

## **CHAPTER 6**

### **SUMMARY AND CONCLUSIONS**

#### **6.1 INTRODUCTION**

This investigation has been carried out for evaluation of Science curriculum as it is being operated at the secondary school level (8th to 10th standards) in the schools at Varodara under implementation by the Gujarat secondary Board of Education since 1992. Briefly, the objectives for this investigation were to make an assessment of whether, and to what extent, the intended curriculum in science is being implemented in the secondary schools at Varodara in its transaction by the teachers. For this purpose,

- (i) a study was made of the intended and prescribed curriculum in science as given in the relevant documents.
- (ii) observations were made by the present investigator in the classrooms at Varodara (240 sessions).
- (iii) questionnaire covering the different aspects of curriculum evaluation was circulated to teachers (120 responses from 46 secondary schools were received). This was followed up by interviews with the teachers; and,
- (iv) textbooks and question papers were also evaluated. A summary of results from this investigation is given below.

## 6.2 MAJOR FINDINGS

The content analysis of the science curricular documents indicated that at secondary level, the main intended objective of science education is the development of scientific literacy in all its dimensions among the learners:

- (i) that the learners acquire scientific knowledge and understand nature of scientific knowledge;
- (ii) develop scientific temper and attitudes such as open mindedness;
- (iii) develop instrumental, communication and problem solving skills;
- (iv) an increased;  
awareness about ones environment and science- technology-  
society issues; and,
- (v) develop instrumental, communicational and problem solving skills. This objective was found to be in consonance with the present curricular trends worldwide.

Majority of the teachers (83%) indicated that the objectives of teaching science were precise. During the follow up interview on the questionnaire the other teachers (17%) said that one of the objectives is to develop scientific temper but how it was to be developed had not been stated in the textbook. Statements like cultivating social, moral, ethical aesthetic values are also not clear to them.

The shared view among the teachers about science curriculum intentions were the emphasis on imparting 'scientific knowledge' and, secondly, students' exposure to laboratory through simple experiments. About the rest of the curricular objectives, most of the teachers opined that students would acquire scientific temper, attitude etc., if they 'learn science properly' by which they mean as per textbook content.

Most of the teachers feel that 'scientific literacy' meant 'acquiring scientific knowledge'. Only about 5 to 10% of them are aware that it includes developing scientific attitude, scientific temper, problem solving skills and understanding of Science- technological- societal (STS) issues in the learners as specified in the intended objectives.

The teachers conveyed that the objectives of science curriculum which they consider significant are (a) the student should acquire scientific knowledge (laws, theories, principles etc.,) and (b) giving the learner an adequate exposure to practical work.

### **6.3 FEASIBILITY AND FUNCTIONALITY OF OBJECTIVES**

Regarding feasibility and functionality of the objectives, the teachers' response was that: Objectives are feasible (38%) and functional (45%) but 'not feasible' (29%) 'nor functional' (40%) with the rest saying 'partly feasible'. According to them, the objectives, which get taken care of in the classroom, are those related to

acquisition of scientific knowledge and manipulative skills (through practical work) as these are supported by textbook content.

Reasons for their opinion were:

- (i) that science at the secondary level is just one among other subjects;
- (ii) many students may discontinue with science, and emphasis was more on learning science content; and
- (iii) the objectives of development of problem solving skills, scientific temper, cultivation of social, moral and aesthetic values are less feasible as specific guidelines how to achieve or develop these are not available in the textbook content. It was significant to note that those teachers who opined that they are functional and feasible also mentioned 'time' and 'present class strength' as some limiting factors.

Regarding relevance of textbook content to objectives of teaching science, the teachers (70%) found the content to be relevant. The rest did not agree with this; they feel that the content reflected the objective pertaining to developing and understanding of scientific concepts and laws, but does not so other objectives such as developing scientific attitude and values, information about the historical development of science, relation between science and society, and neither does it help in undertaking any vocation or profession.

Analysis of the objectives of the prescribed science curriculum under study by the investigator showed that they have been formulated taking into account the demands and needs of the subject matter, society and national aims as given in the NPE-86 and revised in the year 1992. However an omission is that they do not state the process of achieving the same. This observation was also reflected in the teachers' responses to the questionnaire.

The curricular intentions thus need to be made more explicit by including ways and means of realization of their functionality and feasibility.

#### **6.4 INSTRUCTIONAL ENVIRONMENT**

While the intended objectives as given in the relevant documents were clear about spreading of scientific literacy, several teachers consider this to be the same as acquiring of scientific knowledge or facts and their reproduction by the learners. They expect that the classroom transaction as being practised now would itself provide them with understanding the nature of science and other skills as they learn scientific facts, solving of numerical problems and experimental work. This is a limited view taken by the teachers.

From this, it can be reasonably inferred that instructional environment is deficient in respect of development of scientific literacy among the learners. Some of the reasons in the investigator's opinion are:

- (a) lack of understanding of full import of the scope and meaning of ‘scientific literacy’;
- (b) concentration in the text book content on scientific knowledge in standard 9 but not spread over the three grades 8 to 10;
- (c) experimental work not being a tool for assessment at the examination; and,
- (d) time constraint to some extent contributes to this since in practice, only very few selected topics can be dealt with by following the activity- based instructional strategy.

The manner of introduction of lesson and its transaction is known to affect the response of the students to the instructional process (teaching -learning activity).

The observation of science classes in the present investigation indicated that:

- (i) Lecture method was used in 70% of cases, lecture cum discussion method in 10 percent and lecture-cum activity teaching strategy in 6% of the cases.
- (ii) Non-conventional approaches were observed in the remaining 14% of the classes (read aloud, reading aloud and translating into vernacular language, reading aloud with a brief explanation thereafter and again silent reading by the learners).
- (iii) Rightly or wrongly, a few teachers still feel that experimental demonstrations may tend to discourage the students from learning to think about abstract concepts.

- (iv) In majority of cases, 'teachers talk' predominates say for 26 out of 35 minutes taking a major part of the period without students' participation. In (6%), of the cases, the teacher-talk to student-talk was fairly evenly distributed (14-16 minutes); and the students actively participated in the development of lesson.
- (v) Teaching aids though available, are not generally utilised in the classroom. Figures, diagrams and tables in the textbook are considered relevant and adequate by a majority of teachers.
- (vi) In general, the students were attentive to the proceedings in the classroom but remain as 'passive listeners' throughout.
- (vii) The few questions asked by the teachers if any, were not for eliciting the extent of the students' grasp of the previous day's lesson, nor of the probing type but serve the purpose of introducing or ending a lesson.
- (viii) In none of the classes under observation, problem solving or inquiry-based teaching had been noticed. The learners are not assigned any project work.
- (ix) In all the classes, the language style used by the teacher was the same in which the textbook has been written. It is not simplified and conveyed.
- (x) The instructional activities obtaining in the secondary schools at Varodara in the classroom transaction are centred around the textbook.
- (xi) Child centred, activity-based learning approach, with the teacher acting, as a facilitator is the instructional strategy suggested in the intended objectives. The present classroom transaction is in contrast to this.

Regarding learners' participation, it was observed that :

- (a) With lecture method the students remained passive listeners and subsequent observation of that class by the present investigator indicated that the students rarely participated in the lesson in any other manner except in listening mode, and could not recall the lesson the next day.
- (b) In a few cases where the teacher created space for students' participation, the teacher did not need to dictate or discuss the answers to the end-of-chapter exercises. Also, these students showed a better grasp of the topic.
- (c) In the few cases where the lesson was introduced through activity, the students' response was more in terms of the number of the students ready to answer the teacher's questions about the activity; also, the next day when questioned, 70% of the students showed eagerness to provide the answer, compared to the poor response where lecture method was the only one used.

Teachers' opinion gathered about the appropriate transaction of the lesson showed that :

Ninety percent of the teachers felt that, it was sufficient to write the topic on the blackboard and they did not give elaborate introduction, as that would leave them very less amount of time for the actual lesson.

The lecture method was the most convenient to use as 'large chunks of information' could be conveyed in less amount of time'. Especially for standard



9, the course being vast, with a class strength of 45-50 they would not find it convenient to use any other approach.

The teachers consider this most suitable for transaction of scientific concepts.

Teachers provided the following reasons for the methods used by them for lesson introduction.

- (i) For easy topics like 'water' they do not want to lose time by involving students in developing the lesson.
- (ii) Course completion and revision get priority, as the students were to appear in the board examinations.
- (iii) In large classrooms it was not convenient to have discussions.
- (iv) A lecture comprising of 'teacher talk' only would help controlling the class; this also means that all students listen to the teacher and there was no possibility of students taking down incorrect information.

The teachers who used lecture cum discussion /activity method opined that involving learners in the classroom activity helped the students develop observation skills and critical thinking. They some times found themselves short of time. Most of the topics could be dealt with in lecture mode as these involved elaborate explanations about scientific laws and concepts, and that there were only a few topics where, students' participation could be maximised.

It emerges that in the teachers' opinion, only very few topics could be taught through the activity strategy for :

- (i) Want of time.
- (ii) Where explanation of concepts is involved, lecture method is still preferable and considered sufficient.

The teachers using non-conventional methods justified that:

- (i) These methods are useful as they ensure that the students would read the textbooks.
- (ii) The teacher can proceed to 'teach' systematically (as the textbook has given the content)
- (iii) Students need to memorise facts from textbook as given for the examination.
- (iv) This does not give scope to the students to complain that any portion of the textbook had been left out without teaching in the classroom.

It can be reasonably inferred that instructional environment is deficient in respect of development of scientific literacy among the learners. Some of the reasons in the investigator's opinion are:

- (a) Lack of understanding of full import of the scope and meaning of 'scientific literacy'.
- (b) Time constraint to some extent may be contributing to this since in practice, only very few selected topics can be dealt with by following the activity-based instructional strategy.

Use of available resources:

Laboratory work is an essential part of science education where learning by doing is the most essential process.

- (a) While the resources for laboratory work are admittedly adequate in several schools, this is organised by only 5% of the teachers.
- (b) In standard 9 however, where experiments have been specifically mentioned in the textbook, 20% of them organise laboratory work.
- (c) A double period allotted for practicals is generally used for correcting the notebooks or for teaching backlog if any, or for dictating answers to the end-of-chapter exercises.

All the teachers in principle agreed that science should be taught by 'doing' but doing only the specified list of experiments, which can be reasonably taken care of during the very limited time available for a practical class.

The reasons given for the low percentage were that:

- (a) Several experiments have been explained in the textbook clearly and may not need further stress.
- (b) No experimental work was listed in the content for standard 8 and 10.
- (c) No examination was to be conducted in practical work.

## **6.5 SCOPE FOR PROJECT WORK**

Almost all the teachers agreed that there was scope for assigning project work.

Various reasons elicited from the teachers for not organising the same were:

- (i) Syllabus is too large (100%)
- (ii) Lack of time (100%)
- (iii) Lack of interest shown by students (80% of teachers)
- (iv) Lack of material (20%)
- (v) Lack of space (20%).

The students regularly participated in science exhibitions organised for schools in Vadodara. Other supplementary activities organised were debates and seminars, science clubs and field trips. Mostly these are group activities.

Textbook being self explanatory with relevant and adequate diagrams, teachers do not feel it essential to ask the learners to consult the library or other sources.

## **6.6 ASSESSMENT**

Though curriculum document mentions that evaluation should be comprehended and not restricted to a learner's scholastic achievement alone, written examination is the only method used for assessment through class tests, term and annual examinations. This is considered appropriate by the teachers, as the learners should be able to write definition of terms, explain concepts, draw accurate

diagrams as given in textbooks and solve numerical problems. As per their experience, all these could conveniently be assessed through written examinations only, which can be used for assessment. Analysis of question papers also revealed that the questions are mostly designed to test the recall capacity of the learners about scientific concepts rather than their application. Apart from paper-pencil tests, other modes and sources of evaluation (assignments, projects, oral testing, etc.) proposed in the intended objectives do not find place in the classroom situation.

## **6.7 LEARNING OF PROCESS SKILLS**

According to the teachers, with regard to the development of process skills, students come across many instances of classification (of matter, elements, resources, living organisms etc.,) as well as that of observation in the textbooks and in the classroom.

In the teacher's overall opinion, the process skills developed through the present science curriculum at the end of the secondary school education are Classification (100% of teachers); Observation (100%); Hypothesising (nil); Interpreting data (10%); Questioning (10%); and Communication skills (No response from any of the teachers about this).

## **6.8 CAPABILITIES ATTAINED AT THE END OF SECONDARY SCHOOLING**

Curricular objectives in science state that the learners should develop scientific attitude, scientific temper and concern for STS issues thus leading to spread of scientific literacy. Teachers assessment of the capabilities expected to be attained at the end of secondary school education showed that in their opinion, the learners:

- (a) Acquire understanding of scientific concepts (100% teachers).
- (b) Develop problem solving skills (in the perspective of 75% of teachers, this refers to solving numerical problems).
- (c) Develop manipulative (handling of apparatus) skills (5%).
- (d) Help pursue higher education in science (30%).
- (e) Develop sensitivity towards environmental concerns (67% of teachers, mainly based on textbook content in std. 10).
- (f) Understand interdependence of STS (science-technology and society) issues ('NO'-59% and 'to some extent', 41% of teachers).

## **6.9 ASSIGNMENTS**

In ninety percent of cases, the assignments were based on end-of-chapter exercise.

Such assignments were of two kinds:

- i. Where a teacher would give the answers verbally or get them marked in the textbook and ask the students to write them.

- ii. Where teachers dictated the answers in the class and the students were to rewrite them in homework notebooks as these serve the purpose of the annual examination.

Factors considered by a majority of the teachers in the selection of curricular materials were:

- (a) The textbook content. They expect it to fully reflect the intended objectives.
- (b) Conveying factual information as given in the textbook for success of learners at the terminal examination.

#### **6.10 ORGANIZATION OF THE CONTENT IN THE TEXT BOOKS**

The content analysis of the textbooks at the secondary level indicated that content could be categorised as:

- (i) Content related to scientific concepts, laws and principles. (standard 9)
- (ii) Content related to conservation and preservation of environment, health, industry, agriculture and so on. (Mostly in standard 10)

The features observed are:

- (i) The chapters are not categorised into units and consequently learning objectives are not mentioned.
- (ii) The fundamental concepts precede the more sophisticated concepts in

accordance with the suggestions (NCERT, 1990).

- (iii) Though hierarchy of concepts has been maintained, the topic movement was not in accordance with the principle that it should be from 'concrete to abstract or formal concepts'.
- (iv) The continuity (sequencing) across the grade levels was not consistent. The topics appearing in grade 8 are mostly extended in grade 10 and not so to grade 9.
- (v) Inquiry approach is not evident in the textbook content. It acts merely as a source of knowledge. More probing, applied type of questions and exercises need to be included.
- (vi) In the textbook of Standard 10 however; the topics are so varied that each of the concepts do not seem connected sequentially. And are not directly related to each other.
- (vii) Considering the science textbooks for the three grades together, the content cannot be considered to reflect an integrated approach to science.
- (viii) Interdisciplinary or integrated approach is not evident in the textbooks. The natures of topics dealt are independent entities, and wherever integration is possible, it is not reflected.
- (ix) The course content provides a number of suggested activities and experiments, which would enable the learner not only to understand the concepts better, but also help him/her, conduct experimental work related to the scientific concepts.



- (x) A common feature regarding these activities and experiments noticed as provided for in the content was that the results of the same (experiments) were also given along with them. In other words, these were conclusive in nature.
- (xi) Across the three grades there are adequate number of tables, figures and graphs. Their relevance, quality, quantity, indexing and labelling are quite satisfactory and meet the intended objectives. They convey the information effectively.

#### **6.11 REPRESENTATION OF STS ISSUES IN THE TEXTBOOK**

Although STS issues have found their way into the textbooks, their representation needs to be improved by including more STS related information.

- (i) The STS issues are presented in a factual manner.
- (ii) Some of STS issues of national concern, such as, family welfare and impact of overpopulation on society, find no mention in the textbooks.
- (iii) A serious shortcoming of the prescribed textbooks in relation to the intended objectives has been the inadequate representation and not highlighting both the positive and negative aspects of science and technology on society.
- (iv) Topics related to conservation of natural resources, energy crisis and ecological imbalances need reorientation such that they may arouse the learner's involved concern for the same by citing examples from the region

(in the present case Gujarat State) in which the learners are located.

Some of the reasons for non-optimal realisation of curricular objectives in science at secondary level, which could be inferred from this investigation through classroom observation supported by both the questionnaire and interviews with the teachers, are:

- (a) Lack of full appreciation about the meaning of scientific literacy by a majority of teachers.
- (b) Lack of time (35 minutes periods) where only 5% of the teachers under observation could adjust and adopt activity-based teaching for selected lessons
- (c) Imbalance in distribution of content on theoretical aspects on scientific concepts presently confined to the 9th standard but not to the tenth, almost exclusively dealing with societal and technology, environmental aspects in the 10th without any lessons on basic concepts of science.
- (d) Very few probing or investigative but simple problem solving exercises in the end-of-chapter exercises.
- (e) Absence of practical examination at the secondary school level.

## 6.12 CONCLUSIONS

The teacher and the textbook are the two factors that have emerged out as the most important link between intended curriculum and its full realization. This study has concerned itself with these two aspects through real time observations in the classroom and obtaining of the opinion from the teachers. For several years to come, it is likely that both the teacher and the text book continue to be the most important and perhaps the only factors which govern classroom transaction, indirectly success at the examination being the goal that predominates the thinking of the teachers and learners (and the parents). This investigation has shown that in several cases, it is not lack of material resources like laboratory, library, charts and models that have come in the way of their optimum utilization, but lack of 'time' to complete the 'textbook content' and 'assessment' (success at the examination) that seems to have governed the transactional strategies to a major extent. This is sufficiently evidenced and reflected throughout this investigation whether it is classroom observation, responses to questionnaires and follow up interviews with the teachers or evaluation of instructional materials in relation to the objectives.

The overall assessment of science curriculum indicates that science curriculum has two aspects one that is the official curriculum secondly the operative curriculum which, results from teachers transaction in the classroom. The official curriculum was examined with respect to the structural features of curriculum components and

was found to be appropriate in terms of selection of objectives, content, recommend strategies. However, a wide gap between the intended curriculum and that transacted was observed. The transacted curriculum needs improvement in terms of instructional practices adopted and constraints of time and class strength. For any improvement towards better realization of intended curriculum objectives particularly the goal of spreading scientific literacy among the learners in the secondary schools at Varodara, as it emerges out from this investigation, the following factors need attention of the curriculum framers:

- (a) Re-framing of syllabus keeping in view the time factor of 35 to 40 minutes and the large class strength of about 45 learners in the classroom.
- (b) Improvement in the textbook content, especially with respect to a rational redistribution of scientific, technological and societal aspects among the three grades 8th to the 10th, retaining the sequence and balance.
- (c) Orientation programmes to the teachers about the Science curricular objectives and reiteration of the methods of their realization, with respect to instructional strategies.
- (d) Examination in practicals at least to a limited extent.
- (e) Inclusion of application type of questions (probing type) both at the end-of-chapter exercises, home assignments and in the examination question papers.
- (f) Suggested simple topics for project work for grades 9 and 10, which would be helpful in developing problem solving skills in the learners.

- (g) Demonstration of transactional strategies by teachers who are already practicing activity/ discussion based teaching techniques to other teachers.

Since laboratory facilities and teaching aids can be considered adequate in the secondary schools at Vadodara, it is hoped that with a little effort, improvements suggested above could be carried out which would go a long way in better realization of curricular objectives in science.