

CHAPTER 3

REVIEW ON SCIENCE EDUCATION

3.0 SCIENCE EDUCATION

Science is universal and knows no boundaries. It is future oriented and a disciplined way of seeking new knowledge, new explanations and a deeper understanding. For an education built upon reasoning, problem solving and experimentation, the scientific approach is considered to be particularly suitable. Science education is a part of the equipment and preparation for life so that the pupils may play their appropriate part in the community. Science education is introduced at the primary stage of schooling in the form of environmental studies comprising of the social, physical and biological aspects. In our country at the middle and the secondary stages science becomes an integral part of general education and is taught as a general science course. Science is taught as an essential part of school education up to secondary level because of the recognised need for developing **scientific literacy** (NCERT 1990). The essence of science is to develop a creative inquiring spirit. General Science education thus forms an integral part of school education because of the recognised value to the skills imparted to the learner through an exposure to the scientific method (Gould, 1982). Each individual needs to be equipped with a minimum of scientific knowledge, adequate to pursue his/her professional and personal life. The rapid

advancement of science and technology has made it imperative to provide a science-based education.

3.1 SCIENTIFIC ENTERPRISE AND SCIENCE TEACHING

Science is essentially characterised as a body of knowledge, which has accumulated over the centuries in the form of facts, generalisations, concepts, laws and principles. Science is also viewed as a method and as a way of investigating the natural phenomena. This refers to an organised way of understanding the phenomena and not making unsupportable guesses and inferences. Science is considered to be that human activity (Yager, 1984) which involves the integration of explorative and applicative modes by which one obtains an epistemological understanding of the world. The explorative mode refers to the descriptive and analytical collection of scientific knowledge through empirically validated perceptual facts. The application mode refers to the prescriptive application of an organised body of knowledge obtained by the explorative mode, which is used for the benefit of society.

3.2 CURRICULUM DEVELOPMENT IN SCIENCE

Science curricula have been mostly visualised as discipline based, laboratory based programs across the world. This trend persisted in early sixties and seventies and still continues. The subsequent decades saw the 'essentialist's retrenchment' to textbook curricula (Ramsey, 1993). The 80's saw the emergence of the

approach to incorporate the educational utility as well as the relevance of science (Hurd, 1985). This notion implied that science did not have to be only discipline structured; generalizable learning outcomes are as important for all learners. The inclusion of themes__such as personal needs, academic preparation, career awareness and societal issues have been advocated to broaden the scope of potential curricular and instructional contexts for science education (Harms and Yager, 1981). This approach differs significantly from the traditional conception of science education as discipline bound, content classified curricular material and course work.

Science education should be viewed not as 'education in science', but as 'education about science' (Yager, 1984). 'Education about science' implies science education as an act or process of providing members of a society with scientific knowledge, skills, competencies, as well as, socially and scientifically desirable behaviour. 'Science for all' has been mooted (NCERT, 1988, 1990) as the basis for curricular reform in order to equip the learners to cope with the rapid advancement of science and technology which have presently pervaded almost all aspects of human life.

3.3 SCIENTIFIC LITERACY

Today's science is changing in many ways. The focus has shifted from establishment of theories and laws on to the functional aspects of science

/technology as it relates to human welfare, economic development, social progress and quality of life.

Science is increasingly becoming holistic in nature blending the natural and social sciences (Hurd, 1998). It is seen as a civic competency required for rational thinking about science in relation to personal, social, political, economic problems and issues that one is likely to meet in ones life.

The body of knowledge in science is constantly changing. Science and technology play an integral role in today's society (Bybee, 1995) and therefore science curricula have to be modernised to meet the present and projected future needs. There is an increased awareness regarding the necessity for developing science curriculum, which not only conveys science as a body of knowledge but also incorporates the impact of science and technology on society. Accordingly, the goal of science education in the present curricula (NCERT, 1990) is to prepare scientifically literate individuals at the end of the secondary school education. The need to have STS (science- technology-society) as integrating theme in science programmes has been eloquently argued by its proponents (Harms and Yager, 1981; Yager, 1987). It has been realised that science education cannot be sequestered in the classroom or laboratory (either as a body of knowledge or as a method) but be an active part of the social milieu (Ramsey, 1993). Considering that all the learners may not pursue science at the higher level, it becomes imperative to meet the needs of both the science centred and non-science centred

learners (Hofstein et al; 1990). Their study has advocated scientific literacy with an emphasis on understanding of science-technology- society interface for a relevant science education. Scientific literacy has been recognised as an aim of science education by the Yashpal Committee (NCERT, 1990).

Science educators world-wide have identified social responsibility as an important part of science curricula, and the responsibility of producing individuals prepared to deal responsibly with science related social issues (Ramsey, 1993). The prime aim of the science curricula as recognised worldwide is to produce scientifically literate individuals (NSTA, 1982). Scientific literacy has been commonly accepted as the ultimate aim of science education (Cobern, et al, 1995).

The various dimensions of scientific literacy include a vocabulary of technical words of science and technology, i.e. 'functional scientific literacy'. Bybee, (1995) feels that this dimension has been over emphasised. Scientific literacy is thus not limited to vocabulary alone. It is desirable that the learners understand and relate information and experience to conceptual ideas that unify the discipline and fields of science. It also includes abilities and an understanding, relative to the procedures and processes that make science a unique way of knowing. This dimension refers to conceptual and procedural scientific literacy. Learners also need to develop perspectives about the role of science and technology in personal life and society (Yager, 1993). This is visualised as multidimensional scientific

literacy and also includes the history of scientific ideas, nature of science and technology.

One of the views of scientific literacy presented by Harms and Yager, (1981), has been based upon four independent goal clusters: Personal needs, societal issues, academic preparation and career awareness. This approach implies that the content of science curriculum should be directed at personal, societal and discipline focussed outcomes. Another view about scientific literacy (Pratt, 1983) includes the following three aspects: understanding the scientific approach, understanding basic science concepts and understanding the basic science policy issues.

Scientific literacy has also been defined through the identification of the attributes required of a scientifically literate individual (Chiapetta and Collette, 1984). They are:

- i. Substantial knowledge of facts concepts, theories of science and ability to apply them.
- ii. Understanding of the nature of science.
- iii. Positive attitude towards science and technology and understanding of the inter-relationship of science technology and society.
- iv. Ability to use the processes of science to solve problems and make decisions in daily life.
- v. Acquisition of science process skills that permit an individual to function in work, in leisure and in society.

Seven abilities have been identified for a scientifically literate person by Yashpal Committee. These include: Ability to understand the nature of scientific knowledge and apply the same in interacting with the environment, use the process skills in daily life situation, understand the joint enterprise of science, technology and society, continuation of science education throughout life and development of manipulative skills (NCERT, 1988).

3.4 SCIENCE, TECHNOLOGY AND SOCIETY

A major attribute of scientific literacy is the understanding of Science – Technology – Society interface. STS is one of the more recent trends in science education. It focuses on the various aspects such as: science related social issues, the history and philosophy of science and technology and the presentation of content in relation to science and technology (Hurd, 1985). The inclusion of STS education in science curricula is expected to help the learners develop the knowledge, skills to take responsible action on the myriad of social issues facing human kind (Rubba, 1990).

STS issue based instruction is considered to offer an alternative to sterilised classroom experiences of the traditional curricula and instruction. The traditional discipline which mainly focussed on content without its social context is considered static, (Flemming, 1989) and the STS issue is seen to offer the greatest potential for capturing the dynamic interplay of science and technology. In his

view traditional science curricula limited themselves to academic preparation of learners, with the students mastering content knowledge in text and through lecture, or solving defined problems in the laboratory. On the other hand STS perspective offers multidisciplinary instruction uniting the knowledge and processes of science and personal and societal decisions. STS' movement provides a framework for designing new science curricula (Hurd, 1998) relevant to the life of every student. It is being considered that the nature of general education in the sciences needs to be consistent with the culture and practice of contemporary science and social issues (Curriculum Newsletter, 1997).

3.5 SCIENCE TEACHING

The teachers of science have the challenging task of involving the students in scientific enterprise through science teaching. The science courses should be so structured and taught so that the nature of science pervades curriculum. Science teaching should stress the different aspects of science such as science as a body of knowledge, as a method and as a way of thinking (Chiapetta and Collette, 1984). The kind of activities provided in the classroom by the teachers should enable the students to understand the nature of science and scientific enterprise.

3.5.1 The Logical Plane

Successful science teaching needs to consider the following planes of activity (Stinner, 1992). The logical plane refers to the finished products of science such as laws, principles, models, theories and facts. The fundamental questions in this plane is "What is (are) the operational definition(s) relevant to the concept(s) This question is relevant as it determines to what extent the activity on logical plane relates to the evidential plane.

3.5.2 Evidential Plane

This plane refers to the experimental, intuitive and experiential connections that support the knowledge from the logical plane. The important points to be considered are critically examining the evidence that 'makes sense' to the student (by students themselves) and secondly, the numerous diverse connections of the concept(s) in question. According to Stinner (1992) for students to acquire firm understanding it is important to show the validity of concepts in disparate (seemingly) areas of scientific inquiry as well as the diverse connections of the concepts. This is proposed to be achieved by providing students examples from daily life and their own experience.

The advent of scientific literacy has led to an increased attention being directed towards the philosophical understanding of nature of science as well as the personal and social dimension of scientific knowledge (Driver, 1988). A constructive approach to teaching science has been advocated whereby the

teaching of science is an active social process of making sense of the world and helps students to understand and interacting with their environment (Lorsbach and Tobin, 1992).

3.6 TEACHING STRATEGIES

An important approach recommended to be used for teaching science is through inquiry. Most of the science educators also agree that this approach best suits the nature of science. It is considered that "Inquiry" method embodies all aspects of the definition of science mentioned above. Inquiry approach stresses the investigative method of science (Bruner, 1961) that can be useful not only to scientists but also for everyone in daily life. The appropriate use of this method is expected to encourage students to think, to question, figure out, hypothesise and experiment. This method is also considered to help students to explore, discover and cultivate inductive reasoning. The act of discovery means figuring out something for oneself (Bruner, 1961). In the learning and understanding about scientific phenomenon, it is essential for students to discover for themselves the pattern, the relationships etc. for a better understanding of the concept (Chiapetta and Collette 1984). However some problems with this approach identified by them are: a lot of time is required: secondly a lot of space and materials are required. Guided approach has been suggested as one way of reducing these constraints in this kind of learning in small groups. They suggest that teachers can effectively guide students' thinking through verbal interactions.

1. Classroom Demonstrations

One of the methods of instructional strategy used in science classrooms is demonstration. They help in clarifying concepts and gaining students' attention. Demonstrations can be used to initiate thinking to formulate problems, to review a point and to introduce a lesson, a principle or a concept (Siddiqui and Siddiqui, 1988). A demonstration when presented to the students for the first time will allow the students to search for explanation and initiate student inquiry. The demonstrations serve as concrete techniques that can illustrate science concepts, principles, and laws. A carefully planned demonstration provides stimulation for classroom discussions.

2. Science Projects, Fairs and Field Experience

Activities in science are not to be limited only within the classroom but should extend beyond that. Various activities like science projects, fairs, and field experience find a definite place in the science curriculum. Science needs to be taught in such a manner so that the students perceive it as a dynamic activity (Chiapetta and Collette, 1984) rather than as a static body of knowledge to be memorised and reproduced.

i. Science Projects :

Projects have long been recognised to offer more scope than laboratory exercises. They provide students a chance to take up a problem and work towards a solution in an extensive manner. The project method involves investigation, discovery and finding out something, which the student might not have known before. An investigation is much more than repetition of a standard laboratory experiments. It also offers an opportunity to the students to involve themselves in the process of science like hypothesising, collecting data, inferring, experimentation, seeking more information, verification and communication (Yashpal et al., 1990).

Here the students have to decide what experiments are necessary and how they intends to proceed to carry them out; they may have to design their own apparatus if that is not available and search for the appropriate principles, laws and formulate and originate solutions to the problem (Morrisson and Mc Intyre, 1969). They opine that this method helps to create interest in science, develop abstract and concrete scientific skills, promote curiosity and develop scientific temper in the learners.

ii. Science Fairs :

Science fairs are occasions where students get the opportunity to study different problems, make models, display them, exhibit their creativity, communicate their findings to viewers and interact with them. Through this activity, students get an

opportunity to present their work, explain the principles, involved, support and defend their findings, correct themselves if necessary. Ideas are also exchanged between their own colleagues and the visitors.

iii. Field Trips :

In field trips, the students' interest is motivated. Instructional activity in the field settings make students aware of the organisational aspects and help them to link science with the first hand study of many things that they come across which cannot be brought to classroom (Chiapetta and Collette, 1984).

3. Lecture, Discussion, Recitation Strategies

The most commonly adopted method in the classroom is the lecture method. It has been one of the traditional methods of instruction. Lecture method can be adopted when information has to be conveyed to large number of people (Flemming, 1989). A well organised and planned lecture serves excellently to review and expand content, developing insights and explaining. It helps present science as a selectively and sequentially organised body of knowledge. This is viewed as a teacher structured method where the learner plays a passive and minor role. It has the advantage that it helps knowledge to be imparted in a lesser time and allows the teacher to proceed in a systematic and logical manner. This method is considered useful (Thomson, 1972) when some new topics are to be introduced or abstract concepts have to be taught.

The use of discussion in the instructional process is a powerful strategy to effect cognitive and affective gains in the learner. They can also promote inquiry and develop problem- solving skills (Chiapetta and Colette, 1984). Discussions help promoting exchange of ideas and come to an in depth understanding of concepts, topics and issues. The discussions, which are directed to solution of problems, facilitate cognitive gains such as critical thinking, inquiry and process skills.

4. Use of Teaching Aids

Teaching aids facilitate the illustration of points made during a discussion or a lecture. These can be used to clarify some points, presenting information, initiate discussion as mentioned below.

Chalk Board: It is the most commonly used medium and available in all the classrooms.

Charts : Science teachers make use of charts, which depict diagrams depicting various processes.

Models : Some times scaled models or otherwise are used to depict certain objects, which are not easily available or accessible to the teachers.

3.7 QUESTIONS IN CLASS ROOMS

Questions are an integral part of teaching and learning . The use of 'good' and 'appropriate' questions has been found to be useful on bringing about conceptual changes in science, elicit student explanations, elaboration of previous answers and ideas, and predictions that contradict student's intuitive ideas about natural phenomena (Carlsen,1993; Smith et al. 1993, Roth 1996). Teacher's questions can be considered in a framework composed of the features-- context, content and, responses and reactions to questions (Carlsen, 1991).

Science depends on the ability to ask good questions. Questions such as what, why and how lead to understanding the natural phenomenon and are responsible for initiating research or investigations. Science is also viewed as a way of thinking. There are many ways to obtaining information and how this information is interpreted.

The analysis of questions with respect to content refers to determining the specific instructional intent for asking questions such as, questions to introduce the lesson, help in progress of lesson, and evaluation of students.

The teaching of sciences involves the acquisition of canonical knowledge and the process skills. Questions asked by teachers need to address these aspects. *Content* of the question refers to the teachers need to elicit student explanations, elaboration of previously learnt ideas, knowledge and answers (Smith, et al 1993)

such as knowledge related to natural world, processes of science (classification, formulation of hypothesis, testing of information) and finally what students learn (Lemke, 1990; Roth, 1996).

Response and reaction refers to the wait time given to the students to reply, and manner of reception by the teachers.

3.8 ASSESSMENT

Assessment is considered as an integral part of teaching learning process. The assessment procedures adopted need to be in consonance with the approaches of teaching the particular subject area (Collins. 1992).

In the case of science curriculum, assessment procedures need to address the learner's understanding (Collins, 1992) about:

- (i) a body of content ranging from definitions of terms to conceptual structures that explain and help in interacting with environment;
- (ii) the use of process skills and an array of thinking skills ranging from construction of accurate and rich descriptions of natural events to being able to ask questions and problem-solving and
- (iii) social implications of science, STS issues and the influence/ contribution of science to society.

According to NCERT (1990) the evaluation in science has been expected to reflect the objectives of teaching science viz., acquisition of science concepts, use of scientific method, instrumental skills, and understanding of STS issues.

A variety of procedures have been recommended to gather evidence about students assessment like reports and records of pupil activities simple projects, written work and tests.

3.9 SCIENCE TEXTBOOKS

The use of textbooks is universal but their use in school routine and symbolic function varies. The textbook here represents a collection of lessons, which the teachers have to teach sequentially. In science, the textbooks are expected to provide the student with a link between what is considered an 'established scientific fact' of the topic and the concrete level of evidential and experimental support given to it. (Stinner 1989; 1990; Hewitt 1990).

Textbooks in science are ideally expected to deal with 'why', how and 'what' of the topic/concept in question, help see the connection between science content and students experiences and also be able to highlight the relationship between concepts and topics (Aufshnaiter, 1989) .

According to guidelines of NCERT (1990) the science textbooks are expected to reflect the unity of science through interdisciplinary approach. Other important expectations about science textbooks come from the principles of selection and

organization of content (Armstrong, 1989, Barrow, 1984). The content is expected to be arranged in a sequence where the abstract/formal concepts are preceded by concrete materials, contain adequate number of activities relevant to content and, be suitable for the learners in terms of the language and explanation of concept and arouse interest.

3.10 SCIENCE CURRICULUM UNDER STUDY

The science curriculum being evaluated in the present study is the one designed by the Gujarat Secondary Education Board. The science education programme was revised based on the recommendation of NPE-86 and the new syllabus implemented at the secondary level in the year 1992. The guiding principles of curriculum development were as follows:

3.10.1 Stated Objectives

The objectives of teaching science at the secondary level have been given as:

Acquire an understanding of scientific concepts, principles and laws.

Develop scientific temper and scientific attitude such as open-mindedness, intellectual honesty, respect for human dignity and courage to question.

Develop instrumental, communication and problem solving skills.

Cultivate social, ethical, moral and aesthetic values which exalt and refine the life of the individual and the society.

Appreciation of the contributions of the scientists and develop sensitivity to the

possible uses of science and concern for a clean environment and preservation of ecosystem (NCERT, 1990).

3.10.2 Content

Based on the recommendation 'Science for all', the curriculum organisation stresses mainly on the integrated approach (NCERT, 1990). The content is expected to further the learner's understanding of basic structure and principles of science with special reference to the relation of science to agriculture, industry and technology. The teaching of science is expected to develop an insight into health and environment, Scientific method and processes with a focus on problem solving aspects.

3.10.3 Instructional Strategy Recommended

The instructional strategy emphasised are the child centred and activity based learning approach (NPE –86). The recommendation is that the teacher should act as a facilitator of learning with the child at the centre of the teaching-learning process, and help the learner in collecting information, its verification, and in other processes such as drawing inferences and conclusions. It has also been proposed that instruction be individualised to optimise the learner education. This would mean adopting a variety of instructional strategies (projects, experiments, and lab work) to realise this.

3.10.4 Assessment / Methods /Methodology

Evaluation of attainment and performance are an integral part of planned education. It has been emphasised that evaluation should be comprehended and not restricted to a learner's scholastic achievement alone. The necessity to use other modes and sources of evaluation (assignments, projects, oral testing, etc.) has been proposed instead of relying only on paper-pencil tests.

3.11 REVIEW OF RESEARCHES

The review revealed that most of the researches pertained to instructional strategy for teaching science. Hopper (1982) studied the effectiveness of modular approaches. The findings indicated that the modular approaches used were effective in terms of mean gain in the cognitive achievement. However self-learning approach was found to be more effective. Adinarayana (1979) tried to develop competence criteria for the skills in operational form to construct learning packages suitable for average children in an ordinary classroom situation. The study also attempted to determine the advantages of learning through packages by individuals and groups. It was found that the performance of experimental groups taught through packages was significantly better than the control group taught through conventional methods. Prakash (1976) tried out a workbook in science for standard six students. Gurumurthy (1990) found that the guided discovery approach superior to the instructed performance when it came to the development

of cognitive abilities and practical skills. Begum (1990) showed that more than sixty percent of teachers found the content in the new syllabus not only quite new but also overloaded and that the most dominant method teaching used by them was through the dictation of notes. Goel and Agebi (1990) reported that the acquisition of psychomotor skills favoured the group, which followed the individual laboratory method rather than the lecture cum demonstration method. Arunkumar (1985) found that the prescribed chemistry curriculum and its execution through a dynamic model of instruction positively affected the combinatorial reasoning of the students. Das (1992) found that the self-learning packages with or without teacher's supervision were more effective than regular teaching. Shahjahan developed modules for teaching science and found them more effective than the conventional methods. Khalwania (1986) found that the concept based curriculum than the traditional curriculum in developing process skills. Anjaria studied the effectiveness of the systems approach by preparing an instructional model on the unit of light and found it more effective.

The researches related to the curriculum evaluation were found to be meagre and limited in their focus but were quite useful in identifying the tools for the present study. Bhattacharya (1984) investigated the position of science education in the states of Assam and Meghalaya using tools such as questionnaires and interviews. Muddu (1978) used a questionnaire and evaluated the facilities provided to the teachers such as labs, audio-visual aids and the type of instruction adopted by the

teachers. The main objective undertaken by Singh (1976) was to evaluate the science education of standard eight and modify it to make it achieve skill-oriented objectives. The evaluation was undertaken through use of questionnaires and interview. The modified curriculum was found to be more effective. Shantidesai (1986) investigated into the various aspects of science teaching such as sufficiency of teachers' qualifications, understanding of the course content workload, practical work and methods for evaluation. The tool used was the questionnaire. The findings indicated that the scientific knowledge in the text was suitable in day to day life and that teachers were not specialized to teach science and schools did not have science clubs. Goyal (1982) made a study of the science curriculum of Rajasthan and the one prepared by C.B.S.E. and suggested that curriculum needs to be structured as per historical, social, and cultural influence of science on society.

In the study by Menon (1986) which studied the science curriculum for the secondary schools from the perspective of scientific inquiry, a significant finding was that the curriculum guidelines percolate down to the practicing through the textbooks. Krishnan (1981) made a comparative study of science curriculum of Karnataka and Tamil Nadu and found them to be moderately satisfactory. A few studies were related to the curriculum development also. Ramesh (1984) developed an objective based science curriculum to improve the efficacy in the acquisition of process skills. Ansari (1984) constructed and standardised an

achievement in science for children studying science through the Hindi medium.

There were studies on textbook analysis Joshi (1972) examined the contents of the general science textbooks and found it suitable for the pupils. Gopalkrishnan made

a critical analysis of the textbooks to find out the constraints in implementing the syllabus. The tools used were the questionnaire and interview. Sivadasan (1988) showed that the relevance of science club activities for significant gains in composite performance when linked with classroom teaching. Rao and Gupta (1990) surveyed science labs in the states of Maharashtra and Rajasthan and the overall situation to be favourable although much was not known about their use Malhotra (1988) investigated the existing facilities for science in the Delhi schools and found them favourable. Rao made a comparative study of scientific attitude, aptitude and achievement and found them to be related to each other. Research regarding the teacher's conceptions and their classroom practice by Gess-Newsome and Lederman (1995) found that teaching is affected by their conception of science. The research by Brickner and Bodner (1992) indicated that classroom practices are influenced by the institutional constraints and the pressure to cover the content in the given time period.



3.12 NEED FOR PRESENT STUDY

The above review shows that it is both purposeful and essential to know how a prescribed curriculum in vogue is being translated, whether the objectives are being fulfilled, if so, to what extent, how a prescribed curriculum gets transacted in the actual teaching-learning situation, to examine and evaluate the teaching strategies employed, whether the content development is continuous and suitable for the learner and facilitates the fulfilment of curricular objectives and the nature of evaluation methods employed. It is also imperative to find out about the adequacy as well as the provision of the required teaching resources such as teaching aids, laboratories, library, instruments, etc.

A study of the different aspects of curriculum evaluation shows that it addresses itself questions such as worthwhileness of objectives, the extent to which these objectives are attained, the efficacy and adequacy of educational experiences offered (the manner in which the curriculum is translated), the adequacy of material resources, the worth of curriculum materials like textbooks, guides, etc. and finally the methods of assessment.

The present science curriculum followed in Gujarat schools under study was implemented at the secondary stage starting from the year 1992. The new syllabus had been framed keeping in view the curricular recommendation of NPE-86 which required the science curricula to focus on achievement of scientific literacy. It was

of interest to explore the manner in which the newly implemented science curriculum manifested in the schools and classrooms, the opinion of the teachers and their understanding of scientific literacy, the support provided for sustaining the science curriculum in terms of resources and text books and the approach to evaluation of students.

The review of researches also indicates that, most of the studies have concerned themselves with textbook evaluation, determining the efficacy of a particular (or more) instructional strategy(ies), comparison of the planned curricula and development of curricula. Very few studies have been related to evaluation of the entire curriculum. The review also indicated that influence of classroom organisation, of what knowledge is taught and how it is presented, has not been explored adequately. The trend report (NCERT, 1992) also indicates that this area of science curriculum implementation still needs further research by focussing on classroom transaction (Vashishta and Ganguli, 1991). It also became evident that the science curriculum currently in use in the secondary schools of Vadodara had not been evaluated. It was also realised that evaluation in science curriculum had not been approached from the perspective of scientific literacy. The role of teachers also needs to be adequately explored in relation to curriculum transaction, as this does not appear to have received sufficient attention.

3.13 RESEARCH QUESTIONS

For the purposes of this investigation, certain points based on which questions can be framed and answers sought during the investigation which would assist in evaluation of science curriculum.

I. Exploring Science Curricular Objectives :

Objectives of teaching science can be considered to be the guideposts of the science curriculum. These have to be considered in the context of their clarity, significance, teachers understanding (of the objectives) and their significant role in guiding curriculum transaction. The following questions arise in this context.

What are the values, images and practices associated with the teaching and learning of the present science curriculum as can be constructed from the intended objectives of teaching science?

Do the teachers possess a shared understanding of the intended objectives of teaching science?

Do the objectives as framed, serve their functional purpose of guiding the selection of curricular material and transacting the same?

Do the teachers find the objectives significant with reference to the nature of science (disciplinary nature of science) and learner's requirement of science

as a part of general education at the secondary level?

Do the teachers possess an understanding about the thrust on scientific literacy?

II. Exploring the Implementation (teaching-learning process) of Science Curriculum in the Classroom:

This forms the main focus of any study in curriculum evaluation whereby issues related to nature and role of teachers and students in the teaching-learning process are involved.

What are the common instructional strategies adopted by the teachers and how are these justified by them?

What is the rationale behind the selection of a particular strategy

What are the factors considered by the teachers in the selection of curricular materials?

Are the available resources put to optimum use in the teaching?

How do teachers use material to facilitate student learning and student involvement in learning?

Does the instructional environment facilitate the learner to construct a meaningful understanding of the nature of science, develop scientific attitude and scientific temper?

Does the instructional environment facilitate all aspects of the development of scientific literacy?

What are the criteria for assessing student outcomes?

III. Exploring Contextual Factors (in curriculum implementation in the classroom) :

Curricula get implemented in the schools. A curriculum study requires that schools be understood as organisations, which have their individualistic environment. The contexts in which science teaching and learning occurs need to be considered. The nature of interaction among the teachers, the values and beliefs of the school as a system, practices and support need to be studied. (Shymansky and Kyle, 1992)

Do teachers of the schools share a common understanding about the desired outcomes of the curriculum?

What are the specific and general constraints articulated by teachers?

What is the nature of support offered (library, time scheduling, material resources) by the schools for the implementation of the science curriculum?

IV. Exploring Factors Affecting Implementation:

What are the constraints, which affect the implementation of intended curriculum in science?

To what extent are the objectives of the science curriculum reflected in the teaching-learning process?

To what extent do the teacher's conception of the nature of science; teaching and curriculum affect full realisation of curriculum as envisaged?

Do the assessment practices affect the implementation? (Intended outcome)

Do the curriculum materials support the implementation of Curriculum in science at secondary level?

These are typical and representative aspects on which answers are to be elicited in evaluation of curriculum keeping the classroom transaction and its observation as the main focus of the study.

With reference to the research questions, the objectives for the present study are as follows:

1. To study the intentions of science curriculum at the secondary level under operation in schools at Vadodara.
2. To study the curriculum transaction in science in the classroom situations in schools at Vadodara.
3. To gather the teachers opinion about the different aspects of science curriculum (objectives, instructional practices, text books, and constraints, if any) through class room observation, questionnaires and interviews.
4. To evaluate the congruency between the intended and transacted curriculum.

To achieve these objectives, in the framework for determining the methodology, two major dimensions of curriculum namely the structural and operational were considered (Fig. 1 & 2).

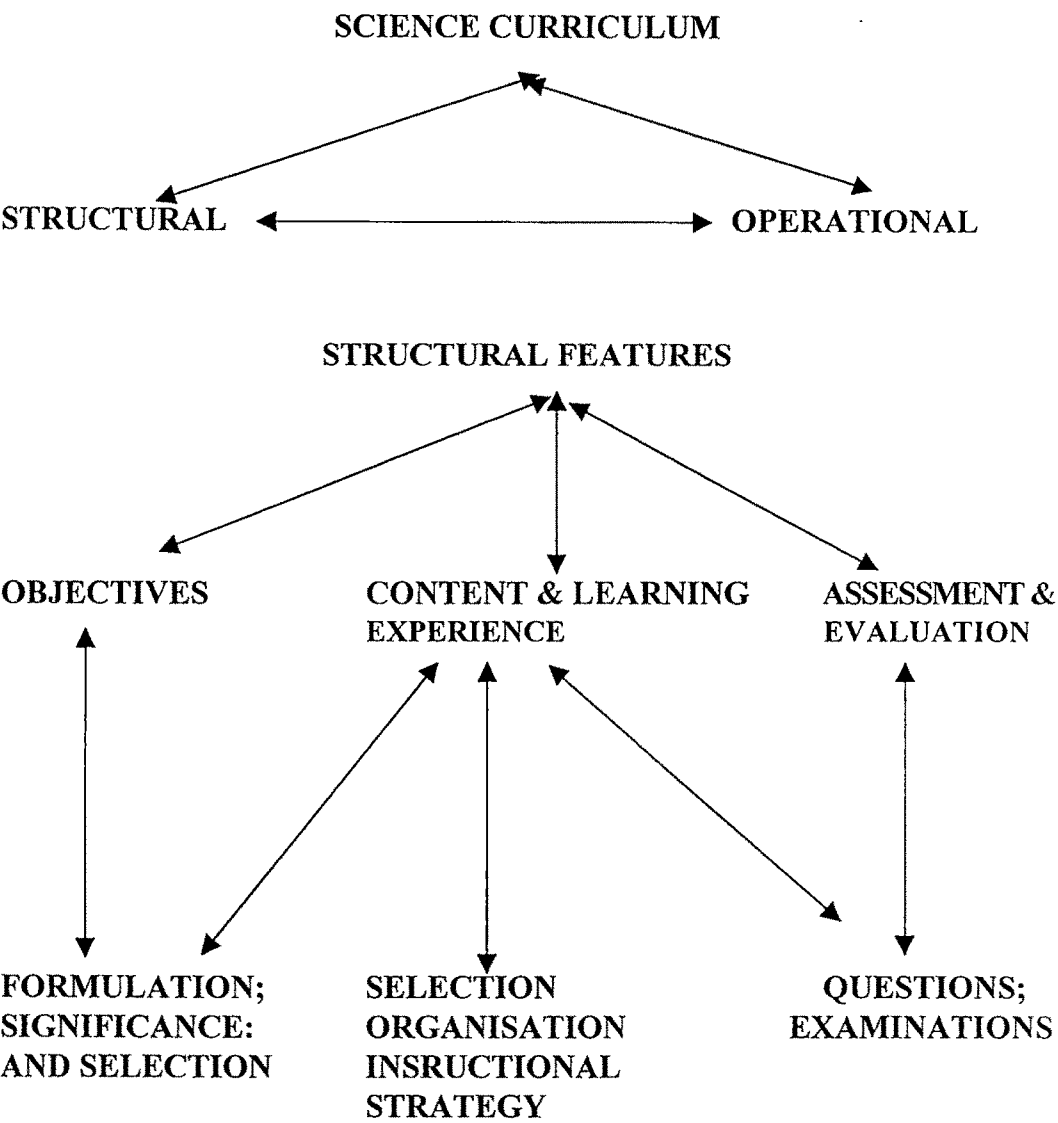


FIGURE 1 : STRUCTURAL FEATURES OF CURRICULUM

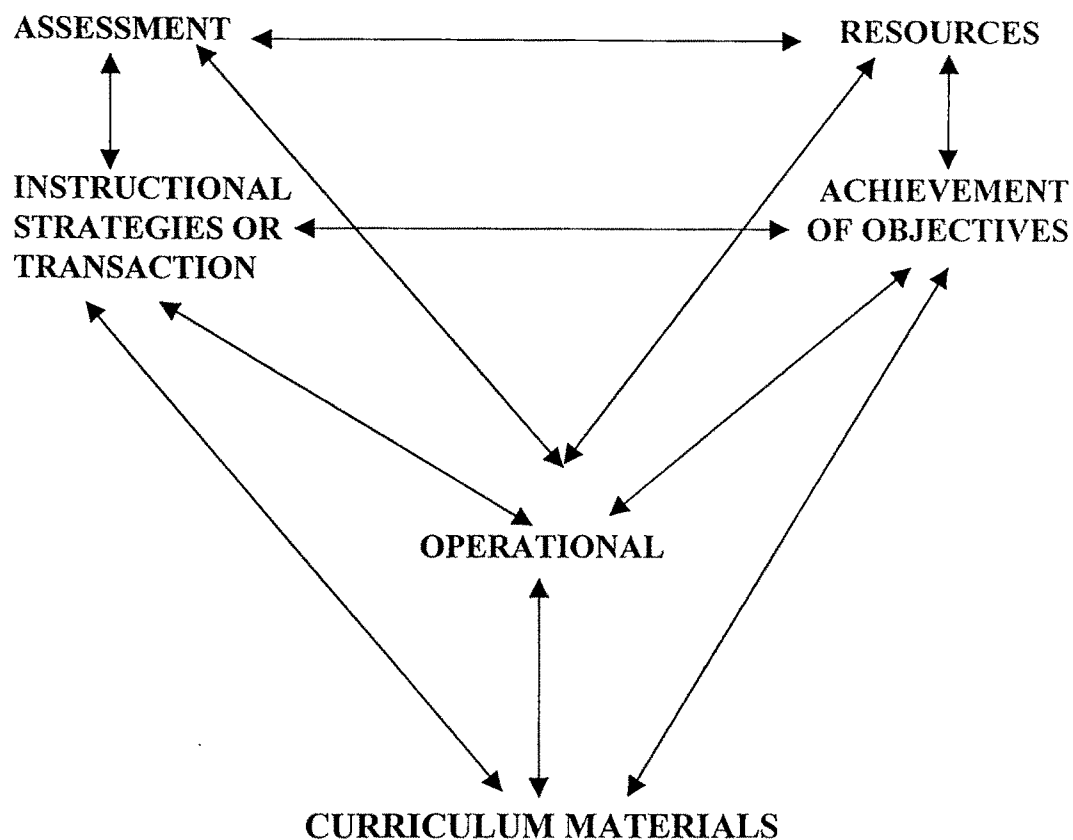


FIGURE 2: OPERATIONAL FEATURES OF CURRICULUM

The structural dimension refers to the study of the objectives of science education, the selected content and recommended instructional strategies and assessment methods for the secondary school science education.

The operational aspects refer to the curriculum as it manifests in the classroom through transaction in the natural environment.