INNOVATING SCHOOL SCIENCE EDUCATION --

THE HOSHANGABAD SCIENCE TEACHING PROGRAMME (HSTP)

PERSPECTIVE

An effective intervention in the way science is taught in our schools has been perceived as an essential step towards achieving a society more capable of developing and absorbing technology creatively as well as giving a more scientific foundation to our cultural. political and economic fabric. This tall expectation from science education has been strongly articulated in various policy statements and recommendations of various eminent commissions and committees which have deliberated on our education system. The directive perspective of the HSTP has been formulated to overcome the gap between these expectations and the reality in our schools :

(1) To remould school science education to fulfil universally accepted national goals and educational objectives. HSTP has attempted to base science education on the principles of `learning by discovery', `learning through activity' and `learning from the environment' in contrast to the prevailing text-book centred `learning by rote' method. A major objective is that the child should become an active participant in the process of learning science through field studies, experiments, observation, recording, analysis and discussions with his or her teacher, fellow students and others. There is a conscious attempt to move away from the prevailing discipline-centred approach to a child-centred approach. We are convinced that treating the child like an empty receptacle in which latest scientific knowledge is to be filled in is not desirable for pedagogic reasons. The process of science needs to be emphasized if we have to fulfil the constitutional goal of promoting scientific temper and make the child a confident self-learner for the rest of his or her life. Science curriculum must relate closely to science and technology experiences of everyday life.

(2) Perceiving Innovation as an integrated whole. It was recognized that it would not be enough to merely rewrite the textbooks and to instruct the teachers to perform experiments in the class room. An effective innovation will have to take into account all the factors that effect the teaching process in the class room and tackle all of them in an integrated manner. Thus the total package is concerned not only with curricular innovation but also with teacher training, kit to do experiments with, examination system, school administration, extra curricular inputs, etc. all of which have been suitably modified to form the innovative HSTP package. In particular, examination reform has been seen as a crucial factor which really dictates how the curriculum is transacted in the classroom.

(3) From innovative model to expansion and adoption by the larger system. The HSTP group has been keenly aware that innovative work can be effective only if it finds acceptance in the larger system and is a model that can be adopted on a larger scale. Thus rather than try it out with a few well-equipped elite schools, the HSTP model has been evolved in Government schools in rural and semi-urban areas in close collaboration with and involvement of the district and state level education department.

(4) Empowering the Teachers. Recognizing the key role of the teachers in the education system, the HSTP innovation has actively involved the teachers themselves in the evolving of the innovative package. This has helped in motivating the teachers and has also resulted in very meaningful contributions to the innovation. It is naturally so because with their grassroots level experience, they are best equipped to critically examine and advise on what would really work in the classroom, apart from providing interesting insights into the process of education and child learning. We strongly believe that empowerment of the teachers academically, administratively and intellectually is an essential precondition for effective reforms at the classroom level. Technological aids can at best support the crucial role of the teacher.

(5) Administrative decentralisation. Kothari Commission had very strongly recommended decentralisation of the school education structure using the school complex model. Utilising and equipping the block-level higher secondary school to administratively and academically coordinate the programme has effectively decentralised the field level implementation of the programme. A limitation has been the inability to decentralise financial powers, a problem that needs to be resolved by policy decisions at the higher level.

(6) Participation of Institutions of Higher Education and Research. HSTP group strongly believes that the effort to improve our school education system needs the involvement and commitment of some of the best scientists, researchers and academicians of our country. HSTP has succeeded in involving resource persons from some of the leading institutions of the country and the state at the field level. A group of scientists and academicians from Delhi University have played a leading role in the evolution of the programme. This has received recognition and support from the UGC and the State Government, without which it would not have been possible.

(7) Role of NGOs. HSTP is an ideal example of close and complementary working of the State Education Department and NGO groups to implement an innovative programme. The initial innovation and system was evolved on a pilot scale by Kishore Bharti and Friends Rural Centre, two voluntary organisations working in Hoshangabad district of Madhya Pradesh. With the district level expansion of the programme, the day to day administrative and academic responsibilities were taken over by appropriate cells and units within the State Education Department. The HSTP group played a major role in training of department personnel including teachers as well as administrative officers. Eklavya was formed in 1982 at the initiative of the HSTP group to provide an institutional base for further development of innovative programmes. It now has a coordinating role in further development of HSTP in collaboration with the SCERT and the State Education Department.

THE INNOVATIVE PACKAGE

The HSTP package consists of the following:

(1) The `Bal Vaigyanik' books. One book each for classes 6,7 and 8 have been prepared. Special characteristics of these books are :

- These books are in combined format of work-cum- textbooks. Based on the discovery principle, the books mainly consist of instructions for activity along with guidelines about how to observe, record and analyse the data and observations. These are followed by a series of guiding questions answering which,

with the help of the teacher, the children arrive at their own conclusions and understandings, which then they have to record. These are also interspersed with interesting and relevant information and accounts of scientific discovery, as well as problems for further practice;

- the layout design of the book has been specially designed to make it attractive and easy to read and follow for the children;
- simple and commonly spoken language has been used to make it easily comprehensible, difficult and complicated scientific terminologies have been avoided;
- each book has section called kit-copy which contains useable parts like graph papers, cut-outs and charts to be used in experimental activity;
- the books have been prepared after intensive field testing incorporating a variety of feed-back gathered from the teachers and children. Two editions of the books have been published till now. Presently the task of revising the books is on;
- the curricula material has been prepared by resource persons from leading institutions of scientific research and higher education who closely interacted with the teachers and children in the field to prepare and reprepare drafts before final versions were ready;
- the books are being published by the M.P. Text Book Corporation since 1978. Since innovative books are published in smaller number, in order to make them available to the children at the same price as other books, the corporation has been subsidising the additional cost of printing, the developmental cost of the books being borne by Eklavya from its grants.

(2) Teacher selection and training. No special criterion has been applied for selection of teachers and the teachers teaching science in the programme schools have been trained further. Interestingly, many teachers teaching science in middle schools have themselves never studied science beyond elementary classes and the training package has had to be suitably designed to take this into account. Even those who have studied science have done so by traditional rote-learning and have to be re-oriented to teach by innovative methods. Each teacher undergoes three trainings of three weeks duration for classes 6,7 and 8 each, the trainings being organised during the summer vacations every year. During training, the 5-hour training daily consists of :

- doing all the experiments and activities of the Bal Vaigyanik and through analysis and discussion reaching conclusions and conceptual understanding expected;
- giving additional information regarding the subject and discussing possible queries that the children may raise;
- discussions about the educational and academic understandings underpinning the programme and the administrative structure of the programme;
- training in evaluation methods and making new questions for open-book examinations;
- the training is conducted in a format similar to a typical classroom with the teachers working in groups of four each;
- apart from the formal training of five hours, extra curricular activities like origami, paper cutting, environment monitoring, lectures, film or slide show on popular science topics, etc. are arranged for teachers to take advantage of.

The training is conducted by a resource group consisting of HSTP resource persons from research and higher education institutions, and resource teachers from amongst previously trained school teachers who have shown exceptional motivation and ability. The resource group normally meets four days before the training to prepare and plan in advance. A ratio of 1:8 for resource persons to trainees is kept.

(3) Resource Group. The quality, motivation and commitment of the resource group has been a crucial factor in the achievements of the HSTP. The resource group has played a key role in :

- development and improvement of Bal Vaigyanik books;
- Training of teachers and resource teachers;
- preparation of teachers' guides and other manuals;
- conducting follow-up and monthly meetings;
- preparing test papers for annual evaluations for written and practical papers;
- preparing evaluation guidelines;
- answering questions asked by children through letters to `Sawaliram', a fictitious character created for children to correspond with.

Apart from this, this group has been conducting trainings, exposure workshops, science popularisation programmes in other states. The resource group consists of following category of persons:

- middle school teachers who have undergone the training earlier and have shown exceptional motivation and ability. At present about 200 such resource teachers have been identified;
- science teachers of higher secondary schools, about 25 such teachers are involved;
- teachers from colleges and universities of Madhya Pradesh who voluntary give time for various needs of the programme, about 15 such persons are actively involved;
- professors, scientists and field workers from various research, higher education and non-governmental organisations all over the country, about 50 such persons.

(4) Kit. The kit designed for this programme is an activity kit designed for children to do their own experiments in groups of four. At present rates, a kit for an average school with 40 children in each class costs about Rs.3,500. A steel almirah (Rs.2,000) is required for its storage. The kit consists of three types of items - consumable, breakable and non breakable. On an average about 20% of the kit needs to be replaced every year to make up the loss of consumable and breakable items. Thus Rs.700 replacement cost needs to be provided annually which works to less than one rupee per child per month. In addition to the supplied kit, the children gather a lot of material from their environment to be used in various experiments. In HSTP, the kit procurement has till now been done through a centralised purchase system which has had its severe limitations. A decentralised system is now being worked out with teachers being given control over financial resources raised through a science fees.

(5) Monthly meetings and follow-up. In order to assist the teacher in the school situation and to encourage peer group interaction , a system of monthly meetings and follow-up school visits has been worked out. Every month, on a fixed date, the teachers gather at the block headquarter higher secondary school, designated as `sangam kendra', for a day long meeting. In this meeting they share their experiences, discuss their problems and are also given a refresher or enrichment lesson by resource teachers. The resource teachers from all the sangam kendras come together on a fixed day at the district head quarter for a preparation meeting to plan and prepare for that month's monthly meeting.

Follow-up visits to schools are organised by assigning a school each to resource teachers to visit and guide the teacher in the school situation itself.

(6) Examination and evaluation. An evaluation system designed according to the objectives of the programme consists of :

- a written as well as a practical examination;
- the written exam is an open-book exam , designed to test analytical skills and de-emphasise learning by rote;
- the practical exam consists of five short experiments to be done and recorded by the child in a sequential setting.

The teachers are trained to design and use small test items in the class to assess children's learning and understanding to assist their teaching.

(7) Administrative structure. The decentralised administrative structure of the programme and its functioning has been codified in an administrative manual of the programme issued by the state education department. Main features of the structure are :

- block-level coordination through a designated higher secondary school (sangam kendra) with its Principal as in-charge, assisted by a senior teacher and a specially appointed assistant teacher;
- divisional-level coordination through a specially created cell, Vigyan Ikai, in the office of the Joint Director Public Instruction;
- State-level monitoring and coordination through a representative Sanchalan Samiti under the chairmanship of the Commissioner of Public Instruction.

(8) Extra curricular inputs. To strengthen curricular achievement and to sustain children and teachers' enthusiasm, a number of extra-curricular inputs have been inbuilt into the programme :

- creation of Sawaliram, a fictitious character. Each book has a letter from Sawaliram addressed to the children asking them to ask questions and much more. Arrangement has been made to reply to their letters. These letters are a rich source of feedback from the children as well as a way of communicating with them. Replies to many questions prepared by subject experts but meant to communicate with children are now being compiled for publication;
- publishing of `Chakmak', a monthly magazine for children, as well as small booklets containing interesting activities to do;
- publishing magazine `Hoshangabad Vigyan' and journal of resource material `Sandharbh' for teachers;
- encouraging teachers and children to participate in various science popularisation activities like jathas, bal melas, etc.

THE PRESENT

Now in its twenty sixth year, the HSTP has a comprehensive base of operation involving:

- nearly 500 middle schools spread over 14 districts of Madhya Pradesh covering over 1500 teachers and annually 40,000 children ;
- a decentralised academic and administrative support structure based on the school complex model of the Kothari Commission working under the aegis of the Madhya Pradesh State Department of Education and the SCERT;
- an academic resource group consisting of about 200 trained and motivated school teachers, backed and supported by a group of scientists and academicians from leading centres of research and education like Delhi University, Tata Institute of Fundamental Research, Indian Institutes of Technology, National Institute of Immunology, and Colleges and Universities of Madhya Pradesh;
- an academic package that encourages learning of science by activity-centred, discovery-oriented, environment-based methods;

- a large scale training system which emphasises hands-on experience in activity-based teaching and attitude building for innovative science education for teachers and teacher educators;
- a comprehensive feedback and follow-up system at the field level which continuously gives directions for further improvement and provides an effective and wide ranging forum for new and innovative inputs in the programme;
- a model situation for comparative evaluative studies in concept formation, cognitive and affective development, programme implementation strategies, etc.;
- a wide network of contacts, exchange and involvement programmes with a number of individuals, groups and organisations all over India working towards innovation and improvement in science education.

THE FUTURE DIRECTIONS

Given the immense possibilities of this base, the following areas of innovative work have been taken up for further development.

(i) Large scale expansion of the programme.

We have been working at the idea of large scale expansion of the programme, eventually leading to a state-level expansion. Keeping in mind the size of Madhya Pradesh, this can only be done in phases. Exercises have been carried out to plan out the logistics and the financial implications of such an expansion. Implementation of such a large expansion would be possible only with decision at the political level. Eklavya and the HSTP group remains committed to laying the groundwork for such an extensive exercise. This would consist of:

- Identification and training of state-level and district-level resource groups which would be primarily responsible for teacher training and other academic inputs for the programme at the field level. About 500 such persons would be required.
- Developing and producing detailed manuals for Teacher training and other academic and administrative aspects of the programme.
- Evolving decentralised systems for kit procurement, distribution and replenishment. This has been a major stumbling block for the programme and alternative effective system is being worked out.
- Development and dissemination of resource material for science teachers in form of magazines, booklets and books. A beginning has been made with the launching of 'Sandarbh', a bimonthly magazine for teachers.

The Eklavya group hopes to play a participative role in large scale expansion of this effort to innovate science education over the entire state.

(ii) Academic innovations in the curriculum material.

Continuous innovation is an accepted norm in the HSTP group. The central concerns of the present round of innovations are twofold:

- the accumulated feedback since the last revision more than five years ago indicates that curricular material needs to be presented in a still more attractive and child friendly form. Another area of concern is the efficacy of conceptual development and the ability to articulate it directly or through use in problem solving in key conceptual areas.

- A common criticism of the HSTP curriculum has been that while duly emphasising the 'process' aspect of science, the 'product' aspect or content is underplayed. Acknowledging this criticism, an attempt is being made to develop materials presenting new areas of content through innovative methods combining activity and narration emphasising understanding rather than rote learning. Initial attempts have been made in areas like 'Atoms and molecules', "Chemical Nature of Materials' and "Chemical Bonding'.

The material prepared is first being tried with teachers and then with children at various levels to establish its affectivity and appropriateness. The question of proper balancing so that the final curricula package does not overload the student or the teacher will of course have to be worked out finally in consultation with the teachers themselves. In order to arrive at a larger consensus on these issues, we propose to involve persons concerned with curricula design and development at various levels in this process through a series of workshops. We have sought collaboration with creative artists and designers for layout design and illustrations.

(iii) Spreading the Innovative Spirit.

The People's Science Movement has proved to be an effective means for spreading the ideas and sharing the experiences of the HSTP . We have been responding to invitations to send our resource persons in meetings and workshops of teachers and people's science activists in various states from time to time. Contingents of participants from various states are a regular feature of our training programmes. Two years ago a workshop was organised under the aegis of the All India People's Science Network in which teams from various states worked together to translate books developed in Eklavya's education programmes into various regional languages. Interaction with other groups continues to be important to our attempt for idea-level expansion of the HSTP. We have committed ourselves to the extent of providing close and extensive collaboration to groups attempting to develop innovative programmes in their states. The prime example is the *Adhyaita Kendrit* (Learner Centred) Science Teaching Programme in Gujarat.

The Gujarat programme is a joint programme of three field based groups - Gandhi Vidyapeeth, Vedchhi, distt. Surat, Lok Bharti, Sanosara, distt. Bhavnagar, Rural Science Extension Centre of Gujarat Vidyapeeth, Sadra, distt. Gandhinagar - and Vikram A. Sarabhai Community Science Centre, Ahmedabad. The group is developing learner-centred activity-based science teaching package for classes 5, 6 and 7, the upper primary classes in Gujarat. The programme has been developed in about 30 rural primary schools with permission and collaboration of the Gujarat State Education Department and the Gujarat Council of Science and Technology.

Eklavya has participated in this programme actively from the stage of conceptualising the project, preparing the proposal and now its implementation. Experimental versions of books in Gujarati for classes 5 and 6 have been prepared and are under trial in schools. Class 7 material is presently under preparation. We have had a major role in developing their resource group by participating in material development, teacher training and school follow-up programmes. The present development phase of the programme will continue for three more years.

(iv) Resource Group Training and Resource Material Preparation.

Keeping in mind the projected needs of the programme, a conscious effort has been continuously made to develop the resource group in numbers as well as quality. A number of motivated and capable school teachers have been prepared to take up various academic and administrative tasks including training new teachers. Dealing with children themselves, most of these resource teachers are confident in handling the method part of the training. However, many have not had a chance to study science subjects beyond school level themselves, or even if they have, their own training has been so superficial that they do not feel confident as far as the content aspect of the curriculum is concerned. This has prompted us to plan content enrichment trainings for the resource persons. These trainings will have to be supplemented by providing reading and work material for them which is pitched at their level of understanding. Given a general lack of familiarity with basic mathematics, the challenge facing our group is to develop modules and materials which would be simple and begin from the basics, and naturally, be in Hindi.

Last summer two courses of ten day each were organised. Everyday a morning two hour session was devoted to a common lecture . Some of the topics covered (with names of the resource persons) are listed in the appendix. The rest of the day was spent in group work taking up an intensive study-cum-labwork project on any of the offered topics (also listed in the appendix). The list of the topics is by no means exhaustive and many more are likely to be added in future trainings.

A first attempt at this kind of training has been highly appreciated by the resource teachers and they have asked that more such courses be organised periodically. Materials prepared and tried out in this training are being reviewed and prepared in modular form along with additional supplementary reading material in Hindi either prepared originally or by translation.

This attempt is leading towards evolving of a general method and materials for training of resource persons and teacher educators. Keeping in mind the level at which it is being pitched, we expect additional fallouts from this effort :

- this package can be suitably modified for training of PSM activists, etc.
- the material generated is roughly of the level of high and higher secondary school level and could be of direct use to students also. It will give us a good base to attempt similar innovative science education at that level.
- This training also provides the base for introducing science teachers to specific technological inputs and science-technology- society issues, something that the restrictions of present school curricula tend to restrict. This exposure will reflect in the future as these resource teachers also get involved in further curricular innovations.

(v) Comprehensive Evaluative Studies and Documentation.

The nature and expanse of the HSTP offer an ideal situation for a comprehensive comparative evaluation of academic, administrative and social impact of such an innovative effort. While some piecemeal evaluations have been attempted from time to time, the expressed need for a comprehensive effort and documentation remains unfulfilled. Such an evaluation requires a complex exercise of selection and development of evaluaton tools and their standardisation before the actual evaluation and analysis. We are looking for a suitable group or agency which can take the major responsibility of organising such an exercise in collaboration. This would have to be undertaken as a separate project with independent funding.

Eklavya

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