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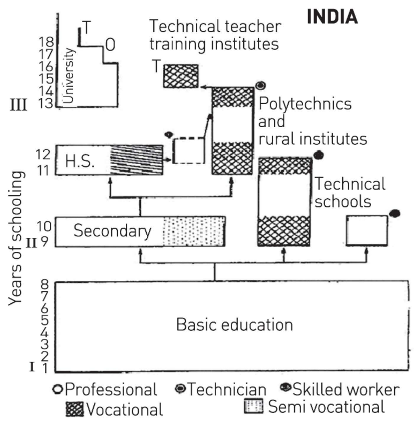

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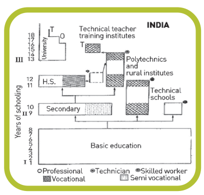

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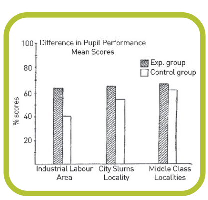

Difference in Pupil Performance Mean Scores
Exp. group
Control group
% scores
100
80
60
40
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Industrial Labour Area
City Slums Locality
Middle Class Localities

EDITORIAL

Education is a form of learning in which the knowledge, skills, values, beliefs and habits of a group of people are transferred from generation to generation. The present issue stands second in the series of '50 years of School Science' which includes articles imparting knowledge, skills, values, etc., through discussion, training, teaching or research.

In the article "Method of Learning in Science" the author describes that all knowledge and understanding of the materials and appliances of practical life and the phenomena of the world of matter and force must be ultimately based on our personal experience, either in perceiving events, or the actions of other people and their effects, or more directly by ourselves acting on things and noting what happens.

"Teaching Science through Television" is a very interesting article in which author discusses teaching of science through television and offers suggestions for increasing its effectiveness for teaching science.

In the article entitled "Classroom Variables and Student Attitude Towards Science" the researcher confers that there is no conclusive research evidence to establish a relationship between these classroom variables (including exemplar science curriculum, laboratory resources and classroom environment) and student attitude.

In "Innovations in the Teaching of Mathematics in Primary School", the researcher figures out the list of various innovative methods like floor discs, flannel graph discs, disc charts for counting, dominoes for teaching of number and values, abacus for place value of numbers, pocket boards for pattern making and geo boards.

In the paper "Content in the Science Curriculum" author explores diverse schools of thought emphasising subject matter to be emphasised in the science curriculum.

"Children's Conceptual Framework about Natural phenomena and its Implication for Science teaching" explains that the teacher can reduce the discrepancies between pupil's intentions and her/his learning and similarity of the constructed meaning by the teacher depends on the way a pupil copes with the language used by the teacher during instruction.

"Relationship between Academic Self-concept in Science and Cognitive Preference Style" aims at finding the relationship between cognitive preference style (CPS) and academic self-concept in science (ASCSc) of the secondary school students and reveals that students differ in their CPS with high and low ASCSSc, and gender differences are absent in CPS.

In the article "Vital Concern in Curriculum Development in Science and Mathematics" the author discusses new concerns in curriculum development in science and mathematics in terms of the explicitly declared national goals and objectives and lists some of these concerns with the hope that these will be reflected in curriculum development. The article "Identification of Scientifically Creative Youngsters—Issue and Implications" discusses about the creativity and scientific creativity and says that the creativity is a complex concept encompassing a wide spectrum of activities, also take up how we can test creativity.

In the article "Innovative Evaluation Procedure in Science" the author discusses about the instructional management system (IMS) to appraise pupil progress because teachers and supervisors need to evaluate and revise the curriculum to provide for diverse needs, interest and abilities of learners in the school.

In the article "Status of Science Teaching in Indian Schools for the Visually Impaired Children" the researcher concludes the status of science teaching in Indian school for the children with visual impairment and discusses the most effective way of their learning, i.e., learning by doing hands on activities with real objects, organisms and suitable teaching aids under the supervision of trained teachers.

In the paper entitled "Pupil's Academic Self- concept and Achievement in Science : The Effects of Home Environment" the author concludes that 'control' and 'protectiveness' are positively and significantly correlated with both ASCSSc and ASc whereas 'nurturance', 'rejection' and 'permissiveness' are negatively and significantly correlated with ASc 'social isolation' is also correlated with ASCSSc significantly.

In "Designing Science Units of Study" the author identifies numerous issues in teaching science including specific versus general objectives, process versus product, ends of instruction, logical versus a psychological sequence, etc., and concludes that the methods of teaching science need to incorporate some ways to resolve these issues.

The article "Science Instruction for Making Children Think and Do" describes that the science teaching can be effective with the cognitive development of students only when project work is done seriously and science curriculum is made child-centred. In the paper entitled "How the Teachers in Ashram Schools Perceive Science Curriculum at Upper Primary Stage" the author has raised issues related to curriculum, teacher preparation, assessment techniques, school facility, etc. Further he concluded that all these issues are important and need to be relooked critically.

We sincerely hope that our readers would find the articles, research papers, etc., interesting and educative. Your valuable suggestions, observations and comments are always a source of inspiration which guide us to bring further improvement in the quality of the journal.

METHOD OF LEARNING IN SCIENCE

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All knowledge and understanding of the materials and appliances of practical life and of the phenomena of the world of matter and force must be ultimately based on our personal experience, either in perceiving events, or the actions of other people and their effects, or more directly by ourselves acting on things and noting what happens. Experience of one kind or another must be the source of all meaning and understanding of physical reality, although thought and imagination can transform experience into the higher and more universal plane of general law and theory.

The primary mode of learning, therefore, is to gain experience of the physical world around us by 'acting on it in various ways and noting what happens'. This is instinctively the young child's mode of learning. He acts on various things in a variety of ways, either on his own impulse, or in imitation of, or under the direction of others, and thus gains an ever increasing experience of the behaviour of things and substances under various conditions. It is true that in certain fields he has little, or no experience, e.g., in the properties and action of magnets, frictional electricity, chemical action, generation of electricity, surface action, etc. He, however, comes to school with a fairly extensive experience of materials, force, motion, heat, light, sound and uses of electric currents. Such experience is of necessity inexact, indefinite, and superficial. It has been subjected to little analysis and organisation by thought. It is merely a loose mass of experience relating to the things of everyday life, and to its practical purposes. It is the aim of science teaching to extend this experience, to make it more exact, clear and full, to organise it into general laws, and to rationalise it through explanation and theory. To quote Dewey, "Science is experience being rationalised".

It is clear, then, that one important method of learning science must be:

The gaining of exact and clear experience in fields in which the boy has little experience by the primary method of "acting on things and noting exactly what happens," e.g., acting on chemical substances with water, heat, or acids and noting what happens.

Observing more clearly and accurately what happens in situations in which they have experience, e.g., friction, pupils have a fairly extensive experience of friction by sliding, sledging and bicycle brakes. There is need, however, for accurate experimentation to make clear and standardise the conditions that determine friction. Similarly with levers, action of forces, etc. The starting point in all such enquiries must, of course, be in the recall and examination of the experience they already have.

Knowledge, however, can advance far beyond the plane of perceived facts. By thought the intelligence can probe behind facts to those factors and conditions that are hidden, obscure, and frequently unperceivable. For example, we can directly experience the upward force necessary to support a solid body by the hand and to move it upwards; but we cannot perceive the upward force that supports a ship, or that causes a cork to rise in water, or a balloon in air. Only thought can reveal these obscure and hidden causes of events that are familiar to all. If the teacher is to guide his pupils' thought in revealing these hidden causes, he must know how such thought proceeds.

It is a psychological truth that an unknown situation is interpreted by, and in terms of, the known on the grounds of some similarity or analogy of the unknown to the known. For example, suppose we are faced with the problem of finding the cause of a ship floating on water, or a cork rising on water, or a balloon in air. If we call to mind the experience that a solid body requires the upward force of the hand to support it and raise it, we can infer by analogy that water is exerting an upward pressure to support a ship, and cause the cork to rise, and also, that air is exerting an upward pressure in supporting and raising a balloon.

It is by such inferences from analogy that the intelligence is able to form conceptions of those conditions and forces operating in the world of reality that are hidden from perception, but the understanding of which is the key to our grasp and mastery of the world of matter and force.

Such inferences are, however, only of the nature of suppositions or hypotheses. They are not established truths. Inferences from analogy are not logically infallible, and must be subjected to test to see if they will work under other circumstances and conditions. Hence the test takes the form of arguing: "If it is true, what would happen under this, that, or other circumstances?" For example: If water exerts upward pressure, what should happen if an object that sinks is weighed in air and in water? Or if air presses upward, what should happen to a column of water, if we arrange to bring the upward pressure of the air to bear on its lower surface?

Such experiments test and verify or disprove our suppositions. They test our thought. They form the dramatic crisis to which our creative thought works, and they decide and resolve the issue of true or false.

The essence of this second stage of scientific method is:–

(a) Examination of some situation familiar to the pupils to reveal some specific problem.

(b) Search in the past experience of the pupils to find some apt analogy that will bear on the problem.

(c) Examination of the analogy to make clear the idea exemplifies, and the application of this idea to the problem to form a suggested explanation.

(d) Investing an experimental test that will verify or disprove the suggested explanation.

It is the art of teaching to stimulate, help and guide the pupils in this process of examination, suggestion, and verification, and of final expression in concise notes and diagrams.

The essential nature of the scientific method is thus clear. It is quite true to say that the natural sciences are observational and experimental studies. They are just essentially studies demanding thought and imagination. Observation and experiment provide the basis of facts of experience from which thought starts; experience provides the analogies by which thought infers possible explanations; and testing experiment gives the facts that verify or disprove our imagined suppositions; but it is thought that leads our understanding to the grasp of what causes lie behind the world of sensible experience.

TEACHING SCIENCE THROUGH TELEVISION

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We are living in a world of science. In every sphere around us we can feel and see as well the terrific impact of science and technology. With the tremendous progress of science and technology, it has become necessary for every man to understand and apply science to his day-to-day life. Contents of study have increased to a great extent. Teachers have to teach and the students have to understand more matter in a given period than they used to do previously. The concept of education has undergone a change. It is not merely the understanding and memorising a body of facts, but is considered to be a process which prepares an individual to become a worthy member of the society. For educating children for life, improvisation of teaching techniques with the help of audio-visual aids has become necessary. Audio-visual aids which include sound films and televisions, are considered to be the most important of all teaching aids. Television is one of the most significant discoveries of recent times in the field of communication.

Scope of TV

Television, which has the best elements of both the radio and the film, has made a tremendous impact on spectators. The scope of TV in education is immense. The learning process, which involves all our senses to the fullest extent, is perhaps the best. Our senses of hearing and seeing contribute about 85 per cent towards the total knowledge gained.

TV in education can either be used as a teaching aid or as a teaching machine. Carefully selected TV instructional programmes can supplement the classroom teaching to a great extent. TV instructional programmes can be developed in almost all the subjects, from the languages to science. Particularly, TV instructional programmes make the study of science easier and more meaningful. Teaching through close-circuit TV, which is a type of teaching machine, has found tremendous encouragement in the developed countries due to its immense usefulness.

Close-circuit TV is a far cry in our present set-up. So, let us confine our discussion to the TV instructional programmes, which are being telecast from the Delhi TV station.

TV as a Teaching Aid

As already mentioned, TV as a teaching aid has tremendous potentiality. Competent and experienced teachers can give demonstrations and talks on TV. Experiments not easy to perform in the classroom situation and the models not easily available to schools can be shown during the TV lessons. A complete topic like flowers, halogens, etc., can be taught through TV. Experimental techniques can be explained and the working of industrial processes can be shown through TV films. So, we see that the ways of using TV as a teaching aid are many. For the most effective use of TV, there should be a good programme and for chalking up of good programme certain points are to be remembered.

(i) *Objective:* It should be always remembered that the TV teacher cannot replace a classroom teacher. He can only help the latter in his teaching a topic or a subject. Objective of TV lesson is only to supplement the classroom teaching.

(ii) *Planning:* Planning is the most important part of a TV lesson. For this, the grade or the class for which the lesson is prepared, the chronological age of the pupils and their intelligence and abilities have to be carefully considered.

Then, there is need to scrutinise the syllabus on the basis of the objective laid down and the portions have to be chosen accordingly. Also, consideration should be given to the problem of textbooks i.e., their worth and availability.

Lastly, the duration of the lesson is an important point to remember.

(iii) *Quality:* The quality, both in terms of the subject matter and the teaching method, should be of the highest order.

(iv) *Preparation of the Students:* One of the factors influencing learning is the 'readiness' both mental and physical. The students can be made mentally ready by arousing their curiosity. This can be done in several ways, e.g., by showing fascinating experiments relating to the topic or by connecting the pupils' previous experience and knowledge with the topic. For making a child mentally ready to accept the lesson pre-telecast activity with carefully chosen questions is essential. This requires good preparation on the part of the classroom teacher. Also, guidance sheets and programme booklets meant to help the classroom teachers should be pro vided with.

To ensure maximum physical readiness on the part of the pupils they should be provided with maximum viewing comfort. The TV set should be placed in a suitable position, so that every student can view it properly, in a room specially meant for TV viewing. The room should have adequate lighting arrangements and comfortable seats. The number of students viewing the TV should be such that those sitting at the back may have a good view of the programme.

(v) *The School Time-table:* TV timings should be such that it can be adjusted comfortably within the school time-table.

(vi) *The TV Teacher:* The TV teacher should have the calibre and personality of the highest order. He should be an experienced teacher with vast knowledge. At every aspect a TV teacher should at least be equal to the classroom teacher, if not better.

Present Position of Teaching Science through TV

In India the school television project was launched in the year 1961 in Delhi. The TV lessons are closely related to the syllabus. The TV teacher works in collaboration with the classroom teacher. Usually one TV lesson per week per subject is telecast. Some of the important topics from the syllabus are chosen for TV lessons. TV lessons in science are broadcast for Classes VI, VII, VIII, IX and X. In the year 1971-72, no TV lessons were broadcast for Class XI. The TV teachers, drawn from various schools, are mostly quite competent. Guidance sheets and programme booklets are sent to the schools concerned regularly. During the lessons, efforts are being made to use other audio-visual aids like charts, models, etc., as much as possible.

Checksheets are invited from the classroom teachers whereby they can comment on the effectiveness of the lesson.

But in spite of such commendable efforts on the part of the TV centre officials, it seems that the programme of 'instructional TV' has failed to make the desired impact on the children. The causes are manifold.

(i) *The Examination System:* The most important cause seems to be our examination. Every action of the teachers as well as the students is oriented towards passing the examination, even if it is at the cost of knowledge. So any portion of the educational programme which does not have any direct connection with the process of securing marks in the examination is treated by the teachers and students alike with scant respect. It is quite obvious that even if there had not been arrangements for TV lessons, the students would have passed the examinations, the usual way, without much difficulty.

(ii) *Lack of Good and Quality Planning:* This is a very important part of the TV lesson. Before the students can accept the TV lesson, a mental background has to be formed. This is done by questioning. Motivation with the help of interesting experiments, which is extremely useful in many cases, is not done usually. Quality of the TV lessons is also, sometimes, not of the highest order - matter not being selected with care. For example, in a lesson on bleaching powder, it is perhaps useless to show its properties, because it is expected that in their regular classes the students have already seen those experiments, as these are quite easy to perform. So, during such TV lessons it is not expected that the students would be attentive.

(iii) *TV Timings and the School Time-table:* Often it is found that the school time-table does not correspond to the TV timings. This makes the pre-telecast and the follow-up activities difficult and thus the effectiveness of the TV lesson is greatly diminished.

(iv) *TV room:* Many schools do not have a separate TV room. TVs are kept in the hall or in the classrooms. So, the proper lighting arrangements which are very much necessary for good viewing are missing. Then, the number of students viewing the television programme is in most of the schools very large, and also proper sitting arrangements for the pupils are not available. Hence, the students sitting at the back can hardly have a good view of what is going on, on the TV screen.

(v) *The TV Teacher:* It would be better if the TV teachers are more carefully selected, keeping in view the fact that they should be better teachers in every respect than the average classroom teacher.

(vi) *Guidance Sheets:* Guidance sheets and the programme booklets are often not received in time and hence their purposes are lost.

Suggestions for Increasing the Effectiveness of TV Lessons

The students have to be made 'mentally' as well as 'physically' ready, as much as possible, to get the maximum benefit out of such instructional TV programmes.

(i) *Mental and Physical Readiness:* For mental readiness the students have to be made curious by (a) making proper pre-telecast activities (this requires the availability of the guidance sheets in time and correct adjustment of the TV timings with the school timetable), and (b) showing some interesting and thought provoking experiments in the beginning of the lesson, e.g. to introduce the lesson on hydrogen, experiments showing the explosion of soap bubbles filled with hydrogen, flight of gas balloons and film on the explosion of Hydrogen Bomb, can be used with advantage. For junior class pupils, with very little background, stress should be given on experiments by which they are easily awed and those which touch their imagination, while the experiments for the higher classes may be of such type which depict a problem and make them think over it. For example, the topic on the heating effect of current is taught in Class VIII as well as in Class XI. For Class VIII students, the approach towards the lesson may be made with the help of such experiments as exploding of Gun Powder by putting a coil of wire inside the powder and allowing electricity to pass through it or by showing the operation of electric furnaces, heaters, etc. For Class XI, the experiments may be somewhat thought provoking, for example, two equal halves of a piece of resistance wire are taken - one is coiled, and then both are attached to the terminals of two batteries separately and a drop of paraffin wax is dropped on each piece of wire and the electricity is allowed to pass through both of them. The paraffin wax will be seen evaporating very soon from the coiled wire; but not from the other one.

For maximum readiness on the part of the students, a TV room with proper lighting and sitting arrangements should be there and also the number of students viewing the programme should not be above 30.

(ii) *Quality of the Lesson:* Next comes the question of the 'quality' of the lesson. Under the present circumstances when it is not possible to provide more than one TV class for each grade, the subject matter of the lesson is very important. Endeavour should be made to clear the fundamentals of a subject than to cover as much portion of the syllabus as possible, e.g., in chemistry topics like Graham's Law and Phosphine may be omitted while more time may be given to the discussion of the topics like 'Theories of Chemical Bonding'; 'Electrolysis and its Application' and 'Periodic Classification of Elements'.

Further, the lessons should be free from errors and omissions, e.g., 'ionisation' and 'dissociation', these two terms are often used in the same sense and the omissions like the time of contact of the reacting gases with the catalyst in the Ostwald's process for the manufacture of nitric acid, and the reaction between arsenious oxide and the gelatinous ferric hydroxide in the purification unit of the

Contact Process for the manufacture of sulphuric acid, are often found.

Models and charts should be extensively used; but when an actual process can be shown either by direct experimentation or by the use of film strips then using a model, instead, would minimise the effectiveness of the lesson. For example, the circulation of blood—instead of using a model to explain the circulation process it would be better either to use a film showing the actual circulatory system in a man or dissect a frog and then show its circulatory system.

(iii) *Laboratory Techniques:* The laboratory techniques are totally ignored. No lesson which demonstrates laboratory techniques is telecast. Correct use of balance, screw gauge, microscope, etc., can easily be demonstrated on TV. Certain manipulative skills like bending of glass tubing, boring of corks, dissecting frogs, etc., are very important and can be demonstrated by experienced and skilled teachers. These procedures would enable a larger number of students to be benefitted because the manipulative techniques can be shown at close range on TV.

(iv) *Home Assignments:* Provision for home assignments based on TV lessons may be made. This, automatically, would encourage students to watch the lessons more carefully.

(v) *Tele-Club:* A Tele-Club may be formed in each school. The activities of the club may be (a) watching all the TV programmes and discussing and writing about them; (b) understanding the mechanism and scope of TV; and (c) holding essay competitions on the usefulness of various TV programmes and so on.

(vi) *Parents' Attitude:* Lastly, the parents' attitude towards such TV instructional programmes should be ascertained and they should be convinced, if need be, about the usefulness of such programmes, so that they may encourage their children to watch such programmes attentively. They may discuss about the TV lessons with their children, judge their reactions, try to remove their doubts, and inform the TV centre or the school subject teachers about their findings. This will definitely inculcate among the students a habit of watching the TV lessons carefully and thus being benefitted out of it.

Conclusion

About the vast scope of TV as a medium of instruction, there is no second opinion. Educating masses is one of our national objectives. This goal can be reached more easily by teaching through TV than by ordinary classroom teaching in a school situation. The Government is quite aware of this fact and hence in a few years' time, a network of TV stations is coming up in various parts of the country. So, it is not unusual to think that within next five years, science students in various regions will be benefited by the instructional TV programmes. From the experience of organising such programmes for Delhi TV Centre, it would be possible to chalk out instructional programmes of the highest quality. Hence, there is need to have an honest look at the present position of TV teaching and thus find its defects which, once spotted, can be removed easily.

INNOVATION IN THE TEACHING OF MATHEMATICS IN PRIMARY SCHOOL

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The tribal children of the North East have been considered to be weak in mathematics. Many of them have even an aversion to or a fear of mathematics. Hence, maths is still an optional subject. However, experience has shown that these children are not less intelligent than others, that their aptitude for learning mathematics is the same as that of any other children in the rest of the country. The reason for their backwardness is that perhaps maths in schools here has not been handled as it should have been keeping in mind the tribal and rural background of the children.

Various attempts have been made during the past ten years to make use of the principles, and to apply these in the teaching of maths to the tribal children. In the process a variety of apparatus has been devised and used in the classrooms with success. The following conclusions have been arrived at from the experience gained in this way:

(1) The mathematical concepts are quickly grasped and fairly well retained when they are learned mainly through the concrete, when learning maths becomes an activity of doing and learning at the same time. Hence the use of the apparatus.

(2) Brightly coloured apparatus seem to yield better results as perhaps they make better and lasting impressions on the young minds.

(3) The tribals of this area, even though illiterate, seem to have a unique way of calculating – adding or subtracting. The children seem to have inherited the genius from their parents. From experience we know that quicker learning is possible with the use of Base-Five for calculations.

The exhibits are some of the apparatus used successfully as teaching aids in a few schools. They have been tried out with children beginning from the children of the pre-school age, where the whole body is involved in the learning process, to those of the Class IV age, where the child is initiated into the beginnings of geometry through the concrete. The following is a list of the aids:

i) Floor discs,
ii) Flannel graph discs,
iii) Disc charts for counting,
iv) Dominoes for teaching of numbers and values,
v) Abacus for place value of numbers,
vi) Pocket boards for pattern making,

vii) Geo boards: *(a)* for pattern making for learning the 2 processes of multiplication and division, *(b)* for introduction to shapes-space-area perimeter, graphs,

viii) Attributes for learning the properties of 4 different shapes and the first stage of fractions.

All these aids have been made with the locally available materials. The children of this area are resourceful and dexterous as they are all of them children of farmers who make their own tools. The aids have been made by the students of middle and high schools where such experiments are carried out, as part of their work experience programme.

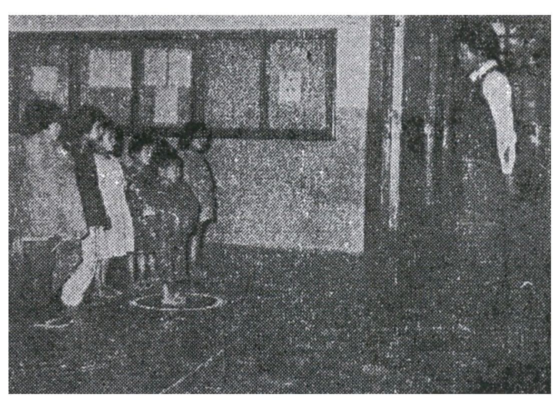
Floor Discs

From experience it has been found that children of pre-school age can quickly grasp the concept of values of the numbers one to ten, with the aid of this method. Not only, the eye and ear, but the whole body is involved in this learning process.

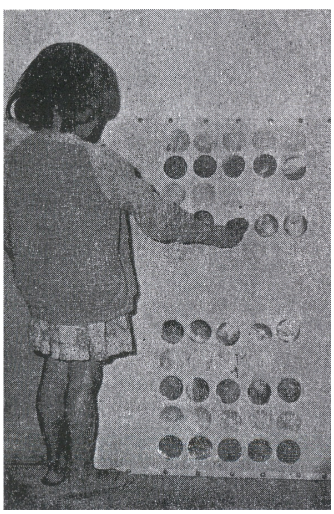
Method : Ten cardboard discs of the same colour are arranged on the floor in front of the class. At the start the child stands a little away from disc No. 1 - a place denoting 'zero'. The child then steps from one disc to the next. At each disc he stops and calls out the number before proceeding to the next disc. Care should be taken that the steps are taken deliberately with a pause at each, before calling out the respective numbers. From disc No.5 to disc No.6, the child does not *step,* but moves with a *jump* using *both feet together,* then proceeds step-by-step as before until disc No. 10 is reached.

Every child in the class should have at least one turn daily for about two months with this method of counting while the rest of the class is lined up facing the discs — disc No.1 being placed to the left of the class and No. 10 to the right. It is not advisable to write the numbers 1 to 10 on the discs as this usually stops mental activity and leads to memory learning, not concept forming. The *jump* between discs 5 and 6 leads the child to the concept:

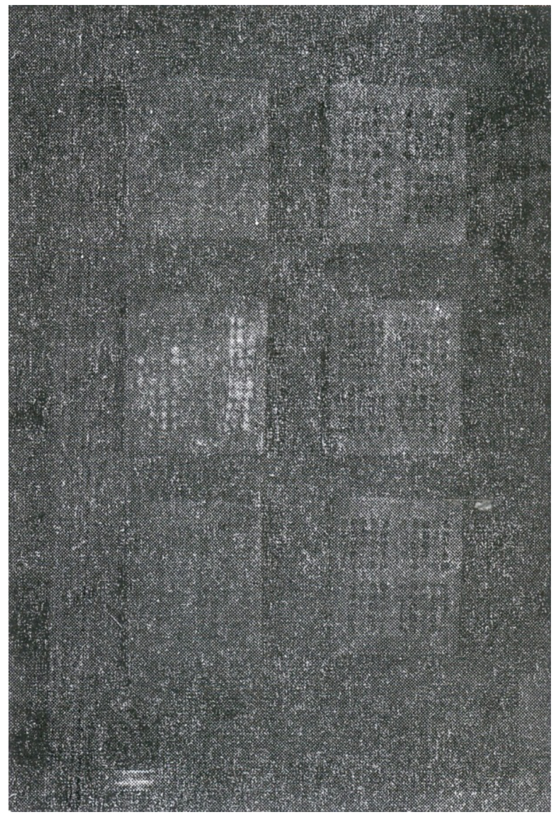
Six is 5 +1; 7 is 5+2 and so on. These mental concepts are very helpful later on for quick and accurate mental work.



Testing : In order to find out whether the children are ready for the next step, the teacher takes his position facing the class with the discs in front of him. The child to be tested and the rest of the class face the teacher and the discs. The teacher then begins to call out numbers. If the child proceeds directly to the required disc, there is the likelihood that mental concepts have been formed. If, on the contrary, the child is not able to identify the disc without counting them all, then it is evident that the child requires more time for the forming of the concepts and should not proceed to the next step.



The learning of numbers up to 100 is a much simpler process if sufficient time is given to this initial stage and the class is not buried through it. Each group of succeeding ten will take about a week. A hundred discs of alternate contrasting colours would be ideal—red and green or red and black—if space permits, 100 floor discs are the best. As a playground activity, this method proves enjoyable.



Flannel Graph Discs

When floor space is not available for the learning of number 1 to 100 the above method should be used to teach numbers 1 to 30. Once the groupings of tens become familiar to the child, the teacher can switch over to the flannel graph board. Here the discs should be of the same colour as those of the floor discs. This is a good classroom exercise. The discs can be easily removed and replaced; the board itself can be seen by the whole class; there is much movement—of discs as well as of children who have to come forward and remove or replace discs as directed by the teacher. It encourages a great deal of concentration, alertness and mental activity. It is also a good testing apparatus, which enables the teacher to judge the progress of individual children.

Disc Charts

Using the same arrangement of circles, and the same colours, skip counting charts could be introduced in the first year. It would be good to keep the colour scheme the same for the following groups:

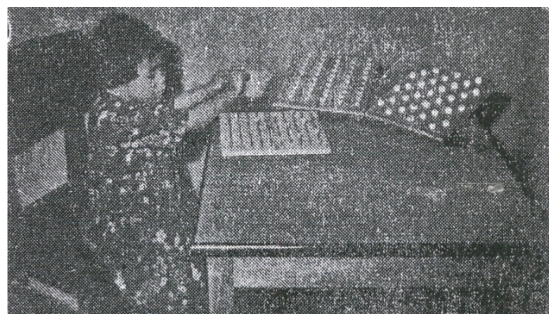
(a) groups of tens and fives;
(b) groups of twos; fours; eights;
(c) groups of threes; sixes; nines; and
(d) an entirely different colour combination for groups of seven.

Here again the charts are smaller, the whole mental picture becomes clearer. If the circles are closer with no gap between five and six (only a dividing line to help), the colour patterns formed by various groupings becomes quite clear and will form clearer mental pictures. This will be of great advantage in future work with multiplication tables and when learning division.

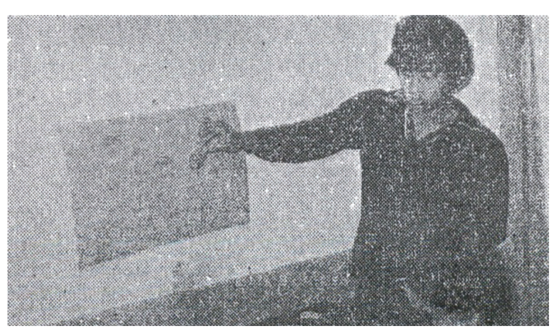
Individual Disc Charts

Children are provided with individual disc charts and are asked to colour the circles, numbers being called out by the teacher. Speed and accuracy are what are aimed at. If different colours are used the patterns are clearly depicted. Patterns should be previously prepared by the teacher. Patterns greatly facilitate the teacher's correction which can be done at a glance. This exercise makes the children alert to probable patterns that emerge while they are colouring.

Geo Board



At this stage the geo board could be introduced, to supplement the learning process. Here again, the moving of coloured beads and the emerging of patterns are two important factors in the process of learning and of fixing the various number groupings. The geo board is a plank of wood thick 1/2 "and 22 cm square. On it are nailed small nails—1/2 "high and 2 cms apart. Across the middle of the board and the down the middle of it are painted lines which take the place of the gap on the disc charts. This line makes for quick calculation.



Pocket Boards

The aim in using these boards is three-fold:-

(a) learning the value of the numbers 1 to 20,

(b) learning the component parts of numbers, and

(c) pattern making.

The teacher places his discs on his board and the children copy the patterns on their boards. This helps concentration; careful placing of discs and selection of colours; later children are made to discover patterns of their own, given a fixed number. Incidentally, the children learn the component parts of numbers by using two or more colours when forming their patterns.

Dominoes

A common game which could be used effectively for testing children's knowledge of the numbers and their values. Each set consists of eleven cards of plywood, carrying the numbers 1 to 10 and groups of coloured dots. No two sets should be similar. The game begins by placing the card that carries a group of dots and a blank. The child is asked to place the cards in such a way that the number corresponds in the number of dots, until he arrives at a blank card. This game is self-correcting. If the child arrives at the last blank card and still holds cards in his hand, he has probably made a mistake and is asked to shuffle up the cards and start all over again. Since no two sets are alike, this game is a good test of speed and accuracy, if a time limit is given.

The Decimal Abacus

This bit of apparatus could be used in the first two years of schooling to teach the place value of numbers up to 1000. A quick and sure means of fixing the place value in the mind of the child is the use of specific colours.

White—for units

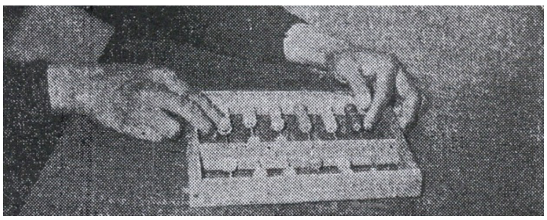
Light pink—for tens

Light green—for hundreds

Red—for thousands

The colours chosen are the same as those used in the Australian Quissinaire method.

The Chinese Abacus



This apparatus is helpful for calculation up to one lakh. Though it has not yet been introduced into the classroom, individual children have taken to it readily and easily. It seems to fit in with some method of calculation of the locals. The fact that each bead on the top half stands for a group of five, does not pose a difficulty. In fact, it facilitates their method of calculation which seems to be in groups of five rather than in tens.

Attributes

A set consists of:

(a) squares 4" . . . .5 each of the four colours: red, blue, green and yellow
(b) squares 2". .. do
(c) circles 4" diameter... do
(d) circles 2'' diameter... do
(e) rectangles 4''x 2'' ... do
(f) rectangles 2"x 1''... do
(g) triangles 4" (equilateral)... do
(h) triangles 2'' (equilateral)... do

A wealth of concepts can be gained through this set, beginning with the pre-primary stage right up to Class IV:

(a) differentiating the four basic colours,
(b) discovering 4 different shapes,
(c) discovering 2 different sizes,
(d) discovering differences in lengths, breadths, angles,
(e) first ideas of fractions, quarters, eights, thirds, sixths, and
(f) pattern making.

Geo Board (Geometry)

Much practice on these boards is essential if children of the primary classes are to move to more abstract forms of thinking in the study of theorems, and the solving of riders. The Geo board besides being an endless source of interest, is a simple and sure way of forming concepts.

(a) Being with plotting of points—north, south, east, west, with the help of coloured beads.
(b) Joining of points with rubber bands forming various kinds of lines—horizontal, vertical, perpendicular.
(c) Forming of angles with rubber bands of two colours—one of the arms should be stationary while the other is moved around to form acute, obtuse, right, straight or reflex angles.
(d) The idea of square measure, perimeter, properties of various figures—3-sided, 4-sided or more—can be *discovered* with the help of rubber bands.
(e) Plotting of graphs—the x and y axis could be learned with the help of the same rubber

bands in the form of various games. In all these forms of learning the stress is on *discovering facts* for themselves.

The above apparatus are designed not to *teach* certain facts but to enable children to *acquire* and *build* up concepts, *discover* facts and, above all, to bring about a quickening of mental activity. These tribal children are on the whole sluggish in their way of thinking. Their reasoning is very slow, but accurate and steady. One of the reasons could be their home background: there is no colour in their homes—no toys, no place for play—they are strapped to their mothers' backs during their most formative and impressive years. Girls have heavy loads laid on their heads from very tender years which perhaps is the reason why they are slower than boys, in thinking.

These learning methods can be introduced by opening crèches where the children are exposed to the influences of colour and play things. They are almost incapable of abstract thinking in their early years, but learn very quickly whenever there is concrete to work with. For this, a variety of opportunities should be given to them in their early years.

Cubic measure, liquid measure, money and time are some of the topics that have yet to be covered by the experiment.

CONTENT IN THE SCIENCE CURRICULUM

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With the explosion of knowledge in science, questions arise as to who should select facts, concepts, and generalisations for students to attain. The balance of this paper will explore diverse schools of thought emphasising subject matter to be emphasised in the science curriculum.

The Structure of Knowledge

A valid means in selecting subject matter for student acquirement might emphasise academicians in the science disciplines choosing vital content. Thus, knowledgeable astronomers, biologists, botanists, geologists, zoologists, chemists and physicists need to agree upon key generalisations. The chosen conclusions might then be emphasised as objectives in the science curriculum. Relevant learning activities guide students in attaining the vital ends, after which evaluation techniques need emphasis to ascertain learner progress.

In emphasising structural content, King and Brownell quote the following pertaining to the thinking of Jerome Bruner.

Bruner hypothesises that learning structures of disciplines:

Is learning how things are related.

Makes a subject more comprehensible.

Slows forgetting.

Permits reconstruction of detail through patterns.

Is the main road to transfer of training.

Narrows the gap between advanced and elementary knowledge.

Leads to intellectual excitement.

Supplies bases for and enhances intuitive thinking.

Is the bridge to simplicity. (Therefore structures can be taught to anybody in some honest form).

Provides a path for progression of learning in each discipline.

Bruner further advocated that students learn to utilise methods of inquiry as emphasised by academicians in their academic areas of speciality. Thus, in the science curriculum, inductive methods of acquiring content are recommended. Laboratory approaches need to be a definite part of each science unit.

Why might the structure of knowledge approach be relevant to stress?

1. Subject matter specialists have selected vital content for student attainment. Trivia may then be minimised in ongoing units of study.
2. By utilising methods of study advocated by scientists in their respective disciplines, learners may well glean worthwhile content as

well as use valid approaches in attaining major generalisations.

3. Science teachers secure valuable help in developing the curriculum by incorporating content advocated by scientists.
4. Relevant objectives may be chosen by teachers when incorporating structural ideas as well as methods of inquiry used by academicians in the world of science.
5. Science teachers can select a variety of activities to achieve the chosen objectives. These include laboratory methods, excursions, slides, films, filmstrips, textbooks, workbooks, supplementary reading materials, transparencies, objects, models illustrations, and drawings. The science teacher needs to be a creative being in guiding students to attain worthwhile objectives.

Reinforcement Theory

If students are successful in achievement, reinforcement is then in evidence. To achieve continuously, students need to acquire sequential small bits of vital subject matter. Attempting to master a larger amount of content at a specific time is not advocated. Thus, in programmed texts or using Computer Assisted Instruction (CAI), the involved learner reads several sentences, responds to a completion item, then checks his/her response with that given by the programmer. If the response was correct, reinforcement is in evidence. If incorrect, the student knows the correct answer and is also ready for the next item. A similar/same approach in programmed learning may be used again and again—read, respond, and check.

Woolfolk and Nicholich wrote the following:

The linear approach is often referred to as Skinnerian programming, because Skinner was its founder and prime advocate. One of its most notable features is that students must actively create an answer, not just select one from a multiple-choice format. They cover the correct response until they are ready to check their own answer. In linear programmes, students move through a fixed sequence of frames designed to lead them from one concept to the next with as few errors as possible. If students do make a wrong response, they learn of their error immediately, see the correct answer, and move on to the next frame.

Linear programmers tend to believe that students should make errors on no more that 5-10 per cent of the frames. In order to keep errors at this low level, the developers of the programmes pilot-test the frames, identifying those frames that give students the most trouble. These error-causing frames are then improved or broken down into smaller steps to make success more likely.

Why is reinforcement theory important to emphasise?

1. Learners can be successful in almost every sequential step in learning.
2. A small bit of context is learned before a student checks his/her response. Thus, misunderstanding of subject matter is minimised. A check is made of a learner's response before moving on to the next sequential item.
3. The programmer, a specialist in subject matter content, sequences content for learners.

Relevant ideas are then in the offing for student learning.

4. Appropriate order (sequence) in learning optimises student achievement.
5. By building on specifics in knowledge, a learner may ultimately achieve major generalisation and main ideas.

Humanism and the Science Curriculum

Humanists also have much to contribute in developing the science curriculum. A devout humanist believes that learners should have considerable input in ongoing lessons and units.

Teacher-pupil planning may be utilised to select objectives, learning activities, and evaluation procedures. Students should then perceive increased purpose in learning. They are involved in determining what is to be learned, the means of learning, as well as appraising progress.

A second approach in emphasising humanism in the science curriculum may involve the use of learning centres. The following centres are given as examples: audio-visual aids; models and objects; experimentation and demonstration; problem solving; excursions; reading and writing; as well as a creative endeavours centre. Tasks may be written on a card with one task card per centre. Learners can select which sequential tasks to pursue and which to omit. Continuous progress on the part of each student is vital.

A third method might emphasise a contract system. Each student with teacher guidance develops a contract. The interests and purposes of the involved learner are involved in developing the contract. Once agreed upon, the learner and the instructor sign the agreement with the due date of requirements attached. The goals of learning are decided upon cooperatively by the student and the involved teacher.

A fourth method of stressing the psychology of humanism emphasises the teacher writing and discussing listed topics for students to pursue. The topics listed on the chalkboard reflect subject matter that the students may learn. For example, if ten questions are listed on the chalkboard, chosen by the teacher, the student may complete any five as a minimum requirement.

Pertaining to humanistic education, Combs wrote:

There are two frames of reference for looking at human behaviour available to us. One of these is the external or objective approach familiar to most of us as the traditional view of American psychology. Seen from this frame of reference behaviour is described from the point of view of the outside observer, someone looking on at the process. Its classic expression is to be found in the various forms of stimulus-response psychology which seeks the explanation of behaviour in the observable forces exerted upon the individual. The perceptual psychologist takes a different view. He seeks to understand the behaviour of people from the point of view of the behaviour himself. His is a phenomenological understanding of human behaviour, emphasising the meaning of events to the person.

Perceptual psychology is basically a field theory and its primary principle is this: All behaviour, without exception, is a function of the behaviour's perceptual field at the instant of behaving. I am using the term perceptual here in its broadest sense as practically synonymous with meaning. Thus, the individual's behaviour is seen as the direct consequence, not of the fact or stimulus with which he is confronted, but the meaning of events in his peculiar economy.

Inherent in humanism are the following tenets:

1. students need to become proficient in decision-making skills.
2. self-fulfilment on the part of the involved student is significant to emphasise in personally choosing what to learn.
3. learners feel increasingly secure and develop feelings of belonging in a humane learning environment.
4. each student perceives significance in learning. The teacher cannot determine relevance for learners.
5. sequence in learning resides within the student, not with teacher determined content for students acquisition.

Conclusion

There are selected philosophies of education which might well provide guidance in developing the science curriculum. The following are recommendable philosophies to consider, adopt, or modify:

1. structural ideas identified by academicians which students may achieve inductively on their own unique levels of understanding.
2. reinforcement theory with sequential programmed steps of subject matter to be acquired by students. Success in learning is inherent, thus providing for reinforcing (rewarding) of desired achievement.
3. humanism which advocates learners choosing sequential content within a flexible structure. Students input are involved in selecting objectives, learning activities and evaluation procedures.

Teachers and supervisors need to study and analyse diverse philosophies with the intent of selecting criteria which guide each student to achieve optimally in the science curriculum.

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VITAL CONCERNS IN CURRICULUM DEVELOPMENT IN SCIENCE AND MATHEMATICS

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During the past three decades or so, India has been struggling hard to achieve universalisation of elementary education. While considerable progress has been achieved in terms of creating an infrastructure, that is, in terms of providing a school within walking distance and in terms of ensuring that there is at least one teacher available per school, the target of achieving universalisation has been eluding us all the time. The aims of achieving 100 per cent literacy, of ensuring 100 per cent enrolment in Class I, and of retaining all the enrolled pupils for at least four or five years, all seem hopelessly beyond realisation.

At this juncture when we are passionately discussing the new policy on education, and when for the first time in our history we have acquired powerful technologies like satellite communication and home computers, it would be very relevant and meaningful to discuss the new concerns in curriculum development in science and mathematics, in terms of the explicitly declared national goals and objectives. The brief note aims at listing some of these concerns with the hope that these will be reflected in curriculum development.

Equality of Educational Opportunity

While the question of physical access seems to have been solved, we are far from achieving equality of educational opportunity in its true sense. The classroom proceedings, instruction and instructional materials, the system of examination, and the school timings, hardly take note of the changing pupil profile. The first generation learner, unable to make progress in this strange inhospitable place called 'school', soon drops out. The first task of the primary school is to realise the fact that the first generation learners are not as "ready for school" as the traditional learners, and need a pedagogy for overcoming this hurdle. While considerable lip service has been paid to this problem, little has been done to change the curriculum in teacher training institutions to make the teachers aware of this specific problem. Even field tested methodologies developed by groups like the Kishor Bharati in Madhya Pradesh and the Homi Bhabha Centre for Science Education in Maharashtra, are not considered for incorporating in syllabi for colleges of education.

Research findings are applauded and promptly shelved. Something has to be done to change this if the concept of equality has to go beyond 'throwing the gates open' and lead to the establishing of equity.

Improving Rural Schools

The quality of education available to the common man will depend upon the quality of typical schools catering to the vast majority of our population. Rural schools as well as schools in metropolitan areas catering to the weaker sections of the society continue to be poor. Almost the entire grant available to these schools is consumed by teachers' salaries, leaving little for laboratories, equipment, consumables, etc. A policy directive changing the grant-in-aid pattern must be issued and implemented on a priority basis. Otherwise we will continue to provide excellent education to the elites whose children will make full use of facilities in rich schools, enter institutions of higher learning, etc., while the rest of the population is at best fed with poor education.

Contents of the Compulsory Package

'Science for all' is yet another slogan that needs to be studied carefully. If science (and mathematics) is to be made a compulsory subject, what is the content of science which every citizen must have? Unlike in developed countries where children are 'humoured' in school up to the age of 18, and are exposed to a large number of gadgets in a technology-oriented environment, school drop-outs in India occur fairly early. These drop-outs are not only not exposed to any technology; they are also denied an opportunity to get exposed to useful language behaviour which would enable them to undertake learning at a later stage. Science is expected to provide the individual with latest information regarding environment, properties of materials, new processes, etc., besides giving tools for (a) further learning, (b) manipulating the environment, (c) entering and continuing in a technical profession, and (d) coping with continuously changing and ever advancing technical world. In other words, science is expected to give the individual a new kind of literacy enabling him/her to function in an environment dominated by S&T, and to offer some insurance against being taken for a ride. I do not think we have identified such a package. Our curriculum for the primary school continues to be based on a pipeline approach (preparing students for the secondary school), ignoring the harsh reality that primary education is 'primary' for very few, and is terminal for most.

The Non-formal Stream

It is recognised that formal education may not reach everyone and that alternatives like the non-formal stream must be considered for achieving the target of universalisation. However, non-formal education as it is practiced today lacks organisation, and is an alternative to total absence of any education. It is an alternative to zero and not to formal education. Firstly, it aims at (and stops there) giving literacy in the sense of encoding and decoding letters, but does not ensure that students acquire reading comprehension. Secondly, it takes students only as far as common sense would take them, and does not introduce them to the faculty of critical and abstract thinking. Considerable R&D needs to be undertaken if one wants to develop a pedagogy for imparting these skills in the non-formal mode. It is a pity that this aspect is being totally ignored.

Vocationalisation

The importance of introducing a vocational stream capable of catering to the bulk of our population has been mentioned repeatedly. However, one must realise that vocational education is expensive; it requires considerable resources to establish a vocational institute. Also, the recurring costs are higher than those involved in non-vocational institutes. It is difficult to see budgetary provisions made on a realistic basis, either in state budgets or in our national budget. Vocationalisation will not occur; we will have to pay for it.

There is yet another factor which is very important. Vocationalisation must be distinguished from professional education like engineering and medicine leading to a degree (and to a lucratice career). Students are unlikely to opt for a vocational stream if this option means burning their boats and losing all chances to enter the university or the professional stream. In that case the steaming would imply 'vocationalisation for the poor, and professional education for the elite'. The two models of streaming, one for India and the other practiced in Korea, are worth studying in this context. The consequences of these two models are obvious.

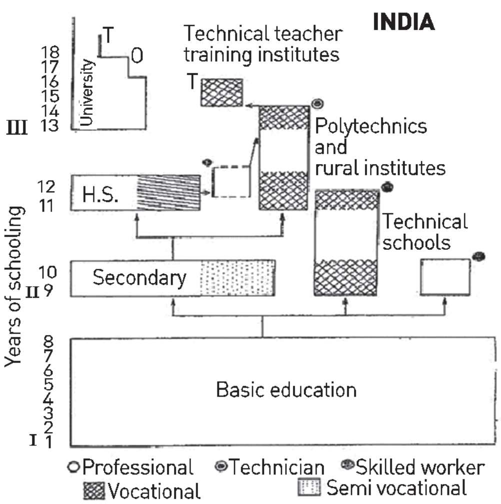

Fig. 1

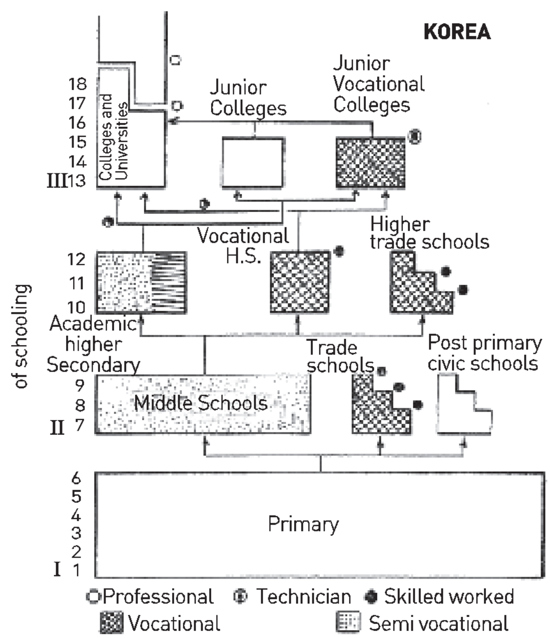

Fig. 2

New Technologies

New technologies like the satellite communication and the home computer are now available in India. Considerable progress is yet to be achieved in terms for providing an effective E-TV network while computers have just arrived. However, there is an aspect of national policy involved in the utilisation of these technologies. How do we perceive the role of the new technology? Are we, as a nation, committed to use these to overcome differences arising out of unfortunate socio-economic-cultural disparities, and to bring about democratisation of education in the true sense? Such a commitment has two major implications:

(a) The average (typical) school and the school in rural or inaccessible areas must get precedence over the elite school in getting the facilities installed. This is not easy. By definition, maintenance facilities are not available where the technology is needed most urgently. A systems approach involving the entire community will have to be adopted to reach the typical school, to install and maintain the equipment, and to train the potential users to derive the maximum benefit from these facilities. In the absence of such a commitment, the facilities will go to those who can afford them, with the predictable result of widening the gap.

(b) If the typical school is to get this priority, the software for the technology should be generated to meet the requirements of students studying in such schools. An all-out effort will have to be made to understand hurdles that prevent concept formation and to prepare software accordingly. Buying software from the developed countries or copying it with only marginal changes, is sure to lead to disaster. Also a stage has come when it is necessary to take deliberate steps to make software available in Indian languages. "Why should the interface between an Indian and technology (of any kind) be in English?" It is not so in Japan or in any of the developed countries in the west which are smaller in size than a typical state in India. The whole concept of Indian scripts, Devanagari or others, being unsuitable for being used as an interface has been blown to pieces by examples from Korea, Japan and China.

Key Schools

The documents on new policy mention key schools to cater for talented students. One hopes that eventually, within a decade or so, a key school would be set up in every district in India. On the other hand, as one wathches the slow progress, one begins to wonder whether the entire scheme is going to be restricted to a few show-pieces. Also, identifying an already established school with considerable reputation, and giving it the status of a key school would be counterproductive. This trick may boost the total number of 'key schools' in the country, but the returns would only be commensurate with the investment involved in changing labels.

In any case, even assuming for the sake of argument that a large number of key schools would be set up, one should be concerned about special curricula for these schools. Should one aim at accelerating the talented students through normal school syllabi, or should one provide a greater width and wider perspective so as to provide additional avenues to the extra intellectual capabilities of talented children? If so, how does one go about it? These are real problems that need considerable thought. One cannot merely invest in brick and mortar and hope that all other problems would sort themselves out.

Values in Education

Science and technology generate their own value systems. For example, S&T have placed in the hands of man extremely powerful tools for manipulating the environment. There are wise and not-so-wise ways of doing it. Also, for the first time in history, man can do much more than hoping and praying for the well-being of mankind. We have all the technology for providing clean drinking water and health services to our villages. However, one sees that 80 per cent people live in villages while 80 per cent doctors practice curative medicine in cities. Why is it that these aspects are not reflected in our curriculum? Certain priorities like reserving copper for taking electricity to the villages, not depending entirely on artificial fibres when we grow so much cotton, keeping public places clean, unpolluted and accessible to all, and teaching preventive medicine in schools, do not find a place in science curricula. This aspect needs immediate attention.

Utilising Field-tested Methodologies

There are several groups in the country who are addressing themselves to some of these important concerns. It should be the endeavour of national bodies like the NCERT to take the initiative and explore the possibilities as well as appropriate ways and means to incorporate research findings of these groups in national curricula. For example, the Homi Bhabha Centre for Science Education has developed a package of inexpensive remedial measure to boost the scholastic achievement of students coming from weaker sections of the society. This package has been field-tested and is so inexpensive that it can be incorporated in the regular school instruction as well as in teacher training institutions. Other groups like the Kishor Bharti have developed methods of integrating science education with rural developmental and awareness. One of the front task scientists in our country has considered it worthwhile to stay in a village in the Pune district in Maharashtra to develop a full-fledged course in appropriate technology, capable of boosting the earning capacity of school drop-outs. Why is it that these experiments, despite their proven merit, do not evoke any response from relevant quarters even when research groups with high credentials present them convincingly and repeatedly? Institutions that should be looking out for such experiments, become hurdles to be crossed or ignored. If curriculum reforms are not a single shot affair, and are expected to be an ongoing feature of our educational system, and if these 'reforms' are expected to improve the quality of education, national institutions in charge of education must develop sensitivity to innovations.

Give us the Tools

Some of the research findings have demonstrated the importance of giving tools rather than information and skills in schools. For example, tools of learning like surveys, data collection, collecting and classifying specimens, studying open-ended questions, are shown to be very effective in boosting the scholastic achievement of even the underprivileged school children. Similarly, making a deliberate attempt at improving reading comprehension has also been shown to be strikingly effective. Now that we are going through the process of curriculum revision, we should take cognisance of these findings and make an attempt to incorporate them.

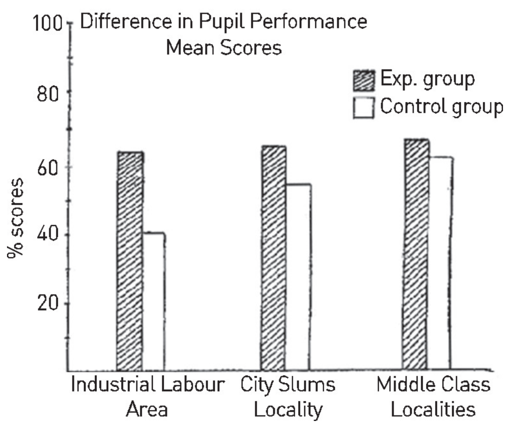

Fig. 3

In a large scale experiment undertaken by HBCSE, it has been shown that simplifying the language of exposition in science textbooks, not only leads to improved performance of students and to much greater teacher-pupil interaction, but also to reducing the difference in performance arising out of differences in home backgrounds. Since this finding has considerable social significance it is presented graphically. It would be a good idea to examine the textbooks for unnecessary linguistic difficulties and to simplify the language wherever possible.

The advantages of preparing an expanded version of the syllabus, mentioning specific objective, pre-requisites assumed, relevance to life, values to be highlighted, and, above all, indicating the end points beyond which the book would not go, were demonstrated in a collaborative programme for writing science textbooks. Since NCERT had taken the initiative in this programme, it would not be unfair to expect the NCERT not to ignore this very useful finding.

IDENTIFICATION OF SCIENTIFICALLY CREATIVE YOUNGSTERS ISSUES AND IMPLICATIONS

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Creativity has been interpreted differently by different researchers. It is a complex concept encompassing a wide spectrum of activities. Now by putting prefix "Scientific" to an already complex concept, a new dimension is added to it. Hence, the problem arises: what is meant by 'scientific creativity'? Has scientific creativity some specialities of its own which are different from other types of creativity? This problem can be best attacked by looking into the very nature of science and to choose what special factors or components characterise the scientific creativity.

Among all the national resources, the creative potential of its human resources play the motive force for the exploitation of other resources. If this potential is utilised properly, other resources get exploited easily and quickly. Thus, the consequent need for ever wider use of human ingenuity is being felt very much by every nation. But unless its identification and proper development is ensured, the very expectation of its maximum utilisation will prove deceptive and imaginary. As such, the research on identification of creativity, especially 'scientific creativity', has been drawing more and more attention in this age of science and technology. Now the problem that arises is: Can we identify the scientifically creative youngsters?

What is Creativity?

The usual method for estimating the intellectual potential of a person is the calculation of his I.Q. But the notion that the traditional kinds of intelligence tests measure all that is worth-knowing about a person's intellectual functioning has been challenged by many researchers. It has been pointed out that the kinds of intelligence-tests commonly in use these days concentrate on convergent thinking and ignore divergent thinking which is considered to be of great importance for creativity. Thus, there is an increasing realisation of the shortcomings of intelligence-tests in the sense that they sample only a narrow band of the total range of intellectual abilities. Hence, the need for a special kind of tool capable of measuring the most important aspect of intellect called 'creativity' is now being felt much. Such a tool must encompass the aspects of divergent thinking. According to Guilford (1956), "Divergent thinking is a kind of mental operation in which thinking proceeds in different directions, sometimes searching, sometimes seeking variety and is opposite to convergent production where the information leads to one right answer or to a recognised best or conventional answer" (p. 269). The unique feature of divergent production is that it produces a number of answers. Here, the examinee produces a variety of responses, rather than selects the appropriate one from among a set of choices presented to him. In doing so, he may produce a novel response. It is the relative variety and novelty of the products found in divergent production that links this category of ability basically with creativity.

According to Torrance, E.P. (1962), "Creativity is the process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, forming ideas or hypothesis and communicating the result, possibly modifying and retesting the hypothesis".

Stein, M.I. (1963) says, "Creativity is a process of hypothesis formation, hypothesis testing, and the communication of results". He further says that for empirical research, the definition of creativity is "that process which results in a novel work that is accepted as tenable, useful of satisfying by a group at a point of time" (p. 218).

Mednick, B.A. (1962) is of the opinion that "creative thinking process may be defined as the forming of associative elements into new combinations which either meet specified requirements or are in same way more useful. The more mutually remote the elements of the new combinations, the more creative is the process" (p. 220).

Wallach and Kogan (1965) in an experimental approach to be nature of creativity, conceive of it in terms of the number of associational responses and the uniqueness of these responses.

Bybee, Rodger W. (1972) is, too, of the view that "creativity is the ability to view the familiar in an uncommon way to make changes or modifications, to see numerous possibilities in a single object and to synthesise isolated schemes is a unique and novel way. The process or product is useful to either self or society" (p. 22).

What is Special about Scientific Creativity?

Thus, it is evident that creativity has been interpreted differently by different researchers. It is a complex concept encompassing a wide spectrum of activities. Now by putting prefix "Scientific" to an already complex concept, a new dimension is added to it. Hence, the problem arises: What is meant by 'Scientific creativity'? Has scientific creativity some specialities of its own which are different from other types of creativity? This problem can be best attacked by looking into the very nature of science and to choose what special factors or components characterise the scientific creativity.

We know science as a system of knowledge, the structural elements of which are the informational facts gathered by observation and experiments. The form of science is established by the organisation of these facts into systems, generalisations and theories. Probably, the first step in the organisation of knowledge beyond simple observation is the process of classification. It is also known as analysing. Although, there are limits on the usefulness of classification, the sorting of observation into categories is necessary and even very effective first step in establishing the patterns and systems of knowledge that lead to understanding.

The next step in system formation is a search for an 'explanation' of the classified information. This is an intellectual non-experimental function. Here, we advance a postulate which most often takes the form of a model. This is termed as hypothesising. It is also known as synthesising or generalising. And if we are scientific about this stage, we maintain an attitude of acepticism and a feeling of tentativeness about the postulate. The important point is that all postulates (hypothesis) of science are constantly evolving suffering modifications, additions, and deletions and sometimes total destruction. The moving force of this change is the constant test of experiment. Thus the steps involved in scientific method seem to be the following: (1) statement of the problem, (2) collection of data by observation or experimentation, (3) analysing the data; (4) hypothesising, (5) testing the hypothesis, and (6) drawing conclusion.

Hadamard (1945) has suggested that the scientific process consists of the construction of ideas followed by the combing and examination of a few useful combinations consciously produced. The distinguishing characteristic of science is, therefore, to relate the facts of the investigation and to weave them into a comprehensible whole. The construction of this web out of facts and ideas, either remotely associated or immediately related, is the most productive area for creative endeavour in science.

As regards process aspect Singh, C. (1976) is of the opinion that scientific creativity appears to be very much different from creativity in other areas. As an example for a person to be creative, he must be highly imaginative. The abundance of fantasy is the prime requisite for him. So is the case with an artist. On the contrary, more imagination and fantasy alone will not be of much help to a creative scientist. Though speculation and bold guess are sometimes needed by a creative scientist to solve his problem, but this alone will leave him in complete wilderness leading nowhere near his goal. To achieve something novel, creative out of his speculation, he must be capable of observing minutely, analysing, elaborating and hypothesising.

What Scientific Creativity Test Should Search for?

A good tool for measuring potential in scientific creativity should therefore, search for novelty in all these abilities required by a scientist. It is also to be noted here that novelty is facilitated by the production of a large number of ideas especially of different kinds. Thus, the consideration of fluency and flexibility as criteria for evaluating creative potential in the areas of science also, seems to be justified. However, to my mind, all the three criteria: novelty, flexibility and fluency are not equally important. Here, they stand in their respective position in decreasing order of importance and therefore, some relative weightage to each of them appears to be rational.

In view of the above discussion, properly loaded factors of novelty, flexibility and fluency applied to different processes involved in scientific method of problem-solving should be a good measure of scientific creativity.

Further, the evaluation of potential for scientific creativity particularly in youngsters is faced with additional problems: Identification of these abilities associated with scientific method of problem-solving which are easily exhibitable by youngsters as well as adequately measurable. Thus, while developing a tool capable of effectively measuring potential for scientific creativity among youngsters, one must keep in mind all the implications mentioned above.

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INNOVATIVE EVALUATION PROCEDURES IN SCIENCE

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Teachers and supervisors need to evaluate and revise the curriculum to provide for diverse needs, interests and abilities of learners in the school and class setting. Each pupil needs guidance to achieve optimally.

There are numerous techniques to appraise pupil achievement in the science curriculum. Traditional techniques which seemingly have stood the test of time include:

1. Teacher-written test items. These include true-false, multiple choice, matching, completion, and essay items.
2. Checklists and rating scales. Specific behaviours are listed and each learner is checked (on the checklist) if more guidance is needed to achieve that objective, or a numerical rating (5 = excellent, 4 = good, 3 = average, 2 = below average, and 1 = poor) is given in terms of perceived performance on a rating scale.
3. Appraising learner products. Each written paper, art project, or construction item may be appraised in terms of desired criteria.
4. Teacher observation and anecdotal records. What the teacher observes as representative learner behaviour may be recorded in a behavioural journal. The date should also be listed with the event.

Additional appraisal procedures will be discussed in the remainder of the paper.

Instructional Management Systems

A school may utilise Instructional Management Systems (IMS) to appraise pupil progress. To develop an IMS takes considerable time and effort on the part of teachers and supervisors in the school/class setting. Generally, at least a year should be given to writing up the diverse sections of an IMS before its implementation. The very first step to follow in developing an IMS is to write precise measurable objectives for pupils to attain in each curriculum area through the sequential years of schooling.Thus, for each grade level and in each curriculum area, there are a certain number of precise objectives that a pupil must achieve. To complete a grade level, a learner then needs to finish the identified number of measurable ends for each subject matter area studied. These are minimal essentials. If a pupil does not complete that which is required for a specific grade level in a given school year, he/she must satisfactorily finish the omitted parts during the next school year. As soon as these have been completed, the learner might then work on measurably stated objectives for the new grade level. Gifted and talented learners as well as numerous average achievers need to make continuous progress, and thus achieve more objectives than the minimum essentials.

The classroom teacher chooses learning activities for pupils to achieve stated objectives. After this, the teacher measures if a learner has been successful in goal attainment. If so, he/she progresses to the next sequential objectives. If not, the teacher needs to utilise the same or a modified strategy of teaching to guide the learner to be successful in goal attainment.

Advantages given for advocating IMS to evaluate pupil achievement include the following:,

1. The teacher can be certain if a pupil has/has not attained any one specific measurable objective.
2. Pupils may know ahead of time what is expected in terms of precise learnings.
3. Parents may also get to know specifically what their offsprings are to learn.
4. Verifiable results may be given to supervisors and other responsible persons desiring knowledge of learner progress.
5. A system of accountability of teachers is in evidence if empirical evidence is available for each learner's achievement. Teachers may be held accountable for pupils attaining the pre-specified objectives.

Disadvantages given for IMS include the following:

1. It is difficult to pre-plan objectives for pupils to achieve. The objectives may need to be pre-planned a semester or entire school year before their implementation. .
2. Learner having achieved an objective (or objectives) does not guarantee, by any means, the retention of subject matter contained in each end.
3. Emerging objectives in terms of questions and comments come from learners as lessons and units progress. These ends may be perceived by pupils more vital as compared to adult predetermined measurable goals.
4. Pupils sequence objectives rather than adults. Thus, sequential learnings accrue in the minds of individual learners rather than instructors.
5. Precise measurable goals might measure trivial learnings, such as specific facts, rather than worth while values, attitudes, problem-solving skills as well as critical and creative thinking.

Preston and Herman[1] wrote the following involving the use of behavioural objectives:

Despite the logical appeal of behavioural objectives, many educators and psychologists do not accept them as a final solution of either the curriculum or the evaluation problem. J.M. Stephens, in an intensive analysis of the process of schooling, found that it consists largely of spontaneous, unsophisticated teacher behaviours and that the teacher's effect upon pupil learning is not likely to be improved by most deliberate innovations, including the insistence in some quarters upon behavioural objectives. He contends that teachers who have a lively interest in a subject, but who slight objectives even outrageously, would probably bring about greater subject matter learning than teachers whose interest is less but who are punctilious about specifying objectives.

Learning Centres and Evaluation

Learning centres may be developed in several ways. The teacher may choose the materials and tasks for each learning centre in the classroom. Or, pupils with teacher guidance might plan concrete and semi-concrete items for each centre as well as the related learning experiences. In either approach, learners need to sequentially choose tasks to complete. There needs to be an adequate number of experiences in order that learners may omit those tasks perceived as not being purposeful or of personal interest. In a humane curriculum, described by humanism as a psychology of learning, pupils need to choose and make decisions. The teacher should not dictate objectives, learning activities, and evaluation procedures. Rather, pupils individually need to achieve self-actualisation.

A.H. Maslow[2], late leading humanist, indicates the following requirements which need satisfying in order that learners may truly achieve self-actualisation.

1. physiological (food, rest, shelter and water)
2. safety (security from danger)
3. belonging (love and affection)
4. esteem (recognition and status)
5. self-actualisation (satisfy one's potential)

Combs, et al[3]. state the following pertaining to humanism:

Perceptual psychology is more than the expression of the humanist movement. It is also a frame of reference specially designed to deal with a question raised by the movement and to contribute to its implementation in the solution of human problems. The humanist movement requires a person-centred psychology, one capable to dealing not only with behaviour, but with the meanings and perceptions that constitute the internal experience of persons as well. Perceptual psychology is uniquely suited to provide this kind of understanding. So it is that the authors of this volume conceive of perceptual psychology as both the expression of the humanist movement and the beginnings of a science through which the humanness of persons can be more adequately understood and the fulfilment of human potential more adequately achieved.

Knowledge is subjective, not objective, to the learner. Thus, adequate emphasis needs to be given to art, music, drama, literature, creative writing, and the social studies at diverse learning centres in the class setting. Adequate emphasis must also be given to subject matter which is more objective in structure, such as science and mathematics.

Advantages given for utilising humanism, as a psychology of education, to appraise learner progress include the following:

1. Open-ended flexible means may be utilised to appraise progress. With pupils being involved in choosing objectives, learning activities, and evaluation procedures, ample consideration needs to be placed upon the quality and ability of learners to make decisions.
2. Pupils must have personal needs met to do well in the school/class setting. Thus, adequate stress must be placed in the evaluation process upon meeting needs of learners to achieve self-realisation.

3. Learners need to have adequate knowledge of the self and of others. Thus, a quality evaluation programme needs to appraise, pupil's increasing knowledge, skills, and attitudes in the affective or attitudinal dimensions.

Disadvantages given for humanistic evaluation procedures include the following:

1. Learners are adequately mature to make choices and decisions in the school/class setting. The school's role is to get pupils ready for adult roles in society.
2. A teacher determined curriculum may meet the personal needs of many learners, especially if learning activities are based on motivating achievement.
3. A teacher determined curriculum can be sequentially arranged so that pupils experience continuous progress, thus aiding in effective development of pupils.

IMS versus Humanism

Teachers and supervisors need to evaluate, rather continuously, appraisal procedures utilised to ascertain learner achievement. Traditional means exist such as using teacher written test items and recorded teacher observations of learner involvement in ongoing learning activities.

Relatively recent evaluation procedures have also appeared on the horizon. These include instructional management systems involving behaviourism, as a psychology of learning. The Missouri Department of Elementary and Secondary Education in their recent brochure entitled *Instructional Management. A Priority for Missouri Schools during the 1980s*, lists the following criteria that effective schools follow:

1. High expectations for learning. Teachers and administrators expect a high level of achievement by all students and communicate their expectations to students and parents. No students are expected to fail, and the school assumes responsibility for seeing that they don't.
2. Strong leadership by building principals. The building principal is an instructional leader who participates in all phases of instruction. The principal is a visible leader of instruction, not just an office-bound administrator.
3. Emphasis on instruction in the basic skills. Since mastery of the basic skills is essential to learning in all other subjects, the effective schools make sure that students at least master the basic skills.
4. Clear-cut instructional objectives. Each teacher has specific instructional objectives within the overall curriculum which are communicated to students, parents and the general public. In effective schools, teachers and administrators – not textbooks –are clearly in charge of the curriculum and teaching activities.
5. Mastery learning and testing for mastery. Students are taught, tested, retaught and retested to the extent necessary to assure mastery of important objectives. Students are not taught more difficult objectives until prerequisite objectives have been mastered.
6. School discipline and climate. The effective schools may not be shiny and modern, but they are at least safe, orderly and free of distractions. All teachers and students as well

as parents, know the school's expectations about behaviour and discipline.

Humanism has its supporters in the educational arena. Self-actualisation is a key concept in the thinking of humanists. Maslow[4] wrote the following:

Self-actualisation is defined in various ways, but a solid core of agreement is perceptible. All definitions accept or imply: (a) acceptance and expression of the inner core or self, i.e., actualisation of these latent capabilities and potentialities, " fully functioning", availability of the human and personal essence; and (b) minimal presence of ill health, neurosis, psychosis, or loss of diminuation of the basic human and personal capacities.

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CLASSROOM VARIABLES AND STUDENT-ATTITUDE TOWARDS SCIENCE

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A review of empirical studies reveals a positive relationship between several science classroom variables and student-attitude towards science. The classroom variables include exemplar science curricula, laboratory- centred instruction, laboratory resources and classroom environment. However, there is no conclusive research evidence to establish a relationship between these classroom variables and student-attitude due to discrepancies in the attitude testing instruments utilised.

Introduction

This paper will review the effect of science classroom variables on student-attitude towards science. There is evidence to the fact that students indeed develop a better attitude towards science through learning by experience (Kyle, Bonnstetter, McCloskey and Fults, 1985). The classroom variables that provide opportunities for experience-based science learning are exemplar curricula, laboratory, hands-on discovery methods, laboratory resources, the teacher and the teacher's attitude, etc. Since the relationship between these variables and attitude is covert, only by utilising attitude testing instruments student-attitude towards science is measured.

Student-attitude towards science. According to Gauld (1982), and Haladyna and Shaughnessy (1982) there are two ways the term "attitude" is defined with respect to science. These are: scientific attitude, and attitude towards science. Scientific attitude refers to approaches utilised for problem solving, decision making and scientific thinking by acting primarily on evidence. Attitude towards science, on the other hand, may address a person's affective domain-specific feelings, such as views, judgements, thoughts and opinions towards science. For example, discovery learning could affect a student's attitude towards science (Kyle, et al., 1985).

Attitude testing instruments. Generally attitude testing instruments are questionnaires designed to determine opinions. For example, in the "Science Attitude Questionnaire" developed by Okibukola and Adeneyi (1987), students would select the most appropriate answers reflecting their attitudes towards science learning. In the "Projective Test of Attitudes" (Lowery, 1966), an interviewer will make an assessment of student-attitude based upon his or her personal interview with the students. In the "Preference and Understanding" (Vargas-Gomez and Yager, 1987) developed from the National Assessment of Educational Progress Survey (1978), there are separate statements representing student-attitude. The students will choose appropriate Likert type numerical ranks which follow each statement to express the degree to which they agree or disagree with the statement. For additional information on attitude testing instruments refer to Kyle, Penick and Shymansky (1980), National Assessment of Educational Progress (1978), Lowery (1966), Simpson and Troost (1982), Osgood, Suci and Tannenbaum (1967) and Remmers (1960).

Review of Empirical Studies

Twelve attitude studies were randomly chosen from those studies published between 1975 and 1990 in the *Journal of Research in Science Teaching, Science Education, and School Science and Mathematics.* One study did not provide any quantitative data hence was removed from the sample resulting in eleven studies ($N = 11$). They are either correlational or experimental studies (Table 1).

Exemplar science curricula positively influence student-attitude towards science. In an experimental study involving the Science Curriculum Improvement Study (SCIS), a significant increase of positive student-attitude towards science was recorded by Kyle, Bonnstetter and Gadsden (1988). The "Preference and Understanding" attitude testing instrument was used in this study. When compared with the attitudes of the students in the control group, the experimental group said science is their favourite subject, it is fun, exciting, interesting and curious. Also, the experimental group students requested more time for learning science.

In another research where the SCIS curriculum was followed for six years, the student-attitude towards science and scientists showed a significant increase (Lowery, Bowyer and Padilla, 1980). Students have enjoyed the experimenting activities of the SCIS curriculum more than anything else. This research has used the Projective Test of Attitude for testing student-attitude.

Vargas-Gomez and Yager (1987) studied the attitudes of students using exemplary curricula across the United States of America. The sample for this survey was randomly selected from a target population of third, seventh and eleventh graders across the U.S.A. The attitude testing instrument used in this study was the "National Assessment of Educational Progress" attitude survey. Vargas-Gomez and Yager (1987) reported that students in the exemplar programme developed a positive attitude towards science as well as their science teachers. Both the students and their teachers exchanged questions and engaged in sharing ideas.

Hofman (1977) compared the effect of the National Science Foundation (NSF) curriculum with traditional curricula on the attitude of eight-year-old students. His experimental group used the NSF science curriculum, and the control group used textbook-based curriculum. The students who followed the NSF curriculum showed a significant positive attitude towards science whereas those who followed textbook-based curriculum did not show any significant change of attitude.

High school students using the "Interdisciplinary Approach to Chemistry" (IAC) curriculum reported that chemistry was fun and they liked it (Sherwood and Herron, 1976). IAC is a process oriented laboratory-based chemistry curriculum. The students who followed the IAC curriculum reported on the "Scale to Measure Attitude Towards any School Subject" that the learning processes involved in IAC held their interest longer. They also reported that they understood chemistry better through the IAC curriculum than the textbook curriculum.

Learning science through laboratory has developed a positive attitude towards science among students with reading difficulties (Milson, 1979). Milson reported in a study involving fifty-four ninth-graders who had reading difficulties that the concrete experience of the laboratory influenced positive student-attitude towards science. In a similar study, Johnston, Ryan and Schroeder (1974) recorded a significant positive attitude among 108 elementary students who used laboratory-based science learning. Okebukola (1987) in a large scale study of student - attitude, found out the hands-on experience associated with laboratory-based learning as the influential factor for better student-attitude.

Table 1

Reference	Purpose	Research Hypothesis	Subject	Measures	Procedure	Analysis	Results
Kyle, Bonnstetter and Gadson, 1988	SCIS vs. traditional curri. on attitude	SCIS- significant positive effect	Elementary students N = 456 (R)	Preference and understanding	One year instrn. Then post-test	Chi square test	SCIS group- positive attitude
Lowery, Bowyer and Padilla, 1980	Attitude after 6 yrs using SCIS	SCIS-sig. positive	Jr. high N = 110 (R)	Projective Test of Attitudes Lowery, 1966	Interview/ 12 minutes/ student post-test only	AVOVA	Accepted the hypothesis
Gomez-Vargas and Yager, 1987	Attitudes of learners in exemplary programmes vs.traditional programmes	Exemplary-sig. positive	Exempl. N = 150 (R) grades-3/7/11th. Trad. N=2500 from NAEP studies	Preference and understanding	Random post-test	Z-test	Exemplary programmes developed positive student attitude
Hofman, 1977	NSF curriculum vs. traditional on attitude	NSF-positive attitude	Students, 8 yrs of age. N=79 (R)	Projective Test of Attitudes	Pre-test, 8mo. Instrn., Post-test	Two way AVOVA	Accepted the hypothesis
Sherwood and Herron, 1976	Interdisc. Approach to Chemistry (IAC) curri. on attitude	IAC develops positive attitude	High schoolers	Scale to measure attitude towards any school subject Remmers, 1960	Pre-test, Post-test	F-test	Significant influence

Milson, 1979	Laboratory curri. and the attitude of learners with reading difficulties	Concrete exper. develops positive attitude	Grade 9 N = 54 (R)	Semantic Diff. Forms Osgood, 1967	Pre-test, Post-test	AVOVA and multiple linear regression	Accepted the hypothesis
Okebukola, 1987	Influencing factors toward lab. performance	Hands-on and teacher attitude influence student attitude	Grade 11 Students = 819, Teachers = 39	Teach./ Students' Lab. Info. and Attitude Towards Chemistry	Random-3 times	Multiple Regression Analysis	Accepted the hypothesis
Johnston, Ryan and Schroeder, 1974	Lab. centred vs. text-centred learning and attitude	Lab/text-centred differ towards attitude	Elementary students N = 108(R)	Projective Test of Attitudes	Post-test Two- week Instrn.	AVOVA	Lab. has more influence on attitude
Mulpo & Fowler, 1987	Effect of discovery vs. traditional methods on the attitudes of formal vs. concrete S's.	Instructional method has no influence on attitude	Concrete = 60 (R), Formal = 60 (R) Grade 11	Achievement Test on Science Attitude	Pre-test, Ten week instrn., Post-test	Two way AVOVA	Rejected the hypothesis
Talton & Simpson, 1987	Classroom Environment and Attitude	Classroom Env. affects attitude	Grade 10 N = 1560 (R) Teachers = 23	Simpson and Troost Instrn. 1982	Three times per school year	Pearson Corr. and F-test	Accepted the hypothesis
Okebukola & Adeneyi, 1987	Lab. resource utilisation and attitude	Relationship	Students =252 Teachers = 21 Lab. Assts = 18	Scientific Attitude Questionnaire	Random testing	AVOVA and Pearson Corr.	Frequency, quality, teacher's affect attitude

Note: (R) means random sampling

Talton and Simpson (1987) found that classroom environment influences students' attitude towards science. The classroom environment includes factors, such as emotional climate, physical environment, friends and teachers. They found that the teachers' positive attitude towards science as well as peer interaction as motivators of positive student-attitude towards science.

Mulpo and Fowler (1987) studied the effect of discovery and traditional methods of learning chemistry on the attitudes of concrete and formal operational learners. The results indicated no significant difference in attitude among concrete and formal operational learners. However, discovery method of learning showed a higher correlation with student-attitude than traditional method.

Okebukola and Adeneyi (1987) argue that positive student-attitude depends on the extent to which the laboratory resources are utilised effectively.

Their definition of laboratory resources included the teacher, the laboratory assistants as well as laboratory materials. In addition to using the "Scientific Attitude Questionnaire" they also performed direct classroom observations. The outcome of their study revealed a significant positive correlation between frequency as well as quality use of the laboratory resources and student-attitude towards science. They also found that the resource person's (the laboratory assistant's) attitude towards science had an influence on student-attitude.

Discussion and Conclusion

According to this review, several classroom variables influence student-attitude towards science. They include exemplar science curricula, laboratory-based learning, utilisation of laboratory resources, hands-on discovery methods, teacher's attitude, classroom environment, etc. The empirical studies reviewed have been performed in classrooms at various geographical locations representing students from a variety of educational, socio-economic and cultural backgrounds. The studies have employed various attitude testing instruments. Three of the eleven studies reviewed have used the "Projective Test of Attitudes" and two have used the "Preference and Understanding Questionnaire". The remaining six studies have used six different attitude test instruments.

Munby (1980) after reviewing 50 attitude testing instruments in science education opined that "there seems little to be said of the instrument to enlist our confidence" (p. 237). Two major problems of attitude testing instruments are: lack of a theoretical framework to support the instrument (Shrigley, 1983; Munby, 1983; and Zeidler, 1984); and lack of sufficient validity and reliability (Munby, 1980; Gardner, 1987; Bratt, 1984; Schibeci, 1983; and Butts, 1983). Unless these problems are resolved, it would continue to be difficult to establish a conclusive relationship between student-attitude and classroom variables.

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CHILDREN'S CONCEPTUAL FRAMEWORK ABOUT NATURAL PHENOMENA AND ITS IMPLICATION FOR SCIENCE TEACHING

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By appreciating, amongst other things, the perceptions that the learner brings to the class, the teacher can reduce the discrepancies between pupil's intentions and his learning. Similarity of constructed meaning to that intended by the teacher depends on the way a pupil copes with the language used by the teacher during instruction.

During the last two decades there has been a major upsurge in interest in science education. Children's informal ideas particularly about the natural and physical environment have drawn attention of many science educators. The ideas which they bring with them to the science class have great implication in science teaching. Recent studies by psychologists and science educators have indicated that children have views about a variety of topics in science from young age even when they have not received any systematic instruction in those subjects whatsoever. These ideas and interpretations are a result of everyday experience—of practical, physical activities and of talking with other people. Their views are often different from the views of the scientists and are frequently not well known by teachers. To children, they are often sensible and useful views.

Young children, like scientists, are curious about the world around them in how and why things behave as they do. As children attempt to make sense of the world in which they live in terms of experiences, their current knowledge and use of language, they develop ideas which may be called 'children's science'. Although their ideas are less sophisticated than those of practising scientists, some interesting parallels can be drawn. Children, like scientists, view the world through the spectacles of their own pre-conceptions and many have difficulty in making their journey from their own intuitions to the ideas presented in science lessons. They do come to the science class with already formulated ideas or alternative frameworks and these may be at variance with the theories the teacher wishes to develop. However, these intuitive ideas have a powerful influence on subsequent learning.

When children in a class write about the same experiment they can give various diverse interpretations of it. Individuals internalise this experience in a way which is at least partially their own; they construct their own meanings. These personal ideas influence the manner in which information is acquired. This personal manner of approaching phenomena is also found in the way scientific knowledge is generated. The observations children make about natural phenomena and interpretations of them are also influenced by their ideas and expectations. Same ideas may be shared by many pupils about similar events or same child may have different conceptions of a particular type of phenomenon. Thus a child's individual ideas may seem incoherent. It is important in teaching and curriculum development to consider and understand children's own ideas, their conceptual framework about natural phenomena as it is to give a clear presentation of the conventional scientific theories.

By the time children come to school, their expectations or beliefs about natural phenomena are well developed. These intuitions may be poorly articulated but they provide a base on which formal learning can be built. However, in some cases the accepted theory may be counter intuitive with children's own beliefs and expectations differing in significant ways from those to be taught. Such beliefs are referred to as 'alternative frameworks' by Driver (1983). There is evidence from a number of investigations that children have common alternative frameworks in a range of areas, including physical phenomena, such as propagation of light, simple electric circuits, ideas about force and motion and chemical change as also biological ideas concerned with growth and adaptation. To cite an example from plant nutrition it is very often heard that pupils believe in plants taking prepared food from the soil. As regards respiration in plants, children have the notion that plants respire only at night and during day time they only photosynthesise.

It is often noticed that even after being taught, children do not modify their ideas in spite of attempts by a teacher to challenge them by offering counter evidence. Children either ignore counter evidence or interpret it in terms of their prior ideas. What children are capable of learning depends, at least in part, on what they have in their heads as well as the learning content which is presented to them. Learning does not occur by the learner responding in a passive way to the environment but by actively interacting with it. It takes place through the interaction between a learner's experience and the conceptual framework he has to give meaning to such experiences.

Pupils as individuals inevitably construct their own purpose for a lesson, from their own intentions regarding the activities they will undertake, draw their own conclusions and carry these through in their subsequent thinking. The fundamental premise is that children tend to generate perceptions and meanings that are consistent with their prior learning. These perceptions and meanings are something additional both to the stimuli and the learner's existing knowledge. When a teacher talks to his class, draws a diagram on the blackboard, discusses a chart or asks pupils to read a textbook, his intended meaning or that of the textbook author is not automatically transferred to the mind of the pupil. Each child in the classroom constructs his or her own meaning from the variety of stimuli present in his or her environment. To construct meaning, it requires effort on the part of the learner; links must be generated between stimuli and stored information. Teachers must contrive learning situations in such a way that mental constructions made by pupils—what the lesson is about, what is to be done or what can be and what is to be learnt from it correspond with their own intentions. By appreciating, amongst other things, the perceptions that the learner brings to the class, the teacher can reduce the discrepancies between pupil's intentions and his learning. Similarity of constructed meaning to that intended by the teacher depends on the way a pupil copes with the language used by the teacher during instruction.

From an educational perspective it has been argued that it may be necessary to take account of the ideas and beliefs that young pupil bring to their formal study of science if these ideas are to be successfully modified by instruction. The intuitive ideas that students hold prior to instruction are both identifiable and stable and have enough commonality to make it worth planning instructional sequences to change them. The implication of it is that the strategy to be used in any given institutional situation should depend on whether or not children already have many such ideas.

If we adopt a view of learning as conceptual change in its broadest sense then we need to have information about the ideas that students may bring to the learning situation. When students are presented with ideas in science lessons they may fit them into their intuitive ideas and the result may be a mix of taught science and intuitive science. At other times, a student may compartmentalise his or her knowledge and not integrate new knowledge with existing knowledge. When they meet formal science lessons in the school, students have to actively modify and restructure their own ideas. This requires a willingness and effort on the part of the learner. Likewise, if the ideas held by students are to be taken into account, teaching cannot simply be viewed as the telling or giving of knowledge to the students. Teaching involves helping each student to construct for himself or herself the accepted ideas. The starting point of a teaching sequence is then the intuitive ideas students bring with them, the conceptual framework they have with them. Having found out the ideas held by students in a class, the role of the teacher then becomes that of diagnostician and prescriber of the appropriate learning activities. Teaching needs to be related to what is familiar to the children not just at the level of the world of events and experiences but also in their world of ideas.

If a science lesson is related to the world outside the classroom in a way which helps the pupil expand his or her knowledge of that world and to make sense of it in a new way, if it is related to prior ideas that the child has already stored in memory, he or she is able to fit the lesson into the pattern of his/her existing ideas and experience. So to make a lesson interesting it must have relevance to children's everyday life. To be aware of children's existing informal ideas about natural phenomena is important if we are to help them relate these ideas in their minds to the learning experiences provided for constructing new ideas.

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RELATIONSHIP BETWEEN ACADEMIC SELF-CONCEPT IN SCIENCE AND COGNITIVE PREFERENCE STYLES

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The study aims at finding the relationship between Cognitive Preference Styles (CPS) and Academic Self-concept in Science (ASCSc) of the secondary school students. The sample consisted of 200 Class IX students. The study reveals that 'Application' style is positively and significantly related to ASCSc. Students differ in their CPS with high and low ASCSc; and gender differences are absent in CPS.

Introduction

Cognitive preference of Heath (1964) provided a new line of thought to many researchers like Kempa and Dube (1978) and Tamir (1974). Cognitive preference testing helps in determining the livelihood of students using the information intellectually. The construct is regarded as the variant of cognitive style. Congnitive styles are related to the vocational preferences, the choice of specialisation and relative preference within the fields. These predict the direction of achievement and hence provide a potentially powerful basis for career development and guidance.

In India, sporadic researches have been started on Cognitive Preference Styles in various science subjects. But in Israel, America and Britain, Heath, Atood, Tamir (1974, 75, 76), Kempa (1978), Rogal (1979), Brown (1970) and Hofstein *et. al.* (1973) have done a lot of work in this area. In their researches, they have constructed and validated different cognitive preference styles with achievement, intelligence and some background variables like curriculum, teacher bias, teachers' cognitive style and sex. So far, no attempt has been made to study the relationship between Academic Self-concept in Science (ASCSc) and the Cognitive Preference Styles (CPS) of the school students. Therefore, the investigator has attempted the following study:

"The relationship between Academic Self-concept in Science (ASCSc) and Cognitive Preference Styles."

Hypotheses

The following hypotheses were tested:

(i) There is no significant relationship between ASCSc and Cognitive Preference Styles of students.

(ii) The students having low and high ASCSc do not differ in cognitive preference styles.

(iii) There is no significant difference in cognitive preference styles between boys and girls.

Sample

The sample constituted 200 students (102 boys and 98 girls) studying in Class IX in four different schools of Bhopal district.

Tools

The investigator used two instruments. The descriptions are as under :

(i) Academic Self-concept Scale in Science (ASCSSc): A Linkert type scale was developed by the investigator (1988) for his study. The scale consists of 50 items (25 pairs bipolar items) arranged in cyclic order according to dimension in the scale. The reliability coefficient as calculated by test-retest method was found to be 0.84. Internal consistency coefficients were calculated by using Cronbach procedure. The coefficients for the five dimensions of the scale ranged between 0.71 and 0.82. Intercorrelation coefficients between various dimensions were also calculated.

(ii) Cognitive Preference Style (CPS): The Cognitive Preference Style prepared by Atwood (1971) measures three modes of preferences such as Memory (M), Questioning (Q) and Application (A). Out of thirty items, twenty-seven are functional and others are distractors. The items are almost equally distributed between physical and biological sciences.

Results

(1) Relationship between ASCSc and Cognitive Preference Style: Assuming normality in distribution of scores in Memory (M), Questioning(Q), Application (A) and ASCSc, product-moment coefficient has been calculated. The r values are shown in Table 1.

a) Table 1 reveals that the correlation coefficient between ASCSc and M-scores (M) for the sample of boys, girls and the total are found to be negative. For the boys and total sample, they are significant at .01 level whereas non-significant for the girls.

b) The correlation coefficient between ASCSc and Q-score (Q), for the boys group is low positive (r=0.12). For the girls group it is negative and significant at .05 level (r=–20) but for the total sample it is low negative or negligible.

c) The correlation coefficient between ASCSc and A-score (A) is found to be positive for the boys, girls and total sample, and significant for the girls group and total sample at 0.05 level and 0.01 level, respectively.

(2) Comparison of Cognitive Preference Styles of High and Low ASCSc: The groups of students having high and low ASCSc were formed by taking into consideration the mean and standard deviation of scores. The mean and standard deviation of the scores of 200 students were found to be 189.11 and 25.76, respectively. Students having ASCSc scores (M+ISD=189.11+25.76=214.87) 215 were assigned to the group of students having high ASC. Similarly, students having ASCSs scores less than (M–ISD= 189.11-25.76=163.35) 163 were assigned to the group of students having low ASCSc. In a sample comprising of 200 students, 33 fell into high ASCSc and 30 into

low ASCSc group. Mean and SD of M-scores, Q-scores and A -scores are summarised in Table 2. The t values were also calculated to test the significance of difference in the means of M-scores, Q-scores and A-scores of the two groups of students.

Table 1

Correlation Coefficient between Cognitive Preference Styles and Academic Self-concept in Science (ASCSc)

Pair	Boys (N=102)	Girls (N=98)	Total (N=200)
M and ASCSc	– 0.30**	– 0.11	– 0.29**
Q and ASCSc	0.12	– 0.20**	– 0.04**
A and ASCSc	0.18	0.22*	0.20**
*P ← 0.05 ** P ← 0.01			

High ASCSc group and low ASCSc group of students were found to have some cognitive preference styles desired on the basis of their mean scores in Memory, Questioning and Application modes. Both groups had first preference for 'Application', second preference for 'Memory', and third preference for 'Questioning'. So their cognitive preference style was found to be: *Application Memory Questioning*.

As is clear from Table 2, high and low ASCSc groups differed significantly in their M-scores and A-scores. Therefore, hypothesis of no difference in means of M-scores and A-scores of both the groups is rejected in favour of low ASCSc group for 'Memory' and high ASCSc group for 'Application'. No significant difference was found between the means of Q-scores of high and low ASCSc groups. Hence the null hypothesis is retained in this case.

(3) *Gender Differences in CPS and ASCSc:* In order to study the gender difference in CPS, mean and SD were computed for M-scores, Q-scores and A-scores for boys and girls separately. They are summarised along with t values in Tables 3.

Table 2
Mean, SD and t Values of Scores on Three Dimensions of CPS of High and Low ASCSc of Students

Dimension	High M	Group SD	Low M	Group SD	t-value	Significance at .05 level
Memory (M)	7.94	1.89	9.16	2.76	2.04 *	S
Questioning (Q)	7.48	2.17	8.03	2.98	0.84	NS
Application (A)	11.66	2.21	10.10	2.90	2.41*	S

Table 3

Mean, SD and t Values for Boys and Girls for M, Q and A Preference Styles

Dimension	Boys		Girls		t-value	Significance at .05 level
	M	SD	M	SD		
Memory (M)	8.66	2.52	8.43	2.56	0.64	NS
Questioning (Q)	8.08	2.60	8.11	2.44	0.08	NS
Application (A)	10.30	2.71	10.59	2.80	0.74	NS

It is clear from Table 3 that all the three t values are non-significant at 0.5 level. Therefore, the null hypothesis of no sex difference in means of M-scores, Q-scores and A-scores is retained.

Summary

'Memory' is negatively and significantly correlated with ASCSc whereas 'Questioning' to a less extent. These two cognitive preferences are not to be encouraged for enhancement of ASCSc. 'Application' is associated positively and significantly with ASCSc. Thus their preference must be emphasised for development of ASCSc among the students in our teaching-learning process.

Cognitive preference style of both high and low ASCSc groups of students was found to be the same, that is, A-M-Q. It reflects the highest preference for 'Application' and the lowest preference for 'Questioning' mode of cognitive reference styles. This result partially supports the views of Saxena (1989). Significant difference was found in the means of 'Memory' and 'Application' scores of both high and low ASCS groups. No significant difference was found in the means of 'Questioning' scores of both high and low ASCSc groups.

There is no gender difference in cognitive preference style of the student as all the three t-values are non-significant.

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STATUS OF SCIENCE TEACHING IN INDIAN SCHOOLS FOR THE VISUALLY IMPAIRED CHILDREN

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Education for all by 2000, including disabled children, is a global commitment. In this basic education, science education also has an important role to play. The teaching of science at the foundation stage of schooling deserves utmost care. But it is often given a low priority in special education. The disabled children also have a great need, like anyone else, to learn about the world around them where scientific and technological advancement affect everybody's life. Science can be used as a motivation to stimulate learning in a number of different academic and social areas and even to provide a basis for vocational education leading to employment opportunities in the modern technologically advanced environment.

The Workshop Department of the National Council of Educational Research and Training undertook a project on "Adaptations in Science Equipment and Instructional Material for Disabled Children at Elementary Stage" in order to promote science learning with the help of adapted science equipment and instructional material for the visually handicapped children. In this project a study was undertaken with the following objectives:

(i) To get background information about the way science is actually taught in the schools for blind children, in the "special setting" schools, and in the integrated schools (Integrated Education for the Disabled —IED).

(ii) To find out the areas of improvement and deficiency in order to suggest further activities to accelerate science learning.

Method

The study was confined to the lower primary school level in the "special setting" and the "IED school setting". The study was designed to seek information on the age group, the experience, the academic and professional qualifications of the teachers concerned, the number of disabled children in each class from Class III to Class V, the dropouts with reasons, the time allotted to and spent on science teaching. It next sought to explore the position of the availability and use of equipment/teaching aids/resource room facilities and the nature of science teaching. Suggestions from the various schools were also invited for improving the science education for the visually impaired children.

Response

Judging from the number of returns, the response was limited. Questionnaires were sent to 189 IED setting schools and 407 special setting schools. The responses were received from 29 IED setting schools and special setting schools. The special setting schools in the States of Assam, Goa, Bihar, Himachal Pradesh, Karnataka, Jammu and Kashmir, Manipur and the Union Territory of Chandigarh and Pondicherry did not respond to the questionnaire. The IED schools in the States of Bihar, Himachal Pradesh, Karnataka and the Union Territory of Delhi also did not respond.

Major Findings

The study resulted in the following findings:

(i) In the special setting schools the teachers are mostly well-qualified, trained and experienced, except in Uttar Pradesh where the teachers are untrained and with minimum qualifications. In the IED setting schools, most of the teachers are experienced and well-qualified, but they did not have special training for teaching disabled children, except in the two States of Kerala and Tamil Nadu where the teachers were trained also.

The teachers teaching in the IED setting schools are mostly male, young, and in the age-group 20-35 years. In the special setting schools, mostly the teachers are males and in the age-group 40-49 years.

(ii) On an average, the teachers in the special setting schools are teaching science for 40-45 minutes daily in each class for all the States. As compared to the other States, the time spent on science teaching in Kerala is 30 minutes.

In the case of the IED setting schools in Haryana, the time spent on science teaching is one hour daily whereas it is 35 minutes as far as Maharashtra and Rajasthan are concerned.

(iii) The situation regarding resource rooms, aids and equipment needed for science teaching is very bad.

The special setting schools of the following States do not have resource rooms and aids / equipment: Delhi, Haryana, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tripura and West Bengal. The IED schools in the States of Mizoram, Meghalaya and Rajasthan also lack resource rooms, aids and equipment.

(iv) The survey also indicates that there are dropouts from the special setting schools of the following States: Andhra Pradesh, Kerala, Maharashtra, Tamil Nadu, Tripura and West Bengal. The reasons are:

(a) Not properly trained in daily living skills.
(b) Over-protection of the parents.
(c) Home-sickness.
(d) Yield to childhood earning like begging, etc.
(e) Not properly motivated towards the benefits of education.
(f) Unwillingness to learn.
(g) Poor progress in the class.
(h) Poor IQ.
(i) Long absence from the classes.
(j) Parents unwilling to keep their wards in residential set-up.

For the IED setting schools of Haryana, Mizoram, Meghalaya and Orissa, the dropouts are due to the following reasons:

(i) Unable to cope with normal students.

(ii) Advanced age and home-sickness.

(iii) Lack of boarding facilities.

Teachers' Recommendations for Improving Science Teaching

(a) Special Setting Schools

(i) Orientation, training and refresher courses for science teachers based on modern changes. Models, charts and simple equipment are necessary for science teaching.

(ii) Only interest and insight of the concerned teachers can improve science teaching.

(iii) The schools have to be provided with minimum science equipment. Embossed, unbreakable, safe teaching aids and resource rooms for science are a must.

(iv) Adaptation of equipment for disabled children at elementary level will improve science teaching.

(v) Field trips, practical experiment, direct methods, etc., will also help.

(vi) Good textbooks in braille are needed.

(b) IED Setting Schools

(i) Orientation and training courses for science teachers are required.

(ii) Learning by doing should be practised.

(iii) Separate science kits for each topic, models, charts and simple equipment are necessary for science teaching.

(iv) Simplified explanation of the subject matter should be given in the textbooks.

(v) Power glasses should be provided by schools for partially sighted children.

On the basis of the findings, it can be concluded that the present status of science teaching in Indian schools for the visually impaired children is quite poor because of lack of specially trained teachers and suitable equipment and instructional material. It is quite clear that the most effective way for the visually impaired children to learn is that they do hands-on activities with real objects, organisms and suitable teaching aids under the guidance of properly trained teachers.

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PUPIL'S ACADEMIC SELF-CONCEPT AND ACHIEVEMENT IN SCIENCE : THE EFFECTS OF HOME ENVIRONMENT

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Home is the social institution which has the most far reaching influence on the development of the child. It does not only provide the hereditary transmission of basic potentials for his development, but also provides environmental condition, personal relationships and cultural pattern, favourable and unfavourable, positive and negative, as reflected from its structure, social-economic and cultural status and the pattern of relationship and emotional state among its members (Kundu, 1977). The home also sets a pattern for the child's attitude towards people, things and institutions.

In view of the great significance of the family in shaping of children's personality development, numerous researchers made attempts to study the several factors of family ecology in relation to children's development and scholastic achievement. Mishra, et al (1960) found that children coming from high quality environment achieve better in school than their counterparts coming from low quality home environment. Morrow and Williamson (1961) while analysing the background of family factors responsible for higher achievement of school children, concluded that more congenial home environment, less parental domination and sympathy are responsible for the achievement of the children. Studies by Dave (1963), Dayer (1967), Kellaghan (1977) found positive relationship between family environment and measures of academic achievements. Tabackman (1976) found gifted adolescents saw themselves as more independent, permissive and intellectual. These families were structured and cohesive than the families of non-achieving students.

Pandey (1985) reported punishment aspect of the home environment is negatively related to achievement among deprived and non-deprived girls. Other aspects of Home Environment (HE) viz., control, protectiveness, permissiveness, nurturance and reward are not significantly related to achievement in Hindi. She concluded that if proper punishment is given, children must perform in the school.

The nature and extent of relationship between home and specific academic self-concept appears to be a subject which though of great importance theoretically, has been largely unexplored at the hands of research workers. It has been postulated that specific academic self-concept develops in a stimulating environment. Since children pass more of their precious and active time during formative years in the home, its influence cannot be ruled out. It seems that the effect of home has not been studied in depth with empirical approach. Hence, the present study aims to study the effect of family socio-psychological environment on Academic Self concept Scale in Science (ASCSSc) of junior secondary school students.

Hypotheses

The following hypotheses were tested:

i) There is no significant relationship between HE dimensions and ASCSc of students.

ii) There is no significant relationship between HE dimensions and ASc of students.

iii) The students having low and high ASCSc do not differ in HE dimensions.

iv) The students having low and high (achievement in science) do not differ in HE dimensions.

Sample

The sample constituted of 291 students (187 boys and 104 girsl) studying in Class VIII in five different schools of Shadol (a tribal dominated) district of Madhya Pradesh.

Tools

The investigator used two instruments. The descriptions are as under:

(i) Home Environment Inventory (HEI)

The Home Environment Inventory prepared by Mishra (1989) measures ten dimensions of home environment, such as control, protectiveness, punishment, conformity, social-isolation, reward, deprivation of privilege, nurturance, rejection and permissiveness. One hundred items are equally distributed and arranged in cyclic order according to the dimensions of the scale.

(ii) Academic Self-concept in Science Scale (ASCSc)

A Linkert type scale was developed by the author (1993) for his study. The scale consists of 50 items (25 pairs of bipolar items) arranged in cyclic order according to the dimensions in the scale. The reliability coefficients as calculated by test–retest methods was found to be 0.84. Internal consistency coefficients were calculated by using Cronbach procedure. The coefficients for the five dimensions of the scale ranged between 6.71 and 6.82. Intercorrelation coefficients between various dimensions were also calculated.

(iii) Achievement in Science

The marks obtained by the students in science subject in the annual examination of the previous class was taken from the school records.

Collection, Scoring and Tabulation of Data

The data were obtained by administration of the tools mentioned above to the subjects of the sample. The responses of the subjects recorded in the answer sheets were scored following the instructions given in the manuals and the scoring keys provided for the purpose. The scores were tabulated and necessary statistical treatments were given to analyse the data.

Results

(1) Relationship between HE Dimensions with ASCSc and ASc

Assuring normality in distribution of scores in ten HE dimensions, ASCSc and ASc, product-moment correlation coefficient has been calculated. The 'T' values are given in Table 1.

Table 1

Correlation Coefficient between HE Dimensions with ASCSc and ASc

HE Dimension	ASCSc	ASc
Control	0.17**	0.31**
Protectiveness	0.18**	0.82**
Punishment	0.06	0.09
Conformity	0.08	0.08
Social Isolation	0.21**	0.02
Reward	– 0.02	0.01
Deprivation of Privileges	– 0.1	– 0.04
Nurturance	– 0.01	– 0.13*
Rejection	– 0.01	– 0.26**
Permissiveness	– 0.11	– 0.25**
	*P< 0.05	**P< 0.01

(a) Table 1 reveals that correlation coefficient between ASCSc and HE dimensions viz. control, protectiveness and social-isolation are positive and significant at 0.01 level. Other seven correlations are low and some are negative or negligible. Therefore, hypothesis of no-significant relationship between these dimensions is rejected in former three cases and accepted in later seven cases.

(b) ASc is positively and significantly correlated with control and protectiveness at 0.01 level. Again, ASc is also significantly correlated with nurturance, rejection and permissiveness at least at 0.01 level but negatively. Other five correlations are low and non-significant. Thus, the hypothesis of no-significant relationship between these dimensions is rejected in former five cases but accepted in later five cases.

(2) Comparison of HE Dimensions of High and Low ASCSc

The groups of students having high and low ASCSc were formed by taking into consideration the mean and standard deviation of scores. The mean and standard deviation of the scores of 291 students were found to be 113.69 and 10.64 respectively. Students having ASCSc scores (M + SD = 113.69 + 10.64 = 124.33) 124 were assigned to the group of students having 'high ASCSc'. Similarly, students having ASCSc scores less than (M – SD = 113.69 – 10.64 = 103.05) 103 were assigned to the group of students having low ASCSc. In a sample comprising 291 students, 55 fell into high ASCSc and 58 into low ASCSc group. Mean and SD of HE dimensions are summarised in Table 2. The t-values were also calculated to test the significant of difference in the HE dimensions of the two groups of students.

Table 2

Mean, SD and t-values of Scores on Ten Dimensions of HEI of High and Low ASCSc of Students

HE Dimension	High Group		Low Group		t-values
	Mean	SD	Mean	SD	
Control	23.77	2.87	23.45	3.30	0.55
Protectiveness	24.87	3.16	24.70	3.52	0.27
Punishment	25.16	3.45	25.02	3.33	0.22
Conformity	25.68	2.63	25.85	2.73	0.34
Social Isolation	20.98	3.31	21.27	3.71	0.45
Reward	23.80	3.36	24.05	3.17	0.41
Deprivation of Privileges	19.36	3.41	20.49	4.35	1.56
Nurturance	20.46	3.57	21.19	3.69	1.08
Rejection	18.70	2.98	18.90	4.20	0.30
Permissiveness	18.16	3.52	19.84	4.04	2.42*
	*P< 0.05				

As it is clear from Table 2, high and low ASCSc groups differed significantly in 'Permissiveness' of the home. Therefore, hypothesis of no difference in means of ASCSc scores of both the groups is rejected in favour of low ASCSc group. No significant difference was found in between the other nine dimensions of high and low ASCSc groups. Hence, the null hypothesis is retained in these cases.

(3) Comparison of HE Dimensions of High and Low ASc

High and low groups on the basis of ASc scores were formed as per the above procedure. The Mean and SD of 291 students were found to be 45.54 and 10.37, respectively. Students having (45.54 + 10.37 = 55.91) 56 were assigned to the high ASc group and (45.54 – 10.37 were 35.17) 35 were assigned as the Low ASc group. In the sample, 47 fell into high ASc and 95 into low ASc group. Mean SD of HE dimensions are summarised in Table 3. The t-values are also calculated to test the significance of difference in the HE dimensions of the two groups of the students.

Table 3

Mean, SD and t-values of Scores on Ten Dimensions of HEI of High and Low ASCSc of Students

HE Dimension	High Group		Low Group		t-values
	Mean	SD	Mean	SD	
Control	24.89	2.78	22.83	3.88	3.88**
Protectiveness	25.02	3.12	24.37	3.46	1.12
Punishment	26.19	2.65	24.97	3.38	2.35*
Conformity	25.87	2.29	25.69	3.11	0.39
Social Isolation	20.10	4.05	20.77	4.02	0.93
Reward	23.94	3.72	24.49	3.05	0.89
Deprivation of Privileges	19.38	3.82	19.95	3.77	0.84
Nurturance	20.00	4.41	21.77	3.35	2.42*
Rejection	16.34	3.04	18.98	3.07	4.89*
Permissiveness	17.40	3.13	19.99	3.65	4.39*
	* P< 0.05		** P< 0.01		

It is obvious from Table 3 that high and low ASc groups differed significantly in their scores of control, punishment, nurturance, rejection and permissiveness. Therefore, hypothesis of no difference in means of these HE dimensions is rejected in these cases. The high group outscored the low group in control and punishment aspects whereas the low group outscored high group in nurturance, rejection and permissiveness dimensions. No significant difference was found between the means of other five HE dimensions of high and low ASc groups. Hence the null hypothesis is retained in these cases.

Conclusion

It can be concluded that 'control' and 'protectiveness' are positively and significantly correlated with both ASCSc and ASc whereas 'nurturance', 'rejection' and 'permissiveness' are negatively and significantly correlated with ASc. 'Social-isolation' is also correlated with ASCSc significantly.

'Less permissiveness' at home is the characteristic of high ASCSc and ASc pupils. More control, punishment, less nurturance, rejection and permissiveness is the nature of high ASc pupils.

Thus, the homes of high ASCSc are controlled, protective, socially isolated and less permissive and the high ASc are controlled, protective, punishing, less nurtured, less rejected and less permissive.

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DESIGNING SCIENCE UNITS OF STUDY

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To design the curriculum area of science, careful attention needs to be given to the structure of unit planning. The objectives for students to attain may be stated in measurable terms. To achieve balance in the curriculum, cognite, affective and psychomotor ends need to be stated with precision. Each domain of objectives is salient for student attainment. After instruction, it is possible to measure if a learner has or has not achieved the measurably stated objective.

Toward the other end of the continuum, general objectives may be stated and implemented in ongoing units of study. To stress balance among general objectives, understandings, skills and attitudinal goals should be emphasised in teaching-learning situations. With general objectives, it is not possible to measure if a student has or has not achieved the chosen end. However, flexibility in curriculum development may be emphasised, such as student-teacher planning.

The measurably-stated objectives versus general objectives debate represents differences in assumptions and beliefs in education. The measurable objectives movement stresses:

1. What has been learned is observable and measurable.
2. Certainty needs to be in evidence in terms of what a teacher is to teach and students are to learn. Uncertainty of which cognitive, affective, and psychomotor objectives (specificity of ends) to stress in lessons and units represents teachers who waver and are uncertain of themselves.
3. The importance of learning routes or activities which must harmonise directly with the chosen ends.
4. Validity in testing. Items on a test must match the objectives emphasised in teaching-learning situations.

General objectives advocates believe:

1. Important learnings, be it subject matter skills or attitudes cannot be measured with precision.
2. An adequate number of goals should come from teacher-student planning of the curriculum.
3. Individual students may well pursue goals different from other learners. Common goals for all to attain then is not possible.
4. An open-ended curriculum needs to be in evidence which meets student's interests, purposes and needs. General objectives can make provisions for individual differences among learners.

The debate between measurably stated and general objectives might be harmonised in utilising the former where feasible and possible and the latter whereby students with teacher assistance develop goals, learning opportunities and appraisal procedures.

The writer recommends the following for science teachers in the measurably stated versus general objectives debate:

1. Teachers individually need to be highly knowledgeable pertaining to assumptions involved in each of the two kinds of objectives.
2. Both measurable and general objectives need to be implemented in the science curriculum.
3. Science teachers need to appraise how specific and general objectives affect student progress in on-going lessons and units.
4. Each teacher needs to analyse the quality of teaching being emphasised when contrasting the utilisation of measurably stated versus general objectives. Under which conditions does the teacher of science believe that learners can achieve in a more optimal manner?
5. Curricular constraints need to be taken into developing the science curriculum. Does a state mandate Criterion Referenced Tests (CRTs) with tile utilisation of measurably-stated ends to ascertain learner progress in science?
6. The ultimate statement in the teaching of science pertains to helping each student achieve as much as possible in each lesson and unit of study.

Philosophies of Science Education

Diverse philosophical schools of thought in science are in evidence to develop and implement lessons and units in science.

Experimentalism emphasises the use of problem solving experiences for students. Flexible steps in problem solving involve:

1. Identifying the problem.
2. Gathering data to solve the identified problem.
3. Developing a hypothesis directly based on the obtained data and in answer to the problem.
4. Testing the hypothesis.
5. Revising the hypothesis, if evidence warrants.

Experimentalism emphasises that real life problems be identified by students. The problems then come from society. In society, earthquakes, hurricanes, tornadoes, volcanic eruptions, among many other natural phenomena, occur. Out of these scenes and situations, problems arise and are identified, such as "What makes for the happening of earthquakes?" Information then needs to be gathered to answer the problem or question. An answer, tentative in nature, is then developed. The answer, a hypothesis, is then checked against further content, secured from a variety of reference sources. Modification of the original answer or hypothesis may then be needed.

Idealism, as a philosophy of education, emphasises in idea-centered curriculum. Science then becomes a part of the general education programme. A subject-centred, not an activity-centred philosophy, is then in evidence. Diverse academic disciplines, such as zoology, botany, physics, astronomy, biology, chemistry and geology provide subject matter for on-going units of study. Textbooks, workbooks, worksheets and a few selected audio-visual aids provide content to students. Universal ideas or generalisations in science units need to be achieved by students. The teacher needs to be a true academician and scholar to stimulate student learning.

Realism, as a third philosophy of education, advocates the utilisation of precise, measurable objectives. Realists believe that the real world of science can be known in whole or part as it truly is. What students achieve in each science unit can be measured. The real world of natural phenomena can then be stated in precise, measurable objectives. A variety of concrete learning activities, in particular, should be provided for students to attain the specific ends. Semi-concrete as well as abstract activities also should be in the offing. After instruction, it is observable and measurable if an objective has been achieved by students.

Existentialism, as a fourth philosophy of education, emphasises the learner, himself or herself, being heavily involved in deciding *what* (the objectives) to learn, as well as the *means* (learning activities) in on-going science units of study. Thus, a learning centres philosophy may be emphasised. More centres and tasks for learners to pursue are in evidence than what can be completed. Each student may then sequentially choose which tasks to complete, as well as which to omit. Students individually are involved in making these decisions. The teacher develops the centres for learner interaction. Better yet, student-teacher planning may be used to develop the centres and their inherent tasks.

When looking at the diverse philosophies of education and their implementation for the science curriculum, the writer recommends the following:

1. Each teacher needs to become thoroughly familiar with each philosophical school of thought.
2. Each philosophy needs to be implemented on a trial basis in on-going lessons and units.
3. The effect of the diverse philosophies needs to be observed in terms of student progress in science.
4. The science teacher needs to appraise the self as to how each philosophical strand affects one's own teaching style.
5. Teachers individually need to develop their very own philosophy of teaching science. The adopted philosophy must harmonise with students learning styles and one's own beliefs about learners and the actual act of teaching.

Processes versus Products

Science educators tend to disagree as to which is more significant in the curriculum—the processes or the products of learning. The American Association for the Advancement of Science (AAAS) in Science: A Process Approach (SAPA) emphasises in the programme of units of instruction that students achieve the following processes:

1. Observing
2. Recognising and using number relations
3. Measuring

4. Recognising and using space-time relations
5. Classifying
6. Communicating
7. Inferring
8. Predicting
9. Defining operationally
10. Formulating hypothesis
11. Interpreting data
12. Controlling variables
13. Experimenting

The above-named processes can be utilised in any academic discipline in science. With quality processes emphasised in teaching-learning situations, students in science lessons and units should attain vital, relevant subject matter. However, emphasis in the AAAS SAPA programme, processes are more important than products, that is subject matter learnings acquired by learners.

Other science educators advocate products (vital facts, concepts and generalisations) as being the major outcomes of teaching-learning situations. Thus, from the academic disciplines involving zoology, botany, biology, astronomy, chemistry, physics and geology, students should acquire structural ideas as well as significant concepts and facts.

The writer recommends that:

1. Processes and products receive equivalent emphasis. With quality processes stressed in science, worthwhile facts, concepts and generalisations should follow as end results.
2. Each teacher should be highly knowledgeable about diverse process and product goals in teaching science.
3. Objectives in the science curriculum reflect an adequate number of processes as well as products.
4. Learning opportunities to guide students to attain process ends as well as product goals should be inherent in each on-going lesson and unit.
5. Evaluation procedures need to emphasise processes and products in the science curriculum. A variety of appraisal procedures should be utilised, such as teacher observation, student self-evaluation, teacher written tests as well as standardised tests.

A Logical versus a Psychological Curriculum

Who should sequence or order objectives and learning experiences for students to pursue? The science teacher, a team of teachers and/or State-mandated Criterion Referenced Tests (CRT) may determine sequence in attaining objectives in science. These educators then base the order of learning for students on logic or rational thought.

Toward the other end of the continuum is a psychological science curriculum. A learning centred psychology may well be emphasised here. An adequate number of centres needs to be in evidence. At each centre, five or six different tasks should be available. Enough centres and tasks should prevail so that students may truly select what to pursue and complete, as well as what to omit. Interest, purpose and meaning need to be in evidence for each learning activity pursued. The teacher develops the centres and tasks. Teacher-student planning can also be in evidence at the diverse centres with its inherent tasks. In a psychological science curriculum, each student selects sequential tasks within a flexible framework.

In viewing the logical versus psychological science curriculum, the writer recommends that:

1. Each student needs to achieve optimally regardless of which psychology is utilised.
2. The best order or sequence in learning needs to be in evidence for students individually.
3. New ways of developing sequence need to be sought and tested in actual teaching-learning situations.
4. Experimental studies need to be conducted to determine under which sequential plan—a logical, a psychological or a combination of the two approaches—is best for guiding students on an individual basis to achieve as much as possible.
5. Teachers should focus on the concept of sequence when implementing on-going lessons and units.

Scope in the Science Curriculum

What should be the breadth of knowledge, abilities or attitudes emphasised in science instruction? Each of these categories of objectives should receive adequate attention. Numerous ways are in evidence to determine scope.

First of all, problem solving can be emphasised in a quality science curriculum. The problems should be real and life-like. Students need to perceive purpose and meaning within the problems identified. Thus, from current events items, the following come up repeatedly:

1. What causes rain, dew, frost, snow, and hail to occur?
2. What causes mountains to form?

A variety of reference sources need utilisation to secure reliable information in answer to the identified problems. Testing and revising of answers is a definite possibility. A quality science curriculum in stressing scope might then emphasise problem solving.

A second approach in achieving scope would be to utilise basal textbooks, single or multiple series, together with workbooks and worksheets. The table of contents of the basal series will indicate which units are to be emphasised. The writer would thoroughly recommend if textbook contents determine scope in the science curriculum that an adequate number of audio-visual materials be utilised to clarify ideas presented from the reading materials.

A third approach in determining scope in the science curriculum is to emphasise teacher-student planning. Within each science unit, the teacher can stimulate students to plan definite goals, learning opportunities and appraisal procedures. Students are encouraged, not hindered, to participate in developing the science curriculum.

A fourth method of scope emphasises project methods of instruction. The late William Heard Kilpatrick (1871-1964), Professor at Columbia University in New York City, advocated flexible steps to follow in the project method. In the project method, Dr. Kilpatrick recommended open-ended flexible procedures. First of all, the student needs to perceive purpose or reasons for the project. Next, the learner with the teacher plan the project, as established in the purpose. After the planning has been completed, the student guided by the teacher carries out the plan. Once the project has been completed, its quality needs to be evaluated in terms of desirable standards. The total number of projects, successfully completed by students, would pertain to the *scope* of the science curriculum.

There are numerous approaches available in determining scope in the curriculum. When using problem-solving procedures, the textbook method, student-teacher planning, and/or the project method, provision needs to be made for fast, average and slow learners. The writer recommends the following in achieving a desirable scope in the curriculum:

1. Use diverse, not a single procedure. Students like variety of methodology in teaching and learning.
2. Determine under which conditions students achieve more optimally. A carefully developed research design could emphasise quality practical research in the curriculum.
3. Study other methods of determining scope in science. Scope should not remain static, but be subject to modification and change to provide more adequately for each individual student.
4. Use the carefully selected basal textbook as the core in determining scope. Have problem-solving, student-teacher planning and the project method elaborate on textbook subject matter.

In Summary

The writer has identified numerous issues in teaching science. These issues include

1. Specific versus general objectives in teaching.
2. Diverse schools of thought in the philosophy of education.
3. Process versus product ends of instruction.
4. A logical versus a psychological sequence.
5. Numerous different means in determining scope in the science curriculum.

Methods of teaching science need to incorporate ways to resolve the above identified issues. The ultimate goal of teaching science is to assist each student to attain as much as possible in the science curriculum.

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SCIENCE INSTRUCTION FOR MAKING CHILDREN THINK AND DO

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Introduction

It is matter of great concern that in this age of science and technology, aspects of science teaching are not getting the proper attention in our country. The emphasis is still on rote learning of science. On the other hand, in many advanced countries the cognitive development practices have become an important area of linking of science instruction with students' cognitive development. Goods (1980) observes the following:

> Where 'thinking' is a desired outcome, the teacher must have an understanding of the general cognitive characteristics and range of abilities of the children. Many textbooks and materials that have been developed for science instruction assume a level of thinking that is not available to many or, in some cases, to all children in the classroom.

Thus, the blame for science curricula not catering for the cognitive development lies squarely on the outdated textbooks and classroom instructional techniques, like lecture and discussion methods. These practices do not provide opportunities for scientific investigation and experimentation. Therefore, it becomes imperative to switch over from the lecture method to the problem-solving and project methods of instruction.

Some people and investigatory experiments can be easily set for students to collect observations and interpret those on their own. For this purpose a deliberate attempt should be made to familiarise students with the variables and controls in the experimental situations.

Role of Science Project Work

Furthermore, the idea of project work in India has been so devalued that all sorts of normal pieces of school work are being taken as project work. Even preparing charts, writing a story and preparing scrap-books, etc. are being designated as project work. In respect of the meaning of project, Ponts E.M. *et. al* (1971) observe the following:

> The educational philosophy underlying the project method is that children learn best by trying out their ideas in the practical solutions of real problems which have freely

chosen to tackle. In science teaching its great value may be the opportunity it provides for direct creative activity. In carrying out the projects, the students would learn a good deal of science, by studying many sources of information, by devising experiments, making trails of apparatus and by a critical examination of results leading to redesigning of the experiment.

Thus, it becomes evident that the project work must form a part of science curriculum and children should be encouraged to do simple projects related to the problems around them. This kind of activity results in developing their higher levels of cognition like comprehension, application and synthesis.

Focus on the Child

Child-centredness

Another method of cognitive development through science teaching is by making classroom instruction child-focussed. Teachers can identify the individual needs of students and develop science curricula catering to the needs of each child. The individualised curricula should be based on certain tested assumptions and principles. In this connection, Good (1980) further suggests the following assumptions on which science teaching should be based.

1. It is possible to logically derive learning conditions from goals and characteristics of learners.
2. Learning conditions must reflect what is not known as well as what is known about students.
3. Teacher behaviours and learning materials are dominant factors in determining learning conditions since these two factors communicate to the students' conceptual and operational meanings of learning.
4. Learning how to learn can be facilitated by school experiences.
5. Self-actualised learning should be the goal of education.
6. Learning conditions can be tested by studying interactive processes and outcomes of educational activities.

An Example

A good model of think-and-do science has been developed under the Andhra Pradesh Primary Education Project (APPEP) which has now been replaced by District Primary Education Programme (DPEP). Six instructional (APPEP, 1993) postulates derived on the basis of practical implementation of the project are summarised in the following table.

Table 1

The Survey of the Six Instructional Postulates for Think-and-do Science (Adapted Version)

S.No.	Postulate	Components	Details
1.	Providing	1.1 Activity	• Relevance of the activity • Appropriate concept pitching • Process learning emphasis

		1.2 Planning	• Sub-activities are steps • Sequencing • Time framing
		1.3 Providing materials	• List of materials • Quantity of materials • Availability of materials • Norms and rules for the use of materials
2.	Promoting learning by doing	2.1 Observing	• Use of two or more senses • Observing objects: properties, features, attributes • Observing actions, events, happenings, phenomena
		2.2 Raising questions	• Promoting children's questions • Raising questions on children's discussion • Asking questions from students
		2.3 Generating ideas	• Thinking divergently • Providing alternatives and extension activities • Conjecturing, hypothesising forecasting, predicting
		2.4 Investigating	• Putting things together for experimenting • Verifying hypothesis • Collecting information
		2.5 Recording	• Words and numerals • In diagrams
		2.6 Interpreting	• Looking at data for relations • Finding patterns • Making sense
		2.7 Communicating	• Through talking, report writing, dramatising • Through models, displays, charts, graphs, pictures
3.	Developing task	3.1 Individual task	• Personal assignments • Individual study for remediation and enrichment • Special interest activity
		3.2 Group work	• Share ideas • Discuss problems • Peer-tutoring • Process review
		3.3 Whole class	• Giving overview and instructions for tasks • Summing up • Making presentations • Organising camps and fairs
4.	Recognising individual differences	4.1 Self-pacing	• Preparation of graded material • Self-evaluation exercises • Demonstrating mastery on given task

		4.2 Addressing to multiple intelligence	• Puzzles, games • Music, singing • Role plays, performing arts • Guided visualisation and fantasising • Making and doing things
5.	Using local environment	5.1 Natural surroundings	• Study visits, field visits • Nature hunt • Gardens, nurseries
		5.2 Physical surroundings	• Using discarded, low-cost and no-cost materials • Using local available inexpensive materials
		5.3 Societal resources	• Local artisans for making teaching aids • Community resources • Museums, science parks, fairs
6.	Creating interesting classroom	6.1 Wall displays	• Children's work • Posters, charts, pictures, drawings, paintings • Pocket board
		6.2 Suspended displays	• Mobiles, kites • Cut-outs, masks • Puppets • String-library • Self-made big books
		6.3 Self-displays	• Collected objects, materials, equipments, instructions • Models, toys

In Conclusion

Thus, we see that science teaching can be effective in the cognitive development of students only when project work is done seriously and science curriculum is made child-centred. In such circumstances alone, students will acquire the abilities to sense problems, collect observations, make interpretations and arrive at conclusions which are basic to effective learning of science.

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HOW THE TEACHERS IN ASHRAM SCHOOLS PERCEIVE SCIENCE CURRICULUM AT THE UPPER PRIMARY STAGE

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The tribal population in the state of Maharashtra is about 10 per cent of the total population. They are clustered in three traditional regions: Sahyadri, Satpura and Gondvan. Tribal Development Department of the Government of Maharashtra has established adequate number of Ashram schools to facilitate the education of tribal children in each of these regions. After the initial reluctance from tribal communities the enrolment in these schools has improved considerably. Nevertheless, because of lack of tradition of education in their homes, learning of formal school subjects remains a Herculean task for the students. Teachers are expected to make an extra effort to facilitate learning of technical subjects like science and mathematics. In order that they do their job well, they need to have proper perception of the subject as well as of the difficulties faced by the students. What is the perception of teachers related to the aims and objectives of science curriculum? What are the learning difficulties of students and how to facilitate better concept formation in science? What modifications the present evaluation methods demand to asses the knowledge and skills acquired by the students? These are crucial questions and demand for critical exploration.

As a part of its manifold activities the Homi Bhabha Centre for Science Education (HBCSE) conducts in-service training of science and mathematics teachers. Because of its interest in the education of socially disadvantaged students, HBCSE has been interacting with Ashram school system for about seven years. It had arranged training courses for teachers teaching science and mathematics to Grades IX and X in Post-basic Ashram schools. While interacting with students at secondary level it was observed that many of them had poor initial preparation. This observation brought out the need to improve teaching at the upper primary stage (Classes VI to VIII). Accordingly, in-service training programmes for the teachers' teaching in upper primary classes have been initiated for the academic year 2002-03. In order to assess the needs of practising teachers, an attempt was made to understand their perception about the curriculum, areas of difficulty, ways and means to overcome the difficulties, suitability of evolution methods, etc. This paper describes the design of the study, data collection, their analysis and implications.

Designing a Questionnaire and Data Collection

The researchers had an opportunity to interact with about 60 teachers dealing with students at the upper primary classes during a training course arranged for Ashram school teachers. This opportunity was used to identify crucial issues related to the teaching of science in their schools by forming six groups from among the participants. The leader of the each group was expected to present the summary of the deliberations. The presentations brought out the urgency to tackle issues related to the suitability of school curriculum, teacher pupil interaction, remedial teaching for tribal children, etc. Based on these inputs, a questionnaire was framed to get the opinions of practising teachers on teaching objectives, students' difficulties, validity of evaluation techniques, etc. It had following seven questions:

1. What do you think are the aims and objectives of teaching science at upper primary stage?
2. Which concepts do the students in your classrooms find difficult?
3. In your opinion what are the causes of the difficulty?
4. What do you do to overcome these problems?
5. What is your opinion about the present method of evaluation used to assess the students' understanding?
6. What modifications do you suggest in the evaluation procedure?
7. Taking into account the needs of the country and the requirements of tribal population what changes do you recommend in the school science curriculum?

After each question, enough blank space was provided for teachers to express their opinions in detail. They were encouraged to use additional sheet if required. The sample for the study consisted of 57 teachers who participated in yet another training camp of HBCSE. They were from 57 different schools in Thane, Pune and Raigad districts of the state of Maharashtra. The students to whom they cater to, come from communities living in the Sahyadri ranges of the state. This region inhabits the communities like Warli, Katkari, Kokna, Mahadev Koli, Malhar Koli, Dhor Koli, Thakar, etc. All these castes are categorised as the Scheduled Tribes (S.T.) and are given facilities as per the norms of the State and Central Government.

Traditionally, in the state of Maharashtra, Classes V to VII are considered to be the part of upper primary stage and Class VIII is attached to secondary schools. The basic Ashram schools with upper primary classes terminate at Class VII. The sample of teachers included in the study, therefore, consisted of teachers teaching Classes V to VII. They had Higher Secondary School Certificate (H.S.S.C) along with a Diploma in Education (D.Ed.). Most of the teachers were new to the profession with 1-5 years of teaching experience. Of the 57 teachers who filled the questionnaire, 39 were males and 18 were females. Since teachers are expected to live within the campus of the schools, female teachers are usually reluctant to accept the job in Ashram schools. However, with special drive to get female teachers at the primary level, some of the Ashram schools could appoint good number of them.

Data Analyses and Discussion

All the seven questions included in the questionnaire were analysed separately. The salient findings of the analyses are presented in this section.

Responses to Question 1

Teachers were expected to list the aims of science education they considered important at the upper primary stage. It has been found that teachers usually express more than one aim. The analysis of the data is shown in Table I. From the table it can be seen that a large number of teachers consider developing scientific temper as the most important objective of science teaching. Attempts were made during the course to explore if the teachers really understood the meaning of this phrase. Surprisingly, only a few had a clear understanding of what the phrase really means and what is expected when aims at developing "scientific temper".

Table 1

Aims of Science Education at Upper Primary Stage

Aims	Number of teachers	Percentage
Development scientific temper among the students	36	63.15
Understanding incidences occurring in the vicinity	30	52.62
Creating interest towards science	26	45.61
Brining out social development	23	40.35
Development science related competencies	21	36.84
Preparing students to deal with future problems	15	26.31
Explanation of some simple concepts in science	12	21.05
Developing experiment skills	11	19.29

The second aim referred to by a majority of teachers is to help pupils understand the incidences and happenings in their vicinity. Teachers think that this aim is important for the tribal students as many of them are under the influence of superstitions prevailing in their society. The lack of understanding of cause-effect relationship usually forces people to believe that there is some mysterious power behind it. Most of the teachers displayed the concern of the removal of wrong beliefs possessed by the students. They felt that teaching of science would enable them to think rationally and explore cause-effect relationship behind everyday occurrences.

A little less than half of the teachers (26) believe that the aim of the teaching science at the upper primary stage is to create interest among the students towards science. It is hoped that positive attitude towards science might motivate them to undertake higher students in science and to pursue career related to science. Teachers were aware of the need for adequate number of scientists and technocrats for the country. They were also concerned that the tribal communities are grossly under-represented in these professions. They were, however, optimistic that with special efforts this picture can be changed.

Social upliftment was considered to be an important aim of science education by 23 teachers. They were more concerned with the improvement of the status of tribal communities. They believed that learning of science would bring about social development by enabling these communities to adopt hygienic practices, by making use of resources properly and by adopting appropriate methods of cultivation. A small number of teacher view teaching of science as a vehicle to bring out the relation between science and social development. Although teachers look at the science curriculum as a means of achieving these objectives, many of them have a feeling that the present content is inadequate to fulfil these demands.

In the recent past, focus of teaching science has shifted from information sharing to developing science related competencies. A programme on competence-based teaching has already been launched in the country for the primary grades. Some teachers (1) are influenced by this thinking and envisage development of these competencies as the main aim of teaching science even at the upper primary stage. The competencies involved are the development of curiosity, skill of observations, ability to draw inference, etc.

Preparing children for their future is considered an aim of science education by 15 teachers. The term 'future' has two connotations: preparing for further studies, and preparing for good citizenship. Learning of science at the upper primary stage is expected to prepare student to deal with high school science without any difficulty. In addition, learning of science is expected to prepare them to face challenges in the future. Further explorations, however, showed that teachers' understanding of 'good citizen' was unclear.

A dozen of teachers opine that teaching of scientific concepts discussed in the respective textbooks is the necessary task. Teachers should ensure that students have a proper concept formation. Good understanding of textual material would enable them to score better in the examinations. This success is expected to motivate children to read science based material from newspapers and magazines and get enriched.

A small number of teachers (11) view developing experimental skills as an important aim of science teaching. Students with rural background are usually well prepared to work with hands. However, when it comes to handling laboratory instruments these students commit mistakes. These teachers opined that science teaching should aim at providing adequate practice to enable the students to acquire necessary laboratory skills. Acquisition of the skills, they believed, would hopefully develop confidence among the students.

Responses to Questions 2, 3 and 4

Questions 2, 3 and 4 focused on students' difficulties, their causes and possible remedial measures. Because they were closely related to each other, the analysis of responses to all the three questions is presented in one section. As a response to question 2, teachers were expected to list the concepts from the syllabus of Grades V, VI and VII that are found difficult by a majority of students in the classroom. Since most of the teachers had the experience of teaching science to all these classes or to at least one of these classes, they could supply a considerably long list of concept. Looking at the list, one finds that they can be classified under three categories:

1. *Concepts involving symbols/formulae:* Teachers reported that the concepts involving symbols and formulae are found difficult by a majority of students. For example, when the concept of density is described as ratio between mass and volume (m/v) students are unable to know what it means. It might be because students are not familiar with the symbolic language in science.
2. *Concepts that cannot be shown:* In the opinion of teachers the concepts are found difficult if they cannot be shown or demonstrated by an activity/experiment. Examples in this category are: photosynthesis, atomicity, gravitation, digestion, etc. Lack of direct experience adds to the abstract nature of the concept.
3. *Concepts devoid of daily relationships:* If the concept has no relation to the daily lives of students, they find it difficult to understand. Concepts in this category are: catalysis, tides, function of a cell, etc. Since they find no relevance they are not motivated to learn.

Why do students find it difficult to deal with above types of concepts? Question 3 sought for teachers' views on this issue. In addition to listing difficulties associated with specific type of concepts, teachers attempted to mention general difficulties faced by the students in science education. The analysis of the data, thus obtained, is presented in Table 2.

The analysis showed that teachers find unfamiliar language as the single most important area of difficulty. It would be proper to discuss what sort of linguistic difficulties students encounter. Textbook of science makes use of technical terms derived usually from Sanskrit. Students are unable to decode the meanings of these terms (Agarkar, 1985). Although science textbook is written in Marathi (the official language of the state of Maharashtra) the nature of language spoken by the tribal communities is often different from that used in school textbooks. Teachers too, are tempted to use textual language in classroom discourse making teacher-pupil interaction non-productive, as the students prefer to keep silent when they find the language unpalatable to them.

The second culprit in the eyes of teachers is the poor initial preparation on the part of students. Teachers felt that because of poor learning skills, students were unable to handle involved concepts. On the affective side, teachers felt that students were ill motivated to struggle until mastery in learning was achieved. Thus, inadequate cognitive entry behaviours as well as improper affective entry characteristics were responsible for poor concept formation among the students.

In the views of an appreciable number of teachers (19) it is the lack of facilities in schools that is to be blamed. The laboratory facilities in schools are so meagre that activity based teaching can hardly be undertaken. Apart from teaching school subjects, the Ashram schools have the responsibility of providing education opportunities. In this regard the teachers felt that the situation is far from satisfactory. Since the schools are located in remote areas, opportunities like public lectures and public library are almost non-existent in their vicinity. Electronic media like radio and television have made a great headway in recent years. These facilities are, however, not available to students. Lack of proper educational opportunities, in the eyes of teachers, hinders the fixation of knowledge gained in school classrooms.

Although most of the teachers have blamed school system, a small number (11) hold teachers responsible for the lack of students' understanding. Bad teaching, in their opinion is the main cause of poor learning. They felt that many teachers do not have clear understanding of the aims and objectives of science curriculum. Some of them were themselves poor in content knowledge with large number of unsolved questions and doubts in their minds. Since there is no mechanism where teachers can receive guidance, they continue to teach badly without ensuring the comprehension on the part of the learners.

Table 2

Causes of Difficulty

Nature of difficulty	Number of teachers	Percentage
Linguistic difficulties	25	43.85
Poor initial preparation	22	38.59
Lack of facilities in schools	19	33.33
Lack of educational opportunities	11	19.29
Improper teaching method	11	19.29
Non-conducive home environment	10	17.54
Conceptual difficulties	07	12.28

Non-conducive home environment of the students is said to be the cause of poor learning by 10 teachers. In their opinion, the home environment, being deprived in a variety of ways, does not provide any motivation to the students to learn science seriously. The educational status of members in the society is such that it fails to provide relevant academic inputs or to satisfy the curiosity aroused in the minds of children.

Are the concepts within reach of students? A few teachers (7) feel that the difficulty level of some of the concepts is so high that students are not prepared to cope with them. Some of these teachers even went further to state that students from deprived homes have a lower I.Q., and hence are incapable of dealing with involved abstract concepts. These teachers need to re-look at their belief system.

Related to various educational problems, question 4 attempted to seek information from teachers about special efforts that they make to help children learn difficult concepts. Barring a few who left the question blank, a majority had mentioned what they do within and outside classrooms. The nature of efforts made by teachers can be conveniently categorised as shown in Table 3.

The large number of efforts are concerned with activities/experiments. In the opinion of teachers it is the abstractness of the concept that makes it difficult to understand. This abstractness can be removed by performing suitable activities. Even though many (41) have said that they resort to laboratory programme, it must be noted that it is mostly of demonstration type. Students are hardly given an opportunity for hands-on activities (Agarkar, et al. 1997).

Since language difficulty was considered to be the main hurdle in learning science, teachers (29) seem to take care of this difficulty very seriously. On one hand, they try to familiarise students with the formal language by giving reading assignments to the students. To achieve a little fun in this assignment, some teachers even arrange blind games of picking up sheets to decide who should read. On the other hand, teachers attempt to simplify the language of the textbook by providing meanings of technical terms and using colloquial language in the classroom.

Table 3

Efforts by Teachers

Nature of efforts	Number of teachers	Percentage
Emphasis on experimentation	41	71.92
Language simplification	29	50.87
Examples and anecdotes	14	24.56
Enhancing pupil participation	13	22.80
Outdoor activities	09	15.78
Question-answer and revision	07	12.28

A substantial number of teachers (14) stated that they resort to giving examples and anecdotes to clarify science concepts. Science textbooks attempt to provide some relevant examples and anecdotes. However, since they are prepared centrally for the use by schools in the entire state, examples cited in the book are seldom relevant to the lives of students. In such a situation, teachers have to look for life-related examples. This is certainly a challenging task that is undertaken by only a small number of teachers.

A group of teacher (13) struggled to enhance pupils' participation in the classroom. Due to fear of committing mistakes, students prefer to remain passive in the classroom. Many of them are afraid of the punishment that the teacher might give if they do something wrong. It is a matter of concern and skill to make students actively participate in the classroom deliberations. It is heartening to note that a small number of teacher strive to achieve this goal.

A few teachers (9) have said that they focus on arranging outdoor activities. Because of the scenic location of the schools, students have a good scope for nature study. Some of the teachers make use of this opportunity by arranging outdoor activities. In their opinions, outdoor exposure is as important as classroom interaction as it provides opportunities for experiential learning among the students. By some (7), however, dealing with students' questions sympathetically is seen as a solution to overcome students' problems. Since the time available in the classroom is not enough to deal with students' questions, these teachers usually arrange separate question-answer sessions during the free time of the students.

Responses to Questions 5 and 6

These questions were framed to get teachers' opinion about the present mode of evaluation and to seek their suggestions for modifications. Nine teachers did not attempt to respond to these questions. Of the remaining, roughly half of the teachers felt that the present method of evaluation is proper while the other half opined that it is grossly inadequate. It would be informative to inquire why these teachers feel the way they do.

Let us look at the arguments made by the teachers who felt that the present mode of evolution is appropriate. Some of the reasons given by them are as follows:

1. It helps us to discriminate who have acquired concepts and who have not.
2. It enables us to understand the lacunae in the conceptual understanding of the students so that the difficult portion can be revised.
3. It provides an opportunity to the students for written communications and facilitates teachers to know who can express their knowledge properly in the written mode.
4. Since students are expected to remember information for examinations, it helps to develop the skill of memorisation.
5. Examinations arranged at regular intervals of time prompt the students to revise the matter and keep themselves up-to-date.

Why do many teachers think that the present mode of evaluation is not proper? In their opinions it has the following drawbacks:

1. It focuses only on the written mode of communication. Those who are unable to express properly in written mode are at loss.
2. It encourages mugging up of the information without understanding. Good score in the examinations is often wrongly equated with good understanding of the subject.
3. It does not test the skills like keen observation, handling of instruments, ability to draw inference from the data, ability to use information in daily life, etc.
4. It puts undue emphasis on objective testing and hence students usually avoid going deep into the matter.
5. The question papers are usually same for urban as well as for rural children. Rural children are at loss as they have different domain of experience and different level of linguistic competence.

Teachers were asked to make suggestions for the improvement of the present mode of evaluation. Their responses belonged to three different categories. The first category of teachers (19) comprised those who stated that present mode of evaluation is appropriate and needs no modification. The second category comprised those who felt that the evaluation method is generally acceptable but desires some modifications (06). The last category of teachers (23) consisted of those who felt that the present method is grossly inadequate and needs drastic changes. Suggestions made by second and third categories of teachers can be classified as shown in Table 4.

Table 4

Suggestions for Improvement in Mode of Evaluation

Category of suggestions	Number of teachers	Percentage
Within class evaluation	16	33.33
Use of experiments/ activities	15	31.25
Diagnostic testing	14	29.16
Based on experiences	09	18.75
Style of questioning	03	06.25
Testing of personality traits	03	06.25

A majority of teachers suggested that teacher-made test should be given importance. A little explanation is required to appreciate the concern expressed in this suggestion. In order to keep pace with other schools, the Tribal Development Department acquires and uses tests made by other educational institutions for the terminal examinations of Ashram schools. Teachers feel that those tests are framed taking urban middle class students into account. Some teachers (3) even felt that the language and the style of questions are unsuitable for the students coming from tribal homes. Due to the common mode of testing students, they felt that their students often performed at a lower level than they deserve. Hence, teachers advocated that testing should be entrusted to the teaching community of the Ashram-school system.

As mentioned above, many of the teachers (15) were worried that the school testing neglects evaluation of experimental skills at the upper primary level even though practical examinations are conducted at school leaving stage. In their opinion, due importance should be given to the laboratory programme both in teaching and in assessment. Activity based assessment would enable the teachers to not only assess students, laboratory skills but also to find out if students can make use of scientific knowledge in practical set up. Along with laboratory testing, a small number of teachers (3) even went further to suggest that personality traits should be assessed.

Appreciable number of teachers (14) suggested that diagnostic tests should be prepared and used frequently to assess the lacunae in pupils' understanding. Such a test should be administered soon after the completion of the unit in the classroom. Ashram schools cater to a special group of students. Their home background and the nature of experiences are very much different from the other students. The testing that assumes a normal classroom interaction is not suitable to these students. Hence, teachers (9) suggested that the tests should be prepared taking into account the nature of experiences the students have.

Responses to Question 7

Teachers were asked to offer suggestions of the modifications in science curriculum at upper primary stage taking into account the needs of the country and of the community the Ashram schools serve. Only a small number of teachers could make suggestions taking into account the needs of the country. All those suggestions refer only to the teaching of information technology. They were, however, not clear as to what extent it should be taught to the students. Many of the teachers felt that they have no authority and experience to think of national level policy. They (52) could, however, make suggestions taking into account the requirements of the students, as they have been interacting with them day in and day out. Some of the suggestions made by the teachers are mentioned in Table 5.

In the opinion of a large number of teachers, the textbook is the most important instructional material used in school teaching. The content and the style of textbook influence not only classroom interaction but also learning of the subject. They, therefore, recommended that the textbooks should be modified suitably to facilitate learning

Table 5

Suggestions for Curriculum Modifications

Nature of suggestions	Number of teachers	Percentage
Inclusion of content useful for social development	24	42.10
Style of presentation in the textbook	19	33.33
Bringing out relation to daily life	15	26.32
Opportunities to develop competence	06	10.52

of science among Ashram school students. The tribal communities are usually dependent on the forest products and agriculture for their livelihood. It should be useful if the science curriculum provides them guidelines to make use of their resources optimally. Lack of hygienic habits is another problem worth-reckoning. It would be desirable if science curriculum attempts to tackle this issue. Because of the isolation from the mainstream, many of the communities are still unfamiliar with the recent technological developments. An attempt to acquaint them with the modern technology and equipping them to use the technology for their benefits would also be welcome.

Apart from the choice of the content, the teachers (19) have specific suggestions for the style of textbook presentations. Firstly, all of them have recommended that it should be written in a simple language palatable to the students coming from tribal homes. Secondly, it should have adequate number of examples and anecdotes to explain involved concepts. Thirdly, it should provide sufficient number of activities that can be easily performed in the schools. Lastly, it should suggest model questions to assess conceptual understanding of students.

In addition to charges in curriculum and textbook preparation, a substantial number of teachers have made suggestions for the change in teaching style. There were two specific suggestions made by the teachers. The first suggestion refers to relating science to daily lives of students. In order that students are motivated to learn the concepts in science, teachers suggested that the relevance of the content should be brought out clearly. To achieve this goal, teachers will have to make special efforts. Since the textbooks are written centrally, it will not be possible to refer to diverse experiences within the textbook itself. It would be the duty of a teacher to look for appropriate experiences and examples to illustrate or explain the concept at hand.

In the teaching of science, many teachers equate transfer of scientific information to the teaching of science. One of the main aims of teachings is the development of skills pertaining to scientific pursuit. Along with teaching of science, one needs to take into account teaching through science (Shayer and Adey, 1981). Some of the teachers have realised this need and hence suggested modification in the classroom interaction to put emphasis on skill development. In addition to providing opportunities in the classrooms, some teachers feel that deliberate efforts be made to provide out-of-classroom opportunities for learning and fixation of knowledge (Kawathekar and Agarkar, 2002).

Conclusion and Implications

The study referred to in the paper was conducted on a sample of teachers drawn from Ashram schools in Sahyadri ranges. There are a large number of such schools catering to rural population in the country. The study has raised issues related to curriculum, teacher preparation, assessment techniques, and school facilities, etc. All these issues are important as far as the teaching of science in Indian schools is concerned and need to be looked critically.

Framing of School Curriculum

Education is on the concurrent list of the State as well as of the Central Government. The main responsibility of framing curriculum falls on the central agency (National Council of Educational Research and Training). It usually makes available the framework of curriculum and sample textbooks for the consideration of the state governments. Some of the state governments accept the curriculum as it is, while some others adopt it to suit the needs of their population. The study brings out the fact that requirement of the tribal population are very much different from other population and this aspect must be taken into account while framing the curriculum. Rural people look at education with great aspirations to change their lifestyle. Some of them view education as a tool to remove superstitions; some view it as a means to provide bread and butter while some others look at it as a route to proper utilisation of resource. In the centralised mode of curriculum framing, all these aspects might not get reflected. These changes will have to be made at local level.

Teacher Preparation

In India, prospective teachers are expected to undergo training in education. At the upper primary level, teachers usually have Diploma in Education (D.Ed.). It provides general background for the teaching, taking into account the contemporary knowledge in educational psychology. It, however, does not prepare teachers to handle the special group of students like the one being considered in this paper. In the absence of understanding of the difficulties these students face, many teachers hurriedly conclude that the students have a lower Intelligence Quotient (I.Q). As a result, these teachers are so pessimistic that they go to the extent of making statement – "No change will bring these students into the mainstream". There is, therefore, an urgent need to change the attitude of teachers towards the educability of tribal students.

Moreover, there is always a change in the content of the subjects they are expected to teach. In case of science, the changes are prominent forcing teachers to deal with concept that they might have not studied during their school days. This brings out the urgent need for the in-service training of teachers. It has been found in many field programmes of the HBCSE that teachers demand for inputs in content as well as in pedagogy (Agarkar, *et.al.* 1997).

Educational Opportunities for Students

The school system referred to in this paper caters to a special group of communities that hardly provide suitable home background to undertake academic activities. Schools are expected to provide opportunities to compensate for this deprivation. Fortunately, there is a scope for undertaking compensatory measures since teachers and pupils usually stay together even after regular school hours. Students have a considerable free time at their disposal to undertake developmental activities. Some of the activities that have been referred by the teachers are the organisation of the picnic and taking students to outdoor activities. There is tremendous scope to channelise peer interaction making the children to undertake academic activities within the schools or out of the schools (Agarkar, *et.al.* 2002).

Bridging Policy and Practice

One of the major recommendations of the Education Commission Report (1966) was to teach science on compulsory basis up to the school leaving stage. Following these recommendations, curriculum guidelines were prepared and textbooks were written for primary, upper primary as well as for secondary level classes in the decade of 1970.The curriculum was basically discipline based where attempt was made to teach concepts in physics, chemistry and biology. In order that the students can handle these disciplines at the secondary level, the upper primary syllabus was used as a preparatory stage. The New Education Policy (1986), however, brought out the need for the teaching of science in an integrated fashion. Accordingly, new textbooks were developed highlighting the progress of science as a human endeavour for the pursuit of knowledge. As per the recent thinking (NCERT, 2000), science is to be coupled with technology as both of them usually go together. Efforts to bring out new set of textbooks based on this philosophy have been initiated by the National Council of Educational Research and Training (NCERT). Are the changes in policy transferred into practice? The study showed that many of the teachers do not have clear understanding of the aims and objectives of the changed science curriculum. In the absence of proper information, they continue to teach in their traditional way. Special efforts are required to ensure that policy gets implemented at the school level.

There is a standard mode of evaluation that is followed in the Indian school system. It is based mainly on communication. Pupils who have not developed adequate skills in written communication are often at disadvantages and perform at lower level than they deserve. This aspect is found prominent in case of technical subjects like science that make profuse use of technical jargon. What is required is to adapt different methods of evaluation. One suggestion pertained to oral testing and activity-based testing. These methods are seldom used in the testing at the upper primary level. Now is the time to review them to bring about improvement in the method of evolution.

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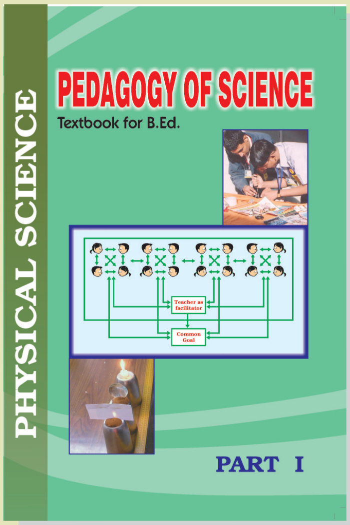

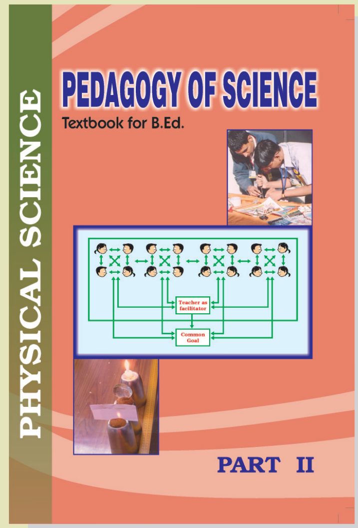

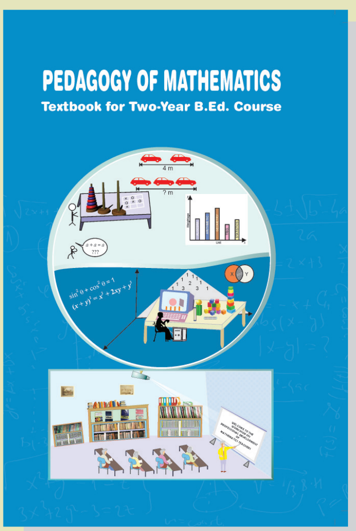

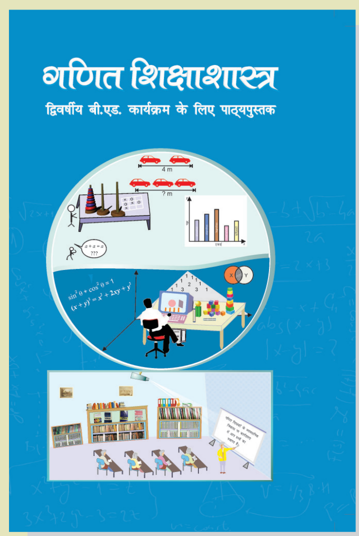

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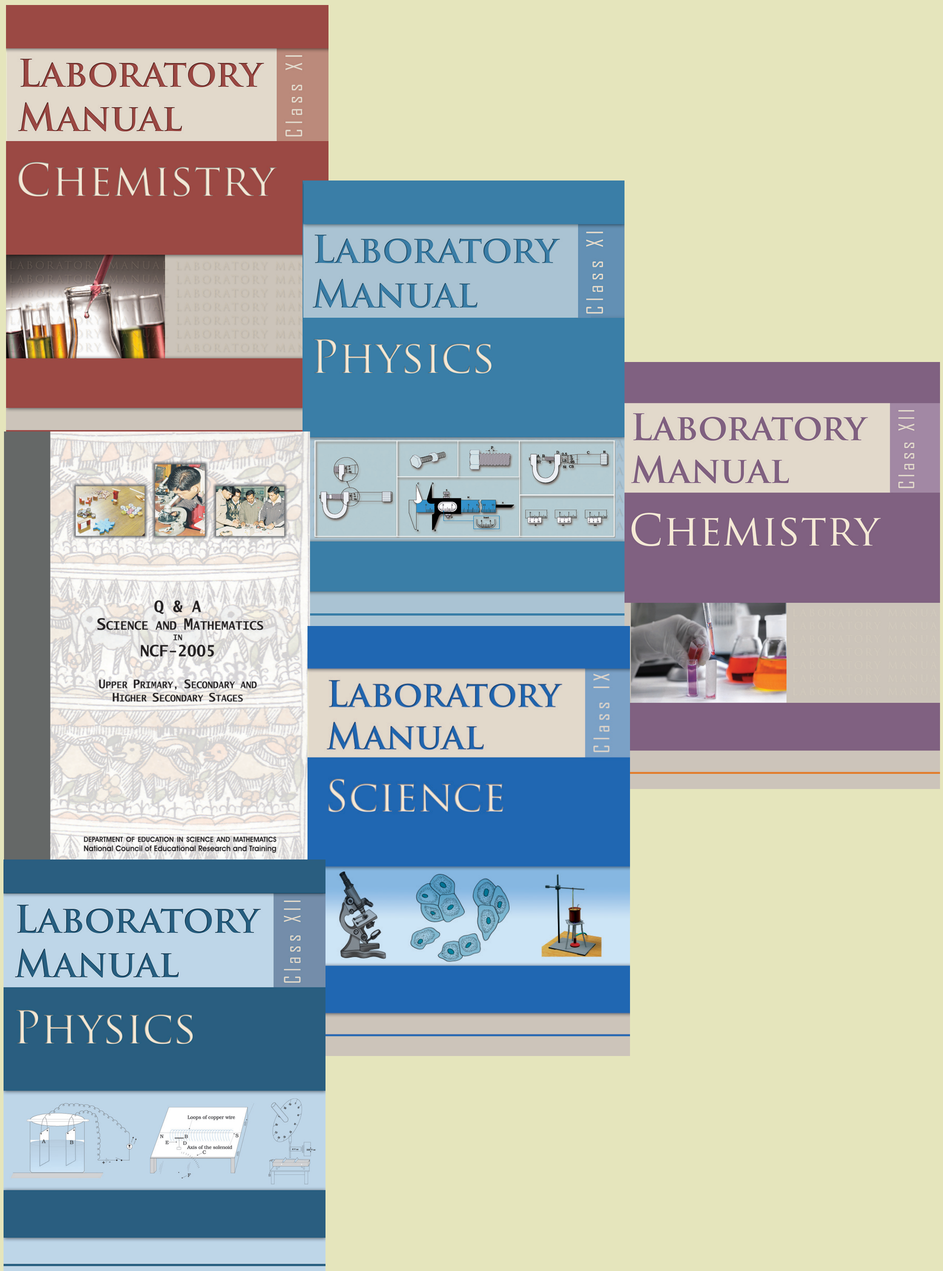

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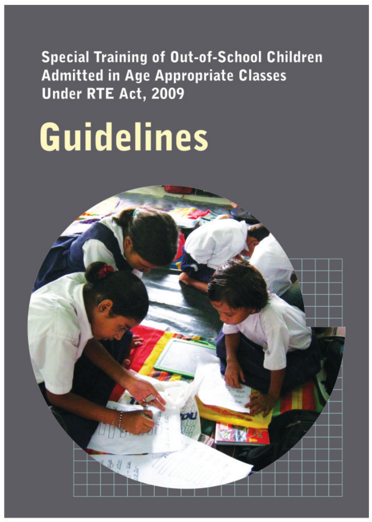

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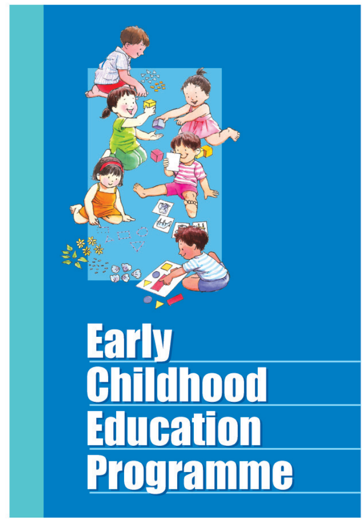

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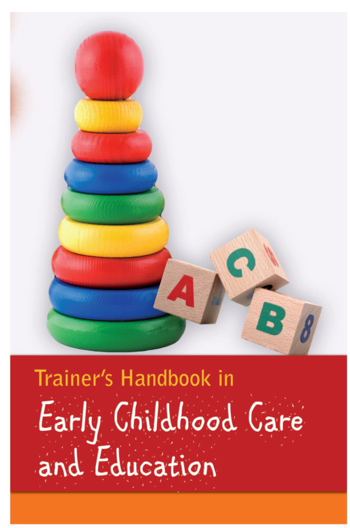

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