UNDERSTANDING THE HSTP CURRICULUM AND SYLLABUS

In this chapter we shall examine the theoretical aspects of the HSTP curriculum and syllabus. To begin with, it would be wrong to assume that the innovation was launched with any clear-cut understanding of pedagogy and educational theory. Rather, as the work in the schools progressed and the understanding of teaching-learning processes grew, the theory underpinning the HSTP gradually emerged, gaining shape and substance. The entrenched belief was that theory emerges from practice so it was clear from the outset that understanding would evolve and develop. So it is fruitless to try and understand the HSTP and its underlying theory by pigeonholing it in any existing school of pedagogical thought.

One thing was clear from the beginning: 'information' could not be the foundation on which to develop the curriculum, given the 'knowledge explosion' we are witnessing in modern times. It was obvious that is impossible to incorporate this exponentially growing body of information into a curriculum. There was another serious limitation. Even if a curriculum managed to cover all the existing information at a given point in time, the children would find the information dated and probably even irrelevant 10 years down the line. That's why the emphasis was on self learning. But the group knew this would be a slow and painstaking process because the child would be a participant in the journey.

Much of the theory of the HSTP curriculum and syllabus emerged during the years from 1972 to 1977, which saw the most intensive field testing of the educational materials that were being developed. This theoretical understanding was presented during a meeting Kishore Bharati organized from October 3 to 8, 1983.

Given below is an outline of different aspects of the theory on which the HSTP curriculum was based. It is derived from the 1983 presentation as well as some other sources and traces the evolution of each aspect:

1. The curriculum should be activity based, with the children performing the experiments themselves. The central idea was that science teaching in middle schools should be based on performing science experiments. But it wasn't enough that the teacher demonstrated the experiments to the children. The HSTP sought to ensure that the children performed the experiments themselves in groups of four and then discussed the questions these experiments raised in class, with the underlying concepts emerging from these discussions. It did not expect the children to learn a concept from a single experiment. Rather, they would need to perform a series of experiments organized in a logical, step-by-step sequence and work their way towards conceptual understanding. Each activity would be chosen keeping in mind their cognitive level. If a concept required further elaboration and consolidation, more experiments and observations would need to be incorporated.

   There was another condition. The textbook could not give the outcomes of experiments. The children had to arrive at the conclusions themselves by doing and discussing the experiments, and they should enjoy going through this process. They also needed to develop the ability to design their own experiments and understand the importance of controls. They would then know how to design comparative experiments to find out which of several factors was responsible for a particular reaction in an experiment where more than one factor is involved.

The main concern of the HSTP and similar educational innovations was that science learning should be structured around experiments and activity, with the children participating in the process of 'discovering' scientific concepts and laws. This became the guiding principle. It meant concepts that could not be 'discovered' through experiments would have to be excluded. This was the reason why a decision was taken not to include atomic structure and chemical symbols in the curriculum.

However, this did not imply that the HSTP held the position that science could only be taught through an experiment-based discovery process. The understanding was that the focus at the middle school level should be more on inculcating a scientific attitude and developing scientific skills in the children and for this to happen, it was necessary that they perform experiments. However, in the higher classes – or even in their daily life – the children would have to accept and understand information from other sources, most particularly the research activities conducted by other scientists over the years. What the HSTP basically sought to develop in the children were those qualities that would help them to use rational methods to acquire knowledge and distinguish between what is true and false.

2. The curriculum should be framed around the environment of the learner. This was not difficult in the case of the life sciences where the approach was to take up topics based on observations of plant and animal life. This was attempted to some extent in physics and chemistry as well, the approach being to initiate discussion on a concept by taking up an example from the daily life of the children, which could be some common experience, or apparatus, or machinery. The idea was to make them feel they were learning something about what was around them.

   To base a curriculum on learning from the environment and to apply what is learnt to understand our environment were both important considerations. For example, when developing a chapter on the concept of volume, we found that the children - and most people - had several preconceptions that influenced their understanding of volume. In the Hoshangabad region, people measured the volume of grain with a vessel known as a *pai*. They knew that a *pai* of one type of grain had a different weight from a *pai* of another type of grain. They used this knowledge to fix wage rates of labourers so we included it as an example in the chapter on volume. Wherever we found contradictions between a scientific concept and what people and the children understood from their experience, we tried to bring up the contradiction for discussion in the chapter.

   A good example of the children getting to understand their environment better by applying what they had learnt can be seen in the chapter on 'Lifecyle of Living Things'. The children have a lot of misconceptions about how living things come into being. For example, they believe that larvae grow spontaneously in cow dung. So we designed an experiment to expose this misconception, helping the children to understand that larvae and flies can develop only in cow dung that contains eggs and no larvae or flies can be seen emerging from cow dung in which there are no eggs. From here, the discussion is guided with the help of leading questions to the subject of commonly held beliefs and superstitions.

One element that was included in the curriculum to link it to the environment was field trips. The idea was to take the children out of the four walls of the classroom to explore their surroundings, collect things and specimens of plants, get more information about them. It was important that they understood that the textbook and the teacher were not the sole repositories of knowledge. So wherever possible, they were expected to collect information from other sources, the emphasis being on talking to people – farmers, village volunteers, veterinary personnel, local artisans and so on. In many instances, surveys were also included as a means of gathering data.

3. One important consideration was that the children should not see the curriculum as being too intimidating and heavy. They should enjoy experiments and take interest in doing them, not just in the classroom but outside as well. They should also discuss their experimental observations with each other and with the teacher to try and distil their theoretical basis.

4. The most important aspect was to understand the objective of each chapter or topic taken up for study. Take the example of the chapter on flowers. Usually, the children are taught the names of the parts of a flower, their stages of development, inter-relationship, etc – basically, general knowledge about the flower. In the *Bal Vaigyanik*, the aim was not just to learn the names of the different parts of a whole lot of flowers and their stages of development, although the children actually did so, but to themselves examine and understand the structure and composition of each flower they collected. They had to learn the process of studying flowers. In other words, they would then be able to continue their explorations on any topic they studied in school outside the classroom as well.

5. There was one other attempt made in the *Bal Vaigyanik.* The children were expected to understand and internalise the method of science, which included the following elements, among others: performing experiments, discussing and analysing the observations from the experiments, distilling a theoretical explanation from their observations and then designing new experiments to test their hypothesis.

6. The children were also expected to develop the ability to express their experiences and observations in their own words. The emphasis was on them writing their own answers to the series of questions given after each experiment. After the experiments were performed and the discussion done, there was no attempt by the teacher to sum up what the children had learnt that day. It was clear that they would not be able to express themselves clearly in writing and there would be mistakes and shortcomings, but still they were encouraged to

write their own answers in spite of their inadequate language skills. Using diagrams to explain their thoughts was seen as another step in developing their understanding.

7. One more aspect that came in for attention was developing the motor skills of the children. They were consciously taught how to handle the apparatus for the experiments, and even to design apparatus and other equipment themselves.

8. Measurement was an important skill that was taught. The curriculum sought to give the children a feeling for numbers and statistics, understand what they are, and how data is to be collected, organised and tabulated for presentation. They were taught how to analyse the data by constructing bar diagrams and graphs and how to draw conclusions from their analysis.

   One feature of measurement that was constantly stressed was that it could never be exact. There would always be some approximation involved and this approximation could never be reduced to zero. You could improve your experiments to get better and more clear-cut results, but the children were made to understand that science can never make the claim that any result is final or exact.

9. Emphasis was placed on the concept of making groups and its use. The concept is woven through the *Bal Vaigyanik*, given its importance in learning science, developing rules, recognising patterns, framing questions for taking the study forward and arriving at a hypothesis.

10. It was also clearly understood that the kit and apparatus are an important part of an experiment and activity based curriculum. A system would have to be put in place to supply a kit box to schools containing apparatus and materials for experiments that could not be obtained from local sources.

Viewing the curriculum from another perspective

We get another perspective of the curriculum in a different context. From the point of view of the examinations, the HSTP emphasised certain skills and concepts which it identified as fundamental concepts. The syllabus and the choice of topics was structured and developed to ensure that the children got a sound grounding in these skills and concepts. It can be said that it is these fundamental requirements that determined the HSTP curriculum and gave it shape because these were the areas in which the children were evaluated during the end-of-term examinations.

These fundamentals concepts include the following:

<u>Scientific skills/abilities</u>

- Make minute and correct observations.

- Conduct surveys and collect data.
- Organise, tabulate and present data – tables, bar diagrams, graphs and diagrams.
- Analyse data.
- Identify linkages between different experiments.
- Draw conclusions by logical reasoning.
- Ask clear, sharp and new questions at every step of logical reasoning.
- Generalisation and abstract thinking.
- Experimental skills.
- Measurement and understanding of approximation in measurement.
- Draw maps.
- Make apparatus/kit from local materials.

Scientific attitude

- Curious and inquiring mind.
- Sensitivity to the environment and ability to continuously learn from it.
- Urge to find out and discover things.
- Understand importance of controls in experiments.
- Demand verification of facts/information before accepting them.
- Accept that a question may have more than one possible answer.
- Open mind to differences, challenges, criticisms.

Concepts

- Groups and sub-groups.
- Classification.
- Coordinates.
- Area, volume, mass.
- Separation.
- Acids, bases, salts and neutralization.
- Identify various substances through chemical analysis.
- Understand the importance of diversity in the living world as the basis for all biological theories.
- Chance and probability.

The logic (rationale) of the syllabus

The guiding principle in defining the syllabus was that only those scientific concepts would be included that can be taught through the medium of experiments or activities, or that are within the ambit of a child's direct experience or observation. If there are no appropriate activities or experiments to explore a concept it was not taken up for study. Appropriate meant those activities and experiments that could be taken up in a rural middle school.

One other guiding principle was that the syllabus should be linked to the environment of the children.

In this way, general scientific processes such as grouping were emphasised and given precedence.

To some extent, the prescribed state curriculum was also kept in mind, especially in the life sciences. This is evident from a note written in December 1990 by Arvind Gupte*, a resource person with Eklavya, in which he stated that the basis for formulating the biology syllabus at the time of the 1978 expansion to the state level was that it should more or less be in line with the prescribed science curriculum for middle schools. So, expectedly, chapters relating to the structure and functions of animals and plants were included. Even then, some topics included in the state syllabus were consciously excluded. These included cell structure, cell division and standard classification of plants and animals. Cells are such microscopic entities that middle school children cannot possibly visualise or understand them. Cell division is even more abstract and any descriptive chapter on the subject would only confuse the children further.

(*Arvind Gupte, A note on biology chapters, December 1990.)

Some topics were included in the *Bal Vaigyanik* which were not in the prescribed syllabus. One example was diversity in the living world, which is a fundamental concept in modern biology. In general, all topics in the state curriculum that failed to meet the criteria of direct observation or experimental investigation and verification were omitted. They included atomic structure, chemical symbols and formulae, equations, standard biological classification and so on.

Another reason for excluding atomic structure and chemical symbols was the belief that children of that age-group (10 to 13 years) are not at the cognitive level where they can understand an abstract concept like atomic structure. A related concern was that if atomic structure had to be taught, it would require the kind of experiments that would help the children understand that concrete objects are composed of minute atoms. There are experiments that can illustrate that atoms form the basic unit of a solid structure, but it requires a level of mental maturity to understand these experiments. Moreover, the equipment required to carry out these experiments is prohibitively expensive. The alternative of a teacher using a model to explain atomic structure to the children was also unacceptable.

Similarly, biological classification has a conceptual basis, but it is a highly abstract concept. Classification is based on evolution. So to talk about classification without going into its evolutionary basis is nothing more than just memorising information. It is useless to burden the children with such inessential information in the preliminary learning stages.

In Madhya Pradesh it is unlikely that many children get to see ferns. Even for those who have seen them, it is difficult to explain to them how they are different from flowering plants that look more or less similar. It is even more difficult to explain that echinodermata are spiny skinned animals whose skeletons are composed of calcareous plates or ossicles.

Another problem is that animal and plant classification has a nomenclature based on Greek and Latin. It would be patently unjust to expect the children who find it difficult to cope with even English to remember or memorise such difficult terminology.

Some salient curricular objectives that emerged from a meeting held on May 12, 1976 to discuss curricular issues:

I. Joy of exploring our surroundings and learning:

1. Desire to find out about things oneself.
2. Urge to ask questions.
3. Enjoy using all ones senses in doing things.
4. Awareness of the diversity of living creatures.

II. Observation, expression and organisation:

1. Ability to group things one collects on the basis of their properties.
2. Ability to group things into living and non-living on the basis of their observed properties.
3. Ability to classify things according to different criteria.
4. Ability to observe regularity in events and processes.
5. Ability to distinguish between relevant and irrelevant observations.

III. Asking questions and designing experiments to investigate their answers; logical thinking:

1. Ability to find answers to simple questions by investigations.
2. Appreciation of the importance of measurement.
3. Comparative analysis on the basis of a property or variable.
4. Identifying the variable that determines a specific property.

IV. Concepts, knowledge and skills:

1. Topics and concepts for chapters, such as acidity, reactions, repulsion, etc.
2. Ability to measure length, volume and weight using arbitrary as well as standard units.
3. Mathematical skills (using both units and decimals).
4. Skill in handling and using experimental apparatus.
5. Ability to search for information in books and other sources.

V. Comprehension and communication:

1. Ability to understand and explain in simple words with the help of diagrams.
2. Ability to record events systematically.
3. Ability to tabulate data and use tables, bar diagrams and graphs.

VI. Recognising patterns and correlations:

1. Understand that the apparent form, shape and context of anything depends on the position of the observer.
2. Appreciation of diversity in living things – seasonal and other changes.
3. Understand cause-effect relationships.
4. Understand the relationship between parts and the whole.
5. Symbiotic relationships between living things.

Comments:

1. It is commonly assumed that 11-year-old children have a sense of meaning or comprehension. We have included comprehension because we feel the children in our schools lack this ability.
2. There are several other abilities that can be added to this list.
3. Goals and competencies that have been achieved, or which are considered minor, should be removed from this list. Similarly, those that cannot be attained should also be omitted.
4. In the Class 8 question paper 60% of the questions are based on V.1, III.1 and IV.1. We have to decide whether this is justified.
5. Authors of chapters should ensure that IV.1 figures prominently and is dealt with in depth in all chapters they develop. For example, that air expands when heated, or that repulsion is the identifying factor for magnets.
6. In the first six months in Class 6, the children should be taken on field trips and asked to write detailed accounts of their observations in order to develop their comprehension abilities.

The importance of classification in science has been recognised but the HSTP has taken a different approach to the concept and has introduced it in the *Bal Vaigyanik* with a different objective. In the chapter titled 'Laws of Classification', the children begin by making groups of the contents of their school bags and slowly work their way up to an understanding of the laws of classification. Classification of living things begins by making groups of living creatures in the environment around the children, based on their properties.

Moving forward step by step

The topics in the syllabus are presented in a very organised and structured manner in the *Bal Vaigyanik*, keeping in mind the step-by-step development of concepts, their inter-linkages, complexity, level of abstraction, etc.

The texbook first introduces quantitative concepts before gradually and progressively moving to qualitative concepts. Thus, in Class 6 quantitative concepts predominate, with the proportion of qualitative concepts increasing as the children progress through Class 7 and 8. There are many examples of this gradual progression. For example, grouping (quantitative) features in Class 6 while area and volume measurements are taken up in Class 7 and more difficult qualitative concepts, such as probability, are reserved for Class 8.

Similarly, in chemistry, separation is taken up in Class 6, while acids, bases and salts, in which counting and measurement are involved, are dealt with in Class 8. It isn't as if qualitative concepts are totally excluded in Class 6, but the focus is on the quantitative, such as measuring distances. Initially, area and volume were also included in the Class 6 syllabus but we soon realised that the children were facing difficulties in dealing with these concepts because they needed to learn many more things before they could handle such concepts. That's why we later shifted the chapters to Class 7.

Many concepts require a higher level of abstraction, conceptual understanding and mathematical skill if they are to be understood and internalised. For example, the children are stumped by decimal division. Or some concepts require the development of experimental skills. For example, to get more exact results in experiments with hard and soft water, it is essential to ensure that the apparatus is cleaned well and special care is taken while conducting the experiment.

There is one more aspect, which educationists call moving from the unknown to the known. We have followed this principle by basically linking concepts to the environment of the children and beginning with familiar examples.

Another guiding principle in evolving the syllabus was that abstract thinking should be developed in the children in a step-by-step manner. Thus, in Class 6 and 7 they are expected to draw a conclusion or reach a theoretical understanding of whatever situation they are studying in a single step. Two-, three- or more step logic is not expected in Class 6. A little more is expected in Class 7 and the proportion of multi-step reasoning increases in Class 8.

The first attempt to move beyond one-step reasoning in Class 7 was in starch production in leaves. After the children learnt in this chapter ('Sunlight and Starch in Leaves') that leaves cannot produce starch without sunlight, they were asked the question: What is the importance in life of sunlight and green leaves? They were then expected to combine concepts they had learnt in several different chapters in searching for the answer, such as the importance of starch in our food in the chapter 'Food and Digestion'. Another question posed to them in the chapter was: Would we get milk if the earth was in permanent darkness?

But this process reached its limit in the chapter 'Looking at the Sky'. This particular chapter, which is essentially a study of the solar system and its motions, was divided in two sections that were taken up separately in Class 7 and 8. It involves combining the results of six or seven experiments to draw some specific conclusions. These experiments generate data that can be interpreted in two ways. One is simple and, hence, considered better, in keeping with the scientific dictum that the simplest solution is preferably the better one. But we found it difficult to explain the solution to the teachers. We even resorted to the technique of using a model to help them understand.

A similar situation was faced in the chapter 'Chance and Probability' – no conclusions seem to emerge from the experiments. The chapter requires a conclusion to be drawn by collating and interpreting a large mass of data. But it is not possible to elicit a straightforward or obvious conclusion – one needs to recognise a pattern in the data to draw any conclusion. This is an even higher level of abstraction.

The inclusion of such abstract concepts gave rise to another concern – is it at all possible to evaluate students' understanding of these concepts in depth in an examination? In this context, the consensus in the HSTP group was that the children should not be expected to fully internalise an abstract concept that requires intricate explanatory processes. It is enough if they gain a broad understanding and sense of the overall concept. For example, in 'Chance and Probability', it is sufficient if they can recognise a pattern in the falling of heads and tails while tossing dice and decipher which possibilities are either impossible or have very little chance of occurring. Such an approach is important from the point of view of introducing an element of flexibility in the chapters.

The general understanding in the HSTP was that information should not be given in the chapters. But there appears to be a misunderstanding on this score that requires to be cleared. The children often require information to help them proceed with some experiments or aid them in analysing the results. If they have no way of acquiring this information while doing the experiment, then the required information is given in carefully measured doses to help them proceed. But this understanding has seen a lot of change over time.

The *Bal Vaigyanik* syllabus has internal links. A lot of work has gone into establishing these linkages, which have two facets. First is the step by step progression of the syllabus. Second is the link between concepts in the syllabus at different levels of complexity. The step by step progress is clearly evident in the chapter 'Learning About Graphs'. The process begins in Class 6, where the children learn to make bar diagrams. In Class 7, they understand how to use Cartesian coordinates and scale to make shapes and forms bigger or smaller in the chapter 'Learning to Draw Maps'. The chapter on making graphs then follows. Similarly, in Class 8 there is a chapter on interpreting the graphs that the children make. Such step by step organisation and progression is seen in many places.

Another example of such progression can be seen in the chapter 'Air'. Several properties of air are studied in this chapter. It is then followed up by the chapter 'Gases' in which the properties of oxygen and carbon dioxide are studied. Next comes a third chapter 'Respiration', which can be taken up only after the children have done the chapters on air and gases and understood the properties of gases.

Considerable effort went into finding new and exciting, yet simple, ways of communicating the syllabus. For example, the children found it difficult to understand why an electric motor rotated. Some volunteers came up with a totally new way of explaining the phenomenon – a toy electric clown. Using this model they were able to demonstrate the right hand rule.

In the chapter 'Internal Structure of the Body', it was felt that a wrong concept was being conveyed to the children – that all body organs were on the same plane, when in reality they are in different three-dimensional planes. A special game was designed for the purpose in which the children cut out pictures of the various organs and assembled them in a given order on a large diagram of the body. In doing so, they saw that the organs are positioned in different planes and levels in the body.

Many similar examples can be cited from other chapters.

Many experiments and exercises were included to stimulate the creative abilities of the children, in particular scientific creativity and the ability to make different artefacts. For example, Class 7 has a chapter on making objects of different shapes using matchsticks and cycle valve tubes. In addition, different chapters carry instructions to make microscopes, lactometers, hand pumps, periscopes, kaleidoscopes and weighing balances. These have been consciously introduced into the syllabus.

The question of environment-based curriculum

Nowadays, most primary education programmes seek to structure learning around the immediate environment of the child.

In a surprisingly prescient decision, the Supreme Court decreed that environmental education should be made compulsory in all classes. The understanding behind this decision was that the environment is an important subject for study.

The HSTP's understanding of environment-based education is slightly different. It believes that the environment (the milieu of the child) should play a major role in the process of learning different scientific concepts. This means taking all examples to further the learning process from the local environment. Any concept or scientific rule discussed in the classroom should be applied to the environment and analysed. For this purpose, all local sources of information and knowledge – village elders, patwaris, ordinary farmers, health workers, etc – should be tapped. The local dialect should also be given its due place. And most important of all, when studying a topic, it is first necessary to examine prevalent local beliefs and understanding on the subject. Underlining this aspect of the HSTP, Yash Pal wrote the following about the programme's very first teacher training workshop:

The HSTP's understanding is that all information is contained in the environment and the objective of school education is to teach the children the methods by which they can acquire this information and analyse it. So it is more appropriate to say the *Bal Vaigyanik* curriculum is linked to the environment rather than say it is environment-based. Education should be linked to the child's environment. This includes not just the natural and physical environment but the community, family, customs, traditions, etc. Culling out information from all these sources is crucial for the HSTP. That's why the children go on field trips, conduct surveys and discuss with village elders, craftsmen, etc to get more information. Many household artefacts are also used as teaching aids to link learning with the child's environs.

Using the environment as a base for learning emerges in many ways in the *Bal Vaigyanik*.

The easiest and most obvious illustrations are in the life sciences. Many biology chapters study things that are present in the children's environment. They collect samples from their surroundings during field trips to study and analyse them and a lot of emphasis is placed on the specimens they bring to the classroom. The 1978 edition of the textbook had 22 biology chapters of which six required the children to go on field trips. Such chapters are an integral part of the curriculum.

Apart from these, chapters like 'Food and Digestion' begin with a discussion of the food of living creatures, ways of eating and the organs for eating. The chapter on food for human beings also does not go into abstractions but begins by examining the foods humans actually consume. These foods are then classified into groups. This chapter also touches on the link between malnutrition and poverty, with the children conducting a survey to find out why the poor get less food.

One of the challenges in environment-based learning is classifying living creatures. We have discussed this issue briefly earlier. Nowhere does the HSTP insist that the children memorise the standard classification categories. Instead, in the chapter 'Classification of Living Creatures' several common sense categories – habitat, skin cover, etc – have been included in addition to standard categories such as vertebrae, wings, presence of mammary organs, number of legs, etc.

The environment base is not as strong in the chemistry and physics chapters. Nevertheless, wherever the opportunity presented itself, attempts have been made to use materials and examples found in the immediate vicinity of the children to develop an understanding of physical and chemical theories and concepts. This can be seen in chapters like 'Soil', 'Acids, Bases and Salts', 'Chance and Probability', 'Separation', etc where the experiments have been designed using locally available materials and the discussions are guided by local examples.

This approach is clearly evident in the 'Measurement' chapter. The local context is used to develop an understanding of measuring distance, area and volume. For example 'area' begins by measuring the area of agricultural fields, while 'volume' begins by examining people's preconceptions about volume, then tries to understand these concepts before using them as a base for proceeding further.

Another aspect of linking learning to the environment is language. The language of learning has three components. First is the language people use in their daily lives to communicate with one another. Second is the language the teacher speaks to the students. Third is the language the teacher expects the students to write, which gets the most attention. While preparing the first edition (1978) of the *Bal Vaigyanik*, the HSTP group paid special attention to using the language the children normally speak to the extent possible.

The biggest problem was dealing with standard scientific terminology and nomenclature. Most of these officially designated words are difficult and create obstacles in learning. The only option the children have is to memorise them. So the HSTP group tried to avoid using terminology as far as possible, taking recourse to it only as a compromise. Take the example of the 'Bones' chapter. Most textbooks have a diagram of the skeleton labelled with difficult Sanskritised names. The *Bal Vaigyanik* used common words in their place to simplify the text, although it compromised by giving the official terminology in parenthesis, for example, *ankh ka gadda* - eye socket – (*netr kotar*). The idea was to help the children to recognise bones, not memorise difficult words.

There was a bit of a problem in using local language because different things are known by different names even within a single district, given the range of spoken dialects. In such situations, the HSTP opted for the local variant even at the cost of antagonising the teacher.

Nonetheless, standard terminology continues to pose a serious problem in school education.

All this shows that an environment-based curriculum or teaching method has many facets. Designing such a curriculum to understand scientific concepts means structuring it around examples taken from the children's immediate context; integrating their knowledge base and understanding into the teaching method and textbook; making full use of knowledge embedded in the local context to develop the dialogue; and making the maximum use of the children's spoken language in the textbook.

When the time came to prepare the *Bal Vaigyanik* textbooks following the initial experiment with chapters on cards, a special 'ruralisation' workshop was organised to study the problem of designing environment-based chapters in greater depth. This was in 1975. Apart from the HSTP resource group around 40 teachers who were active in the programme also participated. The focus of the discussions was on structuring the syllabus around the rural context, the four main points that were taken up being grouping and classification, measurement, biology chapters and experimental kit.

The workshop spent three days in trying to understand how concepts such as grouping/classification and measurement could be of use in a rural setting and how exactly these concepts were seen and understood at the local level. In biology, the point of interest was choosing topics that would be relevant in the rural context. Many small projects were taken up to field test experimental material with potential for inclusion in the chapters but nothing substantial emerged from these exercises. What did emerge, however, was a new and deeper understanding of curriculum and material development. Equally, if not more important, was the fact that the workshop came out with a strong and unequivocal message that environment-based learning is an important component of curriculum development.

But there is a common misconception about what exactly 'studying the environment' means. Generally the exercise is reduced to reading descriptive details about the environment with no attention being paid to the concept of actually interacting with the environment. This point came across strongly in the feedback about the field trips the children were expected to go on in the HSTP classes. The teachers mostly talked about the problems such excursions pose: it is difficult controlling the children; they tend to wander away; they can be bitten by snakes; they ruin the fields; and so on.

The root cause of these complaints seemed to be a cultural dislike of 'muddying one's hands' in a 'dirty' activity, so every attempt was made to keep classroom learning apart from such pursuits. This antipathy was fairly deep-rooted in the public consciousness, as seen in a letter written in 2002 by the Itarsi MLA to the Hoshangabad district (HSTP) project committee: "The children are put to unnecessary hardships because they have to collect specimens of different kinds of leaves for their experiments."

Nevertheless, despite the reluctance of the teachers (and the parents) and the difficulties they faced, the public discourse on environment-based curriculum, teaching methods and textbooks witnessed a sea change by the time the HSTP was being expanded to the district level in 1978. But this expansion phase brought two new challenges for environment-based learning to the fore.

The first challenge was the geographical vastness of Hoshangabad district (which has since been divided into two - Hoshangabad and Harda districts). Different regions in the district have different languages and cultures, while agricultural practices are also quite varied. For example, rice is grown in one region while cotton is grown in another equally large region. This diversity put a new kind of pressure on the *Bal Vaigyanik*, of which the choice of words formed only a small part.

It wasn't just the words themselves. Their choice was affected by the examples chosen to study and the concepts on whose basis learning was expected to proceed. The problem was not limited to biology alone. The most striking example can be seen in the study of chance and probability, about which Krishna Kumar once commented that basing the study of such a difficult concept on the arrival and departure timings of local trains can be considered a unique innovation in science teaching. The study of chance and probability begins with the timetable of a local passenger train at Bankhedi station and the history of its actual daily arrival and departure. This chapter was retained in its original form right through the course of the HSTP although it was unclear whether the children from other regions of Madhya Pradesh were able to relate to the example used. There are other similar examples, including the chapter on volume, which used local concepts as a base for its development.

Whatever be the case, it is important to keep in mind that any environment-based curriculum should be linked to the local milieu and the learning process should be structured around the existing knowledge base of the children. At the same time, one should take care in defining the possible limits to which their understanding can be generalised.

Equally important, one should remember that no matter what the context, the learning process remains the same. So if we are talking about a rural environment, different places could have different crops, or different insects and animals, or flowers and leaves, but the method by which concepts are arrived at would be more or less similar. So the children would use similar methods to study different kinds of farming. That's why every chapter in the *Bal Vaigyanik* can very easily be used across regions. They do not describe a single common environment but expect and encourage the children to study various events occurring in their own environment to arrive at a common understanding.

This approach can be described in another way: the chapters are environment-based but independent of any specific regional environment. Such an approach is suitable for rural areas (although even here there is the question of non-agricultural areas) but urban areas posed an altogether different set of challenges.

The district level expansion brought this problem to the fore because it meant the programme was no longer limited to the rural areas. The *Bal Vaigyanik*, in which the crop-related chapters were exclusively based on local knowledge and direct observations of events in the field, began to be taught in schools in towns and casbahs where a large section of the students had no direct experience of farming. If we accept that agriculture should be a part of a science curriculum the question one needs to answer is: how can the children from urban areas be included in the learning process?

The question has a corollary. If a curriculum is to be environment-based, shouldn't chapters linked to the urban environment of such students also be developed? This was a fresh challenge that inspired many discussions, with one school of thought suggesting that it may be better to present two alternative sets of chapters, one urban-based and the other rural-based. But nothing came of this suggestion. However, in the third edition of the *Bal Vaigyanik*, the format of agriculture-related chapters was modified. Instead of depending on direct field observations, the development of concepts in the chapters was basically linked to the analysis of data provided in the textbook itself. Similarly, in the chapter on plant growth and reproduction, some important experiments were excluded. In any case, even the students in rural schools had been finding it difficult to carry out these experiments but the basic reason for their exclusion was, nevertheless, the HSTP's inability to offer a creative alternative.

This question can be looked at from a different perspective. If expansion of the programme involves replacing interaction with the environment by written data in textbooks, then aren't we depriving the children of an important source of learning? This is a point those who advocate a single textbook for the entire state or country need to seriously ponder on. And if we are to look beyond the physical and natural environment to the total milieu then even more serious questions are raised about the processes of centralisation in curriculum development.

The obsession with not giving information

When the resource group took up the task of writing the *Bal Vaigyanik*, they decided that the children should discover things for themselves. So the emphasis was on discovering information, laws, theories and so on. It also meant that information should not be directly fed to the children. The thinking behind this approach was that providing information in textbooks would lead to questions in examinations being based solely on this information content. This would encourage the tendency to memorise, which would, in turn, weaken the process of doing and understanding. Another fear was that once the doors are open, it would lead to a flood of information, given the fact that the mainstream wants textbooks to be packed with as much information as possible. But the most serious misgiving concerned the negative impact it would have on the discovery process.

The decision to exclude information (terminology, laws, etc) was influenced by another consideration. The HSTP was generally seen as 'learning by doing' science. This led to a widely held misconception that all that was needed was for the children to do a whole lot of experiments. The 'discovery' aspect of the HSTP was never really understood or explained. Its objective is not merely to do experiments but to deliberate on one's observations, express opinions, appreciate and understand the opinions of others, reason, arrive at conclusions, test and confirm one's results and so on. It's easy to negate such a complex process by a catch-all definition. Thinking for oneself and reaching somewhere can often be a difficult and frustrating path to tread. You opt for a rugged road instead of a smooth path when you decide to exclude information and adopt a discovery approach. In the decade of the '70s, mainstream textbooks were obsessed with the 'knowledge explosion', an obsession that is still evident today, although more muted. The credit for this change in thinking, both explicit and implicit, should go to the HSTP group, which refused to structure its curriculum around the 'knowledge explosion' and kept the discourse on the subject alive in the public consciousness. .

But this rigid stand does appear to be a bit unreasonable when we examine it today. By totally excluding information, the *Bal Vaigyanik* tended to make the discovery process appear a bit artificial and sometimes forced. That is why you see two types of language usage in the textbook: instructions and questions.

Quite often, some information is needed to keep the discussions or chain of experiments moving forward. However, the *Bal Vaigyanik* insisted of performing another experiment to acquire this information, which sometimes tended to break the natural flow of the learning process. Later experiences in the HSTP clearly show that it is not always necessary to use the discovery approach to acquire information. In fact, undue insistence on this approach can even prove an obstacle in the thinking process.

For example, there was a chapter 'Sunlight and Starch in Plants' in the first edition (1979) of the Class 7 *Bal Vaigyanik*. The children perform a classical experiment to 'discover' that starch production in leaves occurs only in the presence of sunlight. They cover a portion of the leaf with black paper and examine the leaf a few days later to see in which portions starch is produced and in which portions it is not.

The children need to know that the portion of the leaf covered by black paper does not receive sunlight. But instead of giving them this information directly, the *Bal Vaigyanik* asks them to cover their eyes with black paper, look at the sun and then figure out why black paper is used in the experiment. Ironically, this example is one of those unfortunate exceptions where the *Bal Vaigyanik* actually gives the results of the experiment: "You found out from this experiment that leaves require sunlight to produce starch."

Whenever a choice was required to be made between giving information or doing an experiment, the *Bal Vaigyanik* opted for the experiment.

Take another example from the 'Air' chapter in the 1979 Class 7 edition:

> Experiment 1: Blow on your hand. Explain what you experience. (1)
>
> Hold a leaf or a piece of paper at one end and blow on the other end. What happens to the leaf when you do this? (2)
>
> Now hold the other end of the leaf and blow on it.
>
> Can you tell why the leaf fluttered when you blew on it and what came out of your mouth to make the leaf flutter? (3)

The entire sequence of events appears a bit forced and childish. Perhaps, it is even unnecessary. It may have been better to simply write a good explanatory paragraph instead.

The same chapter provides another example. In one section the children have to measure the volume of air. To do this, some air is collected in a water-filled plastic bottle by displacing some of the water. While measuring the volume of air, the children have to make sure that the air pressure inside the bottle equals the atmospheric pressure. The way this is done is to submerge the bottle in water to the depth where the level of water inside and outside the bottle is the same. Instead of explaining this procedure in the chapter, a question is posed to the children:

> Should the bottle be held in any particular position when examining the level of water inside it? Discuss with your teacher.

This is one of the major problems with the *Bal Vaigyanik*. It raises doubts about the exact role the teacher is expected to play. In many instances it appears as if the question a teacher would normally ask in a given situation is made part of the chapter itself. Like we see in the example cited above. If the question was not there in the textbook the teacher could take the discussion forward in many different ways. One cannot really predict what might happen in a discovery approach or in which way the discussion will proceed. In such instances the attempt to strike a balance between fitting the discovery approach within a classroom framework while retaining its flexibility appears a bit forced.

Perhaps the better approach would be to completely do away with the textbook in a discovery type learning methodology. The teacher would then have only the outline of a chapter and would have the flexibility to structure the classroom activity accordingly. The framework would, however, have to be fairly detailed and based on an in-depth understanding of the subject. It would also contain experiments and activities to help the children understand and internalise its conceptual content. It would also give guidelines to the teacher on how to conduct the activities with the students, giving her the option of choosing what exactly (s)he would like to do in the class.

An even better approach would be to let the children's curiosity and the questions in their mind decide the learning process. The role of the teacher would then be to place these questions in their proper perspective and suggest appropriate experiments and activities to search for answers. One such experiment was carried out in the Science Education and Communication Centre of Delhi University under the supervision of resource persons associated with the HSTP, with many from the HSTP group participating in different ways. However, this is not the appropriate place to discuss this experiment, which was called 'Science and Technology Literacy For All'.

In the present educational scenario, the textbook is considered essential for learning and there are very traditional interpretations of what it should contain. When the *Bal Vaigyanik* was published, the parents always complained that it contained nothing that the children could memorise. They also complained that they didn't have a clue about how to prepare their children for the examinations. The *Bal Vaigyanik* just didn't fit into their conception of a textbook. So one can well imagine what the fate of the parents will be if there is no textbook.

There is another equally important aspect about excluding information in the textbook. The writers of the *Bal Vaigyanik* knew that the children would need information at different stages in the learning process. Such information would guide them to view their conclusions from a certain perspective. Or it would help them understand which new experiment to do or how to reach a conclusion. The writers came up with a way to get around this problem. Wherever information was needed, they instructed the children to discuss the matter with their teacher. Another type of question asks the children to discuss among themselves to find an answer. These are two indicators of the different roles the teacher is expected to play. These questions can't be answered solely on the basis of the experiments but requires additional information, reasoning and experience. The teacher is expected to provide these additional inputs.

One advantage of this arrangement is that there is no need to give the information in the textbook. The teacher can decide how much information to give and in what manner to give it, based on the situation in the classroom. But the disadvantage is that everything now depends on how well the teacher understands the subject and how skilled and prepared (s)he is to deal with the situation. This is one area that requires further innovations.

The teacher guides, supplementary curricular materials and annotated editions of the *Bal Vaigyanik* can be seen as part of this arrangement, although these have not proved fully satisfactory. The later editions seem to have adopted a more liberal approach. For example, in the third edition is more generous in its information content and has made several other departures, including incorporating some supplementary materials.

These changes in the later editions can be seen as a result of the emergence of a school of thought within the HSTP group that the *Bal Vaigyanik* had become too terse and dry, with a rigid and monotonous question-experiment-question-experiment format. Doubts were raised about many experiments that seemed to be without much purpose and didn't appear to contribute much to the reasoning process to derive conclusions. A study conducted in a few schools by Anita Rampal showed that if there is no clear objective or hypothesis the children fail to make even fairly obvious observations. For example, if you place a magnet below a cardboard sheet on which iron filings are spread and if you gently tap the filings you can clearly see the magnetic lines of force as the filings rearrange themselves. But for the children it still remained a jumble of iron filings. Another problem was that most experiments started with no pointers on why they were being performed. The lack of a hypothesis in the children's minds to begin with tended to dampen their enthusiasm and rob them of the excitement of looking for answers.

What was becoming clearer was that some important elements that could contribute to learning were being overlooked in the single-minded pursuit of 'learning by doing'. For example, the process of critical thinking and analysis could gain from reading about the life stories of scientists, the experiments they conducted, as well as the historical development of investigations into the subject under study. Reading interesting accounts about the topic being discussed and seeing one's own activities in the proper perspective contribute to the process.

The issue was intensely debated in the HSTP group but many resource persons continued to strongly believe that introducing such additional elements would weaken the experiment-based methodology. They felt stories and histories would predominate and overwhelm the experiments, leading to a loss of interest among the children to learn by doing.

This phase brought greater clarity to understanding what constitutes 'information'. The meaning was extended beyond giving the conclusions to be drawn from experiments or stating laws and terminology to include descriptive curricular materials that excite the children to think, broaden their perspective and link what they learn in a wider framework.

The single-minded pursuit of learning by doing raised another problem as well – many topics were dealt with partially or incompletely. This could be seen in the case of nutrition in plants, force, agricultural crops, growth and development, etc, which were pursued only to the extent that it was possible to conduct experiments at the middle school level. Even here, many excellent experiments could not be included because the critical thinking and reasoning required to draw conclusions from them were beyond the mental level of middle school children. The limited capabilities of the teachers to guide them also did not help in the matter. Nevertheless, a few such chapters were included in the *Bal Vaigyanik*, the most striking examples being 'Looking to the Sky' and 'Chance and Probability' (from the first edition).

One other practical difficulty with the *Bal Vaigyanik* was the problems the parents faced at home when they tried to help their children in their studies. They did not know what to do with the textbook or how to use it. This was because the *Bal Vaigyanik* was never visualised as a standalone textbook. Of course, it addressed the children directly, but its purpose was to establish and guide the learning process that would be taken forward by the combined efforts of the children and their teacher. The children were not expected to sit alone, do the experiments, and answer the questions to reach the required conclusion. Rather, they work together to look for answers, taking the guidance of their teacher wherever necessary. The teachers were trained to guide this process but the parents were nowhere in the picture.

Supplementary material – a mirage

As pointed out earlier, the HSTP resource group never underestimated the importance of information. It was just that its understanding was evolving. For example, in 1983 it stated:

> We avoid giving information from our side. But we have given whatever minimum information is needed, after carefully assessing the situation, to help the children do the experiments or analyse their observations.

From this it is clear that at no stage was information looked at as a means of learning. It was used as a compromise only when all other alternatives were exhausted. Even then it was used stingily and with caution. The fear was that if information was included the children would begin memorising. But this understanding never came across concretely but only in patches. Information was never seen as an integral part of the process but only as a compromise.

The information problem was first seen in the biology chapters. A comment on these chapters, written in 1990, brings this out:

> Given the nature of biology, it is impossible to adopt the same approach as in physics and chemistry. You cannot completely cut out information and terminology in biology.

Awareness of the importance of information and descriptive details in learning grew slowly and began to express itself in different ways. In the teacher training sessions, there was a growing demand from the teachers for 'additional information' on different topics. But simultaneously, many expressed the fear that the teachers would burden the children with this information. Another demand was for teacher's guides. The teachers felt that these guides could contain the information they would need to carry discussions forward in the classroom.

The information issue came up for discussion in a workshop organised in October 1985 to discuss the *Bal Vaigyanik* revision. Almost all the chapters were reviewed in depth during the workshop and many suggestions for improving them were made. Among them was the need to include more information in some chapters. There were also suggestions to provide the information in the teacher's guides or as supplementary material. But it was never clear how or where this material should be made available to the children so the suggestion was never acted upon in a concrete way. Around this time, Eklavya had launched a children's science magazine and many felt this magazine could serve as a vehicle for reaching supplementary material to the children.

Another suggestion was to add some portions containing information to the *Bal Vaigyanik* with the stipulation that questions on this content would not figure in the examinations. This suggestion made it clear that the central issue was not whether to provide information or not but the fear that there would be pressure on the children to memorise such content.

No decision was taken on whether or not to include information during the second revision of the *Bal Vaigyanik*. At least, no one took the position that information should be included as a medium for learning.

The Ganguli Committee set up by the government fully agreed with and supported the HSTP's curricular objectives and methodology. But the committee expressed concern about the imbalance between the 'method' and 'product' aspects of science in the *Bal Vaigyanik*, pointing out that the product aspect had been almost totally overlooked. The 'product' was a reference to scientific terminology, laws, theories, etc. The committee recommended that the HSTP rectify this imbalance, asking if there was any system for reaching the 'accumulated knowledge' of science to the children.

The committee report was an important reference point in the 1994 *Bal Vaigyanik* revision. But the HSTP group had no model to guide it in using information to foster thinking in a discovery process. Available models were of information-based curricula that focused on the children memorising whatever information was given. The challenge was to devise a new approach. The touchstone would bewhether the information would replace any experiments or activities, or dampen the excitement of discovery, or impact on the primacy of experiments in learning. These were the boundary conditions for the HSTP group. However, once these limits were breached the group willingly accepted information-based chapters. The third edition of the *Bal Vaigyanik* included several chapters in which information or descriptive content were merged into the learning process, for example 'Questions and Answers About Agricultural Crops', 'Nutrition in Plants', 'Where Force is not Present', etc.

Flexibility of the curriculum

The HSTP did not limit its curriculum to the textbook. The chapters were very much part of the curriculum but they served more as a medium to develop the scientific method, with different chapters bringing out different elements of the method. The course the chapter would take in the classroom depended on the teacher and the children. Influencing factors included the interest and ability of the teacher, the atmosphere in the classroom and so on. That's why one could not predict the time required to complete any particular chapter. Nor could one predict all what the children would learn when it was completed. That would depend on how each layer of the chapter unfolded. As Vijaya Verma commented:

> We have emphasised self learning. It isn't necessary that the teacher alone is the guide; what's important is that the children are participants in the process.

This flexibility did make life more difficult for the teachers who were habituated to transacting a pre-determined curriculum where their only job was to complete the lessons in the textbook. Here they often found themselves in situations where the discussion after an experiment was performed became so involved that it took up the entire day. Or an experiment was not done properly so the children found it difficult to proceed. Or a child or group would come up with a different observation about an experiment and time would be spent in resolving the issue. But that's the 'danger' they had to face if they accepted the discovery method. During the teacher training sessions, there were times when an experiment raised questions that needed new experiments to be done, leaving the chapter and the session planning in a limbo.

The traditional practice in the education department is for each teacher to make a 'syllabus'. Quite often, the department makes the syllabus and hands it over to the teacher. This 'syllabus' is a unit-wise framework that specifies the time required to teach each chapter and outlines the teaching programme for the entire year. It is impossible to construct such a syllabus for the *Bal Vaigyanik*. This had been a long-standing demand of the teachers and the education department. The HSTP group opposed the demand but eventually capitulated and made a 'syllabus' that was distributed. The anguish the exercise caused in the group can be seen in the following covering letter of the syllabus:

> This unit-wise science curriculum is a compromise we have reached after four long years of dialogue with you and the education department. We believe there is a contradiction between an experiment-cum-activity based format and a programmed unit-wise curriculum. That is why we request you to view this unit-wise plan as an outline and not a framework with fixed boundaries. The challenge to your enthusiasm, imagination and initiative is to break these boundaries and inspire your students to think independently. We are optimistic that if you transcend its limits you will be able to impart a new direction to the science teaching programme (January 9, 1977).

Actually, this condition is applicable to any process of curriculum development. In fact it should be a basic condition in a situation where a single curriculum is being planned for the entire country. At the time of the district level expansion of the HSTP in May 1978, the demand was for a textbook whose syllabus could be completed in the school year. This is how the HSTP 'syllabus' came into existence, putting a question mark on the flexibility of the curriculum. Was this a positive or negative development? One doesn't know.

From what has been written until now it is clear that the HSTP curriculum went far beyond the *Bal Vaigyanik* and its content. What its chapters did was give concrete form to the different elements of the curriculum and its methodology. We shall now discuss these elements in more detail in the following chapters. We will also trace the evolution of some chapters to see how they developed from the first edition (1978) to the third edition (2000).

But before we proceed it may be useful to have a look at the framework of a chapter to see what elements are common to all the chapters. This is what we will do now. In the process, we will try to bring out some factual aspects of the curriculum as well.