taught as distinct and separate papers in the teacher education programme. Now, there is a consensus that content and pedagogy are to be integrated in the teacher's preparation programme. This is what we call content-cum-methodology paper today. However, this paper is further bifurcated into separate and distinct papers such as biological science method and physical science method. These segregated methods papers are still prevalent in B.Ed programme in the country. Even in the NCERT run B.Sc. B.Ed programme through its Regional Institutes of Education, the students are grouped into PCM (Physics, Chemistry and Mathematics) and CBZ (Chemistry, Biology and Zoology) groups. In the process students from CBZ group find it difficult to teach content related to physics. Likewise students from PCM group find difficult to teach biology particularly in secondary science. Thus, even the products of four year B.Sc. B.Ed programme which is widely acknowledged as the model programme for preparing teachers for the secondary stage have not been able to teach integrated science. The B.Ed programme run in the country gets students from the university system. We also need to recognise the reality that science teachers are graduates with physics or chemistry or botany or zoology subjects and obviously, they do not possess degree in integrated science. That is the way universities have planned the programme of study at graduate level. As a result the current B.Ed or B.Sc.Ed programme running in the country produces specialised subject teachers for teaching secondary science and not science teachers for teaching integrated science.

Organisations such as (KVS) Kendriya Vidyalaya Sangathan, (NVS) Navodaya Vidyalaya Samiti and a large number of private/public schools etc; continue to recruit Trained Graduate Teachers (TGTs) for science subject based on traditional subject combination of Chemistry, Zoology and Botany. It is not clear whether these TGTs are meant for teaching integrated science up to the upper primary or secondary stage. However, it is clear that these teachers may not be able to teach integrated science at the secondary stage. Though there are no clear rules, it is being told that in most of the schools run by KVS and NVS in the country, the science content at the secondary stage is segregated into Physics, Biology and Chemistry and the respective Post Graduate Teachers (PGTs) of the school teach their content area of secondary science. Also if a TGT has specialised in a particular subject he/she teaches that portion of the secondary science. Are the two year B.Ed degree and four year B.Sc.B.Ed degree capable of addressing the specialised needs of the teachers for teaching integrated science up to secondary? The debate continues till today and the consensus can be arrived by introspecting the current system of teacher preparedness.

As mentioned earlier the convenient way of teaching secondary science is to divide the science contents into Physics, Chemistry and Biology portion. Teachers who are specialised in their respective subject areas continue to teach only the portion of science content which falls under their specialised area. In the process, students are exposed to the idea that the concepts are discrete and distinct. The end result is that students develop fragmented disciplinary mode of thinking. Teaching science in a piece meal approach compromise the intended aim of teaching science as an integrated subject. This might not help students to meaningfully understand science concepts and relate concepts to the wide variety of life and natural phenomena existing around them. The idea of teaching integrated science goes beyond merely teaching all contents in a discrete way. From a developmental perspective, the idea is to make students understand the role of interrelationship that exist in real world and also to relate a wide variety of phenomena occurring in their environment, think holistically and address problems confronting them in a holistic way. Above all, our life processes and work which we witness on everyday basis are not stratified and segregated as Physics, Biology or Chemistry.

The conclusion we can draw is that the teaching of integrated science should cover the implications for integrated science teaching in teacher education programme. It is significant to note that the scope is limited for changing the university graduate programme where these graduates are the feeder source for B.Ed programme. The option available to us is to change and modify the existing teacher education programme by judiciously plugging the gaps in the course content. The content may be tailored to suit the diverse academic background of teachers. For example, a science graduate with major subject in physics can be given more content of biology. Likewise, a science graduate with major subject in Zoology or Botany can be given more content of Physics. We also need to do away with the segregated content-cum-methodology papers such as physical science methodology and biological science methodology. Instead this may be replaced with integrated science content cum methodology paper.

References

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