Chapter – II

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2.1 Introduction
Curriculum is a dynamic component of the complex phenomenon of education which itself keeps changing in response to the needs and values of life in any society. Thus a full understanding of the curriculum can never be achieved by analyzing it in isolation from the changing historical context of education. The current practices reflected in any curriculum should invariably be seen as molded through past events and experiences. It is quite evident that the curriculum for secondary education specially for secondary physical science education in Tripura State, a small state of India, in its present form did not emerge in a day. It looks its present shape with respect to contents, practices, structure, organization and quality through a long process of evolution. A number of past events and factors have had their direct or indirect influences on growth and development of secondary physical science school curriculum in Tripura. Therefore, if the researcher is earnest about studying the present curriculum of Tripura as a model, he cannot neglect the sphere of earlier thoughts and influences from which the curriculum has developed into its present form.

Keeping the above consideration in view, a brief historical account of curriculum innovations with particular reference to secondary physical science has been presented in this study.

2.2 Historical Development of Science Education and Its Curriculum.

With a long and chequered history of education and training in pure and applied sciences dating back to over 2,600 years, India has had flourishing tradition of scientific research and technological development. Taxila (6th century BC) one of the earliest universities in the world, attracted students from across the continents. Major fields of study at Taxila included mathematics, astronomy, medicine, surgery and metallurgy. Unfortunately, most of the knowledge was lost during the medieval period. The glorious tradition of original thinking, adventure of ideas and creative innovations was completely snapped.

2.2.1 Science and Science Education during the British Rule.
Modern age is the age of scientific advancement and technological progress. Science the advent of science, the entire thinking mode of living, working conditions and systems of education has undergone a revolutionary change. As a result of scientific development, the mysteries of nature are being revealed to making every day and things considered so far the symbols of supernatural powers are gradually passing under the control of man. The development of modern science in India is not an organic extension of the earlier tradition. It is an implant by the British in a language that was alien to its people. As with other implants, it needed nourishment and nurturing to be absorbed in the society. Science education was lacking and science was looked upon as an appendage thrust by the British for their own benefit.

Until a few decades towards the end of the British rule, the role of science education, scientific and technological research in economic growth and social transformation was rather limited. Only such developments were introduced that did not lead to a conflict with the interests of the colonial power. The only aim of education including that of science education was to turn out men competent to serve the civilian administration. Consequently, science education and research was uneven and patchy with no facilities. Even those few individuals educated in science lacked opportunities for either gainful employment or for scientific research. They could only procure clerical or teaching jobs.

It was only in 1857 that the universities of Bombay, Calcutta and Madras, modelled after the London University, were established. As a concession to the Indian aspirations the foundations for basic sciences were expanded and academic science in the universities received a fillip. It must be stressed that even under such adverse conditions, globally competitive scientific research was carried out by a few scientists like, C.V. Raman, M.N. Saha, S.N. Bose, D.N. Wadia, P.C. Mahalanobis, S. R. Kashyap, Birbal Sahni, S.Ramanujan, S. Chandrashekhar. Many of these were trained in India and carried out their research in Indian universities.
The outbreak of the World War I brought about a radical change in science education and in the pattern of scientific research and technological developments. The colonial government being cutoff from Britain was forced to actively mobilize local resources of scientific and technical personnel to meet wartime needs.

2.2.2 Post – Independence Period: Nehru’s Vision.

Within a few decades of the end of World War I, major colonial empires had disintegrated and India became independent in 1947. It is indeed very fortunate that Jawaharlal Nehru was India’s first Prime Minister. Having witnessed first hand the remarkable developments brought out through the pursuit of science in Europe and particularly in the then Soviet Union, he more than anyone else, realized the crucial importance of science for economic growth and social transformation. Addressing the then National Institute of Sciences (now INSA), Nehru stated, who indeed can afford to ignore science today? At every turn, we have to seek its aid and the whole fabric of the world is of it’s making. He strongly emphasized the inherent obligation of a great country like India with its tradition of original thinking to participate fully in the march of science. It was equally fortunate that in laying the firm foundation of science and science education in the country, Nehru’s vision was shared by the then leaders in science who helped Nehru to realize his vision. Raman, one of India’s most eminent scientists said, there is only one solution for India’s economic problems and that is science, more science and still more science. Homi Bhabha, the father of India’s atomic energy programme, while addressing the General Assembly of the International Council of Scientific Unions, just before his death, emphasized, What developed countries have and what developing countries lack is modern science and an economy based on modern technology. The problem of developing countries is therefore the problem of establishing modern science and transforming their stagnant and traditional economy to the one based on modern science and technology. Bhabha went on to add, An important question we must consider is whether it is possible to transform the traditional economy to the one based on modern technology developed elsewhere without
at the same time establishing modern science in the country as a live and vital force? If the answer to this question is in the negative and I believe our experience shows it to be so, then the problem of establishing science as a live and vital force is an inseparable part of transforming an industrially underdeveloped country to a developed country. In the context of establishing modern science and technology as a live and vital force, the importance of science education cannot be over-emphasized. Indeed, science education plays a crucial and pivotal role in the alchemy of scientific research and technological innovations.

2.2.3 Policy Frame

The vision of Nehru of India becoming a beacon spreading to the world not only the message of Buddha and Gandhi of peace and universal brotherhood but also that of science and technology, was translated into working plans through a policy frame that has evolved over the years. The very constitution of the Republic of India (seventh schedule) squarely puts the responsibility for coordination and the determination of standards in the institutions of higher learning and research on the central government, its responsibility also includes central universities, Indian Institute of Science, Institutes of Technology and institutes of national importance declared by the parliament. The constitutional amendment of 1976 places education including science and technology education in the concurrent list which implies the joint responsibility of the central and the state governments. The Government of India has evolved a machinery to discharge these obligations by designating

Ministry of Human Resource Development to function as an administrative ministry and by establishing the University Grants Commission and the All India Council for Technical Education, by acts of parliament to superintend the functioning of higher education in science and technology respectively.

Over the years, the Indian parliament has adopted major policy statements relating to higher education and S&T development. These developments have been largely guided by the Scientific Policy Resolution of
1958, one of the most comprehensive science policy documents ever approved by any legislative body in the world.

The parliament approved in 1968, the Technology Policy Resolution, which states that research and development together with S&T education and training of a high order will be provided a pride of place. Basic research and building of the centers of excellence will be encouraged. The quality and efficiency of S&T generation and the related delivery system will be continuously monitored and upgraded. The policy statement calls for strengthening linkages between educational institutions, R&D establishments, and industry and government machinery.

The central government has periodically constituted National Commissions on Education to assess the system of education and for recommending ways and means to diversify, improve and update the system, consistent with the changing environment. Some of the commission’s reports were translated into National Policies on Education. Thus the National Commission on Education of 1964 chaired by D.S. Kothari resulted in the preparation of the National Policy of Education in 1968. In 1986, the national Policy was suitably modified, amended and updated. This was further modified in 1992 in the light of Ramamurthy Committee’s report covering a whole range of operational, financial and technical issues. The statements emphasize education to be a unique investment for the present and the future, with emphasis on equal access on requisite merit, mobility of students and faculty and networking of educational institutions, R&D establishments, greater autonomy and accountability, relevance of curricula, excellence in research, and mobilization of resources. Thus the statement first made by the Kothari Commission that the destiny of this country is shaped in the classrooms and laboratories of schools, colleges and universities is re-echoed.

India has committed whole heartedly to science and has provided the necessary policy support for S&T human power development. There is also a systematic planning process in place. The policies and plans have helped India develop a vast infrastructure for higher S&T education, and have provided the second largest manpower in the world, with the best in the system comparable
to the best anywhere in the world. However, inadequate understanding of the spirit of the recommendations has led to over centralisation of authority, bureaucratization by controlling agencies and over-dependence on government support and intervention. The system has become too large and monolithic to ensure quality and accountability.

2.2.4 Growth of the System of Science Education.

Recognizing the crucial role played by S&T in the process of economic growth and social transformation, major emphasis was laid on higher science education during early years of Independence. Thanks to the political leadership, conducive policy support and substantial investment, India today possesses one of the oldest, the largest and the most diverse infrastructure. For S&T education and training several institutions comprising the Indian Institute of Technology (IIT’s), Indian Institute of Science (IISc), about a dozen institutes of national importance, two hundred and odd universities, and over 8,000 colleges, exist. This infrastructure has already made a substantial impact on the country’s scientific, industrial and economic development. There has been impressive development since Independence in various fields such as agriculture, industry, atomic energy, space programmes, manufacturing, and health care.

More than the creditable performance of the S&T personnel in India, the performance of Indian Diaspora cultured in our colleges and universities has been highly impressive. S&T personnel from India are highly sought after and respected in the countries of their adoption. Some of the academic research institutions such as IISc, Bangalore; TIFR, Mumbai; IITs and a few universities such as Delhi, Jawaharlal Nehru University, Poona, Banaras Hindu University, Varanasi, Central University, Hyderabad; and Jadavpur., have developed global reputation and attract increasingly large number of students from South East Asia, Middle East and Africa. The best products of the Indian system are comparable to the best anywhere in the world, although of course the average product is of a poorer quality. Indeed, Indian S&T personnel have assumed leadership role in areas such as statistics, chemical
engineering, biochemistry, information technology, biotechnology, advanced materials and are prominently visible in a number of advanced countries.

Everything is not, however, fine and rosy about India’s science education system. Despite the fact that India today has the second largest education system, it has still to meet the basic needs and aspirations of its billion people. The level of illiteracy still hovers around 35%. The access to science education is on the average around 30%. There is much to be desired in relation to the quality and relevance of higher science education.

Fortunately, India has recognized too well that only by competing successfully in the globally interdependent economy through its S&T human power that the living standards can be raised and the hopes of its people met. It has realized that it is through its reformed, updated and restructured higher science education and training system that the country can advance economically. After an almost explosive growth in the S&T system, at the beginning of the new millennium, India is on the threshold of restructuring and updating its science education system so that the tremendous promise and creative abilities of its talented human power could enable the country to redeem its tryst with destiny.

During the last fifty years, every aspect related to science education, whether it is student enrolment, number of educational institutions, and the numbers of teachers have recorded ten-fold growth. As science education is a continuum, it is necessary to consider its growth and its consequences right from the school level.

Science is taught at lower secondary level as an integrated whole than as a compartmentalized discipline. Discipline-oriented teaching and learning commence at 11th and 12th standards corresponding to the age group 16-18 years. The educational pyramid for a typical year (1993-1994) is shown in Table No. 2.2.4.1

**Table No. 2.2.4.1 Pursuit and Promotion of Science**
Student enrolment at every level has been increasing at around 7-10 per cent each year. These figures may give some idea about the numbers involved in the system at the beginning of the 21st century.

Although, the actual numbers are large, the gross enrolment ratio namely the total enrolment at a given level divided by the population of the concerned age group is considerably low as compared to the corresponding figures for a developed country such as USA as shown in the following table:

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<td>India</td>
<td>74</td>
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<td>U.S.A.</td>
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Looking at the educational pyramid, one finds that within the age group 5-18, corresponding to classes I-XII, nearly 50% of the population remains out of schools. In the age group 17-18 years, the access to education is barely 20-30%. Besides lower access there are gender and regional disparities. Further, due to rapid growth in education starting from extremely low access at the time of Independence, student population at every level constitutes a highly mixed lot such as first generation students mixing with students having several generations of educational background. In addition students are drawn from extremely widely varying social, economic, and cultural backgrounds. These are of course problems of growth itself.

### 2.2.6 Major Areas of Concern
India has realized that in the emerging global scenario wherein intellectual property will be highly valued and rights will be fiercely exploited and zealously guarded the only way to improve the nation’s competitiveness is through better and more productive science and technical education and flourishing scientific research and technological development. It is clearly understood that the world is passing through a transition from international relations being shaped by military might and political considerations to the one in which they will be increasingly determined by scientific competence and technological capabilities. It has more than understood that the arms race of yesteryears has yielded place to technological Olympiads and that military aggression has been replaced by economic exploitation. It is recognised today that, as never before, the competitive advantage of a nation will be increasingly determined by the quality and the number of its S&T human power. The experience of the last 50 years has also underlined that the intellectual raw material available to it in the form of young boys and girls is inherently talented, analytical and motivated and comparable if not better than that available elsewhere in the world. What needs to be done now is to put in place a system of highly productive, exciting and stimulating science education system flexible and accountable, diverse and yet focused, well funded and properly managed so that these young boys and girls flourish and deliver the goods.

A critical analysis of the data presented earlier has thrown a number of areas of concern that need to be addressed squarely and urgently so that the appropriate system which not only responds to the changing global environment but also provides a future direction is evolved. It appears that India has arrived at the most opportune time to restructure its vast educational system, having passed through a phase of massive expansion. The major issues that need to be faced are:

1. over-centralization, lack of autonomy and flexibility and lack of accountability,
2. access to education, removal of gender and regional disparities,
3. high rate of dropouts and failures,
4. shying away from science of particularly brighter young boys and girls,
poor quality of production and lack of relevance, The answers to the above are to be sought by:
providing equity and promoting excellence, and
integration of science and technology education and integration of education and research.

2.2.7 Some Initiatives

Educationists in India have identified the areas of concern mentioned above and have responded to them by certain moves. This section describes very briefly the steps taken.

Use of IT in Education:

The role of Information Technology (IT) as an instrument for progress and development has been acknowledged widely. The use of IT tools in teaching will make the learning process considerably simple and affordable. For a large and developing country like India, technology such as Distance Learning needs to be used in a major way to address the problem of limited educational material and resources. A number of projects have been sponsored in collaboration with leading institutions like IITs, IISc, Indira Gandhi National Open University (IGNOU), Nation Council for Science and Technology (NCST), and Birla Institute of Technology and Science (BITS), Pilani, with its long-term objective being promoting both IT based general education and IT based education itself. IGNOU has several IT enabled courses and is further promoting this culture. National Council of Educational Research and Training (NCERT) has set up a National Centre for Computer-based Education to promote training and development of teachers and teacher-educators. The centre will eventually sustain development of school teachers with a culture of resistance to change and provide schools with IT based inexpensive learning materials in support of the curriculum.

Education through People’s Science Movement:
One of the significant leads taken a few decades ago concerns people’s science movement (PSM) and education through it. The role of PSM is not only restricted to communicating and simplifying science but also to question every aspect of science-related activities, in particular S&T issues involved and intervening wherever necessary with people’s participation.

An outcome of the PSM was the development of the Hoshangabad Science Teaching Programme. Students’ active participation in the process of education was a unique feature of this endeavour. Although it marked a significant deviation from the conventional system and proved effective, it has not yet been absorbed into the formal system. PSM has grown and spread all over the country and has led to the upsurge known as Bharat Gyan Vigyan Jatha and has helped considerably to create the necessary social ethos for absorption of science and scientific temper in the society.

Exploratory - An Experiment in Learning by Doing Science:

A unique institution called Exploratory has been developed at Pune by a few dedicated educators. Exploratory is neither a school or college laboratory nor a museum but is a place where school and college children can explore and experiment, invent and innovate and design and fabricate. There are no teachers in the exploratory but highly experienced guides who explore along with the students the basic concepts in science through carefully designed activities. The purpose is to enable children to learn science by participating in the process of science. The exploratory promotes keen and careful observation, excites curiosity, encourages children to ask questions, question the answers and enables them to generalize and discover.

Although the formal system of science education has not yet adopted the exploratory way of learning science, exploratory are being set up all over the country.

Navodaya Vidyalayas:

Navodaya Vidyalayas were conceived in 1986 by Rajiv Gandhi, former Prime Minister of India. The scheme aims at setting up well equipped well staffed schools in rural areas, almost one in every district to provide better
quality science education to the talented children. These Navodaya Vidyalayas also serve as a resource centre and a pacesetter for the other schools in the region to follow. These Vidyalayas, 425 in number as of today, also aim at promoting excellence and removing disparities.

**Proposal for Restructuring Undergraduate Science Education:** National Planning Commission appointed a Committee to suggest restructuring of undergraduate science education. The Committee has recommended a three-tier approach to revitalise science education at the undergraduate level.

Although the suggestions have been hailed by the entire scientific community, these have not yet become a part of the formal system.

**UGC’s Efforts in Promoting Excellence:** In recent years the UGC has launched a large number of programmes aimed at promoting excellence. These include:

1. autonomous colleges
2. faculty improvement programmes
3. academic staff colleges.
4. centres for advanced studies
5. curriculum development councils
6. career development programmes
7. support for strengthening infrastructure in S&T and removal of obsolescence in the universities
8. identification of universities with a potential and supporting them to become comparable with the best anywhere.

**Inter-University Centres:** One of the most innovative steps taken by the UGC for promoting excellence was the setting up of Inter-University Centres equipped with most modern experimental facilities or providing access to national facilities such as accelerators, nuclear reactors, and synchrotron radiation source, to students and teachers from various universities. Nuclear Science Centre at Delhi, Inter-University Centre for Astronomy and Astrophysics at Pune and Inter-University Consortium for the Department of Atomic Energy Facilities with headquarters at Indore have already been set up and have been extremely useful.
Advance Centres for Science and Technology (ACST): A few senior scientists and industrialists have proposed setting up advanced centres for science and technology. These are composite science and technology education and research centres. They seek to integrate education and research, science and technology, pure and industrial research. These centres will provide a 5-year integrated programme leading to either an M.Sc. or M.Tech. degree. The students will be given a common course in the first year, aimed at ensuring good grounding in physical concepts, equipping them with mathematical techniques and statistical procedures and exposing them to the current excitement in life sciences. A large menu of courses will be offered in the second and the third year from which students can choose, in consultation with the faculty advisors, such courses that would suit their aptitude and abilities. At the end of the third year there will be a test conducted to assess students’ aptitude and ability to pursue basic or applied research. The fourth and the fifth year will be for specialization in chosen fields. It also provides for an internship programme of one year in the related industry for applied stream students and in reputed research laboratories for basic science stream students. The faculty will be carefully chosen and encouraged to forge strategic alliances with the industry and will be expected to remain at the frontiers of science and at the cutting edge of technology. Another distinctive feature of the programme is that the beneficiaries of the products of the system, namely the industry, national laboratories, and government science agencies, will participate in the management, monitoring and funding of ACST. It is gratifying to note that UGC has included the proposal for setting up ACST in the tenth five-year plan.

2.2.8 Curriculum Reforms in India

Against the background of striking curricular developments that are taking place abroad, the school curriculum in India will be found to be very
narrowly conceived and largely out of date. Education is a three fold process of imparting knowledge, developing skills and inculcating proper interests, attitudes and values. Our schools are mostly concerned with the first part of the process- the imparting of knowledge-and carry out even this in an unsatisfactory way. The curriculum places a premium on bookish knowledge and rote learning makes inadequate provision for practical activities and experience, and is dominated by examination, external and internal. Moreover as the development of useful skill and the inculcation of the right kind of interests attitudes and values are not given sufficient emphasis, the curriculum becomes not only out of step with modern knowledge, but need to raise, upgrade and improve the school curriculum. The curriculum reforms have been taken up by Government of India through NCERT and developed National Curriculum Framework -2005. The major issues of curriculum at school education level have been discussed i.e, information loaded textbooks, and memory based examinations dull routine and board teaching and rote systems of learning. And no clear connection between concerns, aims and curricular contains. The pedagogy and the view on knowledge also remain some what not well defined.

History of Curriculum Reconstruction

The first major attempt in Curriculum Reconstruction in India was made in 1937 when Gandhiji propounded the idea of basic education and Dr. Zakir Husain Committee elaborated the scheme of studies of basic education. However, much work in this direction could not be done as India was under the British rule

Indian National Science Academy (INSA) has been deeply concerned with the state of science education in the country since its inception. Many proactive measures have been taken by INSA to improve science education in the country. INSA at international level is collaborating and coordinating with other agencies to address issues pertaining to Science Education which are common to most of the countries. INSA is a member of Inter Academy Panel (IAP) and as a part of IAP initiative, INSA has been requested to lead the programme on school education. The specific message of IAP in this direction
“Taking message of science to primary school children and adult illiterates as a global initiative”. INSA is acting as a Coordinator of the IAP programme along with Brazilian Academy of Sciences and Mexican Academy of Sciences. Each of the Academies will be organizing workshop on scientific literacy for primary school children and adult illiterates and will come out with a brief report highlighting recommendations of these conferences. INSA would collate all three reports and would come up with a statement for global action to tackle the problem of science literacy regarding school children and adult illiterates. This IAP Seminar is the result of the measures taken by INSA to bring to focus the different initiatives of the various Academies in the Asian subcontinent.

INA had made elaborate measures in the organization of this IAP Asian Regional Seminar to enable the participation of many countries not only from the South but also from the developing countries. The two-day seminar was held contiguous with the TWAS 8th General Conference and 13th General Meeting, and TWNSO 7th General Assembly in New Delhi (19-23 October 2002). The IAP Asian Regional Seminar witnessed large participation from many countries and there were 16 presentations from different Academies of which 11 were from the countries of the South, Afghaniastan, Bangladesh, Brazil, India, Kenya, South Korea, Malaysia, Mexico, Nepal, Pakistan and Sri Lanka. The National Science Resources Center, Washington DC of USA, Pontifical Academy of Sciences and the French Academy of Sciences participated in the seminar with presentations. A lively panel discussion at the end of the seminar brought to focus many issues concerning the difficulties in imparting science education. The discussion also had the contributions from scientists from Togo, Tukmankanistan and Germany.

A summary of the presentations made at the seminar is given in the following pages. The speakers from the following countries, Vietnam, Thailand and Phillipines and China could not be present. The outcome of the seminar as perceived by the Convener is included along with the measures taken by INSA in this aspect.
The seminar was opened with a welcome from the Convener, Professor V. Krishnan. He outlined the genesis of the seminar and also brought to the attention the initiative taken by INSA in the organization of a preconference held in New Delhi in May 2002 on Capacity Building in Science and Technology – Science Education Programme – Trends and Future Initiatives. This meeting was largely attended by the various institutions and NGOs in India working in the field of Science Education. The meeting brought forth many suggestions and these are presented in the Convener’s Remarks at the end. Professor G. Mehta addressed the seminar elaborating on the initiatives of IAP in the organization of different regional workshops. He outlined the importance of such meetings towards experience sharing leading to development, a viable model science education programme.

The keynote address was delivered by Prof. C.N.R. Rao, President, TWAS. The lecture covered essential points in the science education in developing countries, the importance of science capacity building in the countries and the widening gap between the countries of the North and South. This lecture emphasized the principle of Science for All Citizens and the different methodologies. The two-volume CD on Learning Science authored by Prof. C.N.R. Rao was shown to the audience and it was highly appreciated. The multimedia package was brought out by the Educational Technology Unit of Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, India and INSA had provided the initial support for this venture under its Science Education Programme activity. A few CDS were distributed to the participants. The CDs have many interesting features and user friendly.

The Bangladesh experience was outlined by Professor Shamsher Ali, President of Bangladesh Academy of Sciences. The lecture on “Innovations in Science Teaching” outlined the importance of science is in performing/carrying out experiments and the necessity of the usage of locally available materials. Many innovative examples were cited – phase transitions in water, energy transformations and others. Many of these examples have a multidisciplinary approach. The lecture also stressed that the law of science game is mathematics and how simple ideas can be quantitatively understood.
It emphasized that the Drama of Science is played by students as key actors and teachers as passive onlookers. Learning Science should be viewed more as a fun.

The Brazil experience was outlined by Professor E.M. Kreiger, President, Brazilianian Academy of Sciences. The lecture on “Inquiry based science education in Brazil – Background and recent events”, he outlined the various approaches adopted by the Government and the Academy. Two education networks (a) preparation for higher education and (b) to prepare the children in streets for work. Brazil has accomplished 100% universal coverage in basic education in 2001. The programmes for science education covers different project types, resources and materials, museums, teacher training. The current situation of science education in Brazil indicates good number of groups in science education, increased focus on high school, successful small scale experiments in inquiry-based science teaching, creation of internet researcher-teacher network. The lecture also stressed for a successful programme, it needs political support and prestige to the groups associated with the proramme and evolution of new partnerships. Any such programme should have assessment, and the results should be introduced to the emerging education – policy making and a need to consolidate efforts around a well chosen themes.

The American (USA) experience has been expounded by Dr. Sally Goetz Shuler of National Science Resources Centre, Washington DC, USA – a blue print for Science Education Reform. The main theme being Excellence in Education to satisfy the critical needs of making young scientifically and mathematically literate and to remain internationally competitive. She elaborated on the genesis of the establishment of NSRC and the basic philosophy of the Centre. The latter revolves around student, science curriculum and the infrastructure necessary to bring about successful reform. The system works on the belief that all students can learn science, and best learnt on an inquiry based environment, and the experiences of learning must be developmentally appropriate. The reform model has the components of curriculum, professional development, assessment, material support and
administrative and community support. The `bottoms-up’ approach starts with Development of vision of effective science learning and teaching with knowledge of research and best practices having contributions from research based curriculum, competent teachers, aligned assessment, material support and school community support leads to establish local school district infrastructure. This leads on to improved instruction in science resulting in increased student achievement.

The Korean experience has been outlined on a talk entitled `Korean experiences in school science education’ authored by Yung Woo Park, Director of Foreign Affairs, KAST and In-Kyu Han, President, KAST. The presentation emphasized science education in developing countries is a fundamental issue to improve economic growth and the living standard of the countries. It recognized that Korea along with Singapore, Hong Kong and Taiwan are most successful Asian countries in accomplishing high tech development. The Korean experience has been interesting in pointing out a few lacunae in the existing system and suggest ways to remedy the same. The frequent changes in curriculum, though takes care of the recent developments does not take into account the adequate preparation of teachers, the teacher-student contact hours, installation of proper experimental set-ups, absence of proper evaluation of laboratory tests and others. The outsourcing school science education provides better opportunities to learn outside school mechanism, however such venues are limited. The presentation lays importance on science parks, museums, Olympiads, science contests to identify talented people. The internationalization of science should take into consideration the tradition of Korean Science to evolve a model. Globalization of science education can be accomplished by scientific exchange and multilateral collaboration with foreign academies. The funds required should originate from Government.

The Pakistan experience has been outlined by Professor Riazuddin, National Centre for Physics, Quaid-I-Azam University, Islamabad on the topic some recent Pakistani initiatives’. The lecture mentioned the two parts in science education (a) school education for the underprivileged and (b) higher
education. The Madarasah education caters to the underprivileged children. The education essentially focuses on Religion and thus has limited scope. Recently, measures have been taken to introduce science in the curriculum. This immediately requires generation of affordable experimental materials, teachers training and adequate infrastructure for these schools. The school education in rural areas has been rather inadequate. In this respect, measures have been taken to design curriculum taking into account the environment in which they live and taking examples of plant growth, agricultural tools, improving skills, arithmetical manipulations, locomotion (cycles) and importance of sanitation. The higher education seems neglected since inputs from schools to colleges/universities have been diminishing. The Government has taken initiative to set up a task force to rectify these drawbacks to improve higher science education. This set-up essentially bifurcates governance from management to provide an enabling environment for faculty to bring about a dramatic change in education. The safeguarding of quality of teaching and research training, enhanced doctoral enrollment and training are the main features of this system. The government is supportive for these endeavours.

The Mexico experience has been expounded by Professor J.L. Moran Lopez on the title ‘Science for Everybody’. The Mexican programme comprises of (a) dissemination of scientific knowledge in Spanish language (accessibility of all Spanish speaking countries in Latin America) (b) improve science education of young students (c) increase the number of students in the science stream (d) actualize high school and college teachers in scientific research and (e) offer to the general public monographs of actual themes of research. The success of this programme lies in the performance of the publication of 189 titles covering astronomy, biology, chemistry, physics, engineering, earth science, mathematics and others. These are written by carefully chosen authors, proper editorial board, attractive illustration, fairly less number of pages and other features. These are found to be highly popular in Latin American countries. The learning from these monographs is being evaluated by national contests open to all, and divided among different age groups by writing reports and essays on topics of choice covered in the monographs. Very large participation over a few years confirms the
acceptability of the programme. This perhaps is a successful outreach programme for the initiated. The almost 50% women participation is the most welcome feature and this will provide a catalytic role in doubling the scientifically literate population. The organization of this programme has the benefits of Ministry of Public Education, National Council of Science and Technology, National Association of Universities and higher educational institution and Mexican Academy of Sciences.

The Malaysia experience has been outlined by Dr. Augustine S.H. Ong and Dr. Omar Abdul Rahman (Academy of Sciences, Malaysia) on the topic ‘The Role of Academy of Sciences, Malaysia in Science Education’. The Academy recognized the importance of Science and Technology education in the building of S&T manpower contributing to economic growth and prosperity. It has taken a large number of proactive measures such as National Science Quiz, back to school lectures, popular science lectures, seminars to evaluate science education, quality improvement project, efforts to set up Teachers Institute for Mathematics and Science, bringing out publication on science and technology topics (‘Estidotmy’), science camps and others. It also has programmes on achieving excellence in science through participation of students with Nobel Laureates and various international programmes. The science education has the components of students and teachers, policy makers, teacher education at all levels, text books and publishers, science museums and community of parents and teachers, business and industry and legislators.

The Nepal experience has been brought forth by Professor D. Bajracharya and K.M. Shreshtha of the Royal Nepal Academy of Science and Technology (RONAST) and Tribhuvan University, Kathmandu, Nepal on a title Science Education at school level in Nepal. The Academy has the main objective of the promotion of development of S&T programmes. The school education system has four parts starting with primary education, lower secondary education, secondary education and higher secondary education. The topics in science covered at different levels are environmental and health science to start with and till secondary level subjects like Physics, Chemistry, Biology, Astronomy and Earth Sciences are covered. In the higher secondary,
Physics, Chemistry, Biology and Mathematics are covered. The enrollment in schools seems improving. The constraints outlined are lack of qualified teachers, absence of instructional materials both for theory and experimental classes and lack of positive attitude among administrators. The Academy has science popularization programmes which include publication of science magazines, radio programme, science quiz contests, science essay competition and others. The Academy envisages other activities to enhance scientific literacy with the establishment of science learning centers, public awareness of science programmes, science exhibitions, modular laboratory exhibitions that are mobile, involvement of media and others.

The Afghanistan experience has been outlined by Professor Abdul Khalil, Vice-President of Academy of Science of Afghanistan. Before the presentation, Professor Abdul Bari Rashed, President of the Academy made a statement on the Transitional Islamic State of Afghanistan. The President mentioned that despite continuous upheavals in the country, the Academy kept its activities, and maintained independent scientific activity. The Academy wishes to have collaboration with other Academies. The condition of Science Education in Afghanistan has been brought out by the Vice-President. There has been shortage of teachers, schools, lack of infrastructure both in terms of materials and instructional materials in the schools. The Academy identified, teachers training, need for specialized science education, skill acquirement and other are immediate needs.

The Sri Lankan experience was outlined by Professor J.N. Olep Fernando, immediate past President, Sri Lanka Association for the Advancement of Science in his talk entitled ‘Sri Lankan experience in school science education’. The educational process in Sri Lanka has its origin during the colonial period. There are two types of schools, rural and urban with a large majority of rural schools. A three-tier system with 6 years of primary followed by Junior Secondary (4 years) and terminates at Senior Secondary (2 years). Of the 11,000 schools, 97% are run by the Government and only 2500 of them cater to senior secondary level. The common syllabus up to Junior Secondary treats science as a general one and not discipline-wise while at the
advanced level (senior secondary) science is being taught discipline-wise. This has created a widening gap in the acquisition and imparting of hardcore disciplines. However, the vernacular medium of instruction plays a crucial role due to absence of authoritative reading and instruction material in these languages. The abolition of practical examination in science subjects is another crucial point in the comprehension of scientific literature. There is an apparent lack of students enrollment for science courses. This possibly arises from societal aspiration. The absence of qualified teachers, lack of experimental infrastructure and absence of funding are some of the factors that need immediate attention.

The Indian experience has been outlined by three eminent people representing nongovernmental and governmental efforts in the area of science education. The nongovernmental (purely voluntary) effort has been expounded by Professor V.G. Bhide of University of Pune, Pune, in his venture in the establishment of Exploratory – A New Experiment’. Exploratory is neither a school or college laboratory but is a place where any one can experiment and explore, discover or innovate, design or fabricate. This provides a unique place wherein only guides are available to help and no formal teaching. A large number of experiments are being set-up wherein one can learn basic concepts of doing science. The categories of activities include Physics, Chemistry, Mathematics, Life Sciences and Electronics and Computers. In addition, this Centre has other activities such as, nurturing and nourishing talent at all levels, publication of informative and well illustrated books, and developing computer aided science education. The results of this venture are truly reflected in many children getting Olympiad medals in science. This has the appreciation of the society.

Another Indian experience has been presented by Professor Aravind Kumar of Homi Bhabha Centre for Science Education, Tata Institute of Fundamental Research, Mumbai in his talk entitled ‘School Science and Mathematics Education in India: Some major concerns and some initiatives’. India being populous country, school science education witnesses many impediments. The democratic frame work entails equity, excellence and
relevance in science education. The language barriers, socio-cultural and gender stereotypes further hamper universalisation of science and mathematics education. The work carried out by Ekalavya (an NGO based in Madhya Pradesh) and the HBCSE, Mumbai in school science education essentially centers around teachers orientation, building high quality team of teacher trainees, innovative curricular materials, popularization of science through bal melas, mobile libraries and child activity centers. The centres work on the theme, empowerment through participation, discussion and questioning, local specific and non-formal education on issues relating to environment pollution, health, education, women and other societal issues. The HBCSE has carried out projects specially for deprived groups and remedial programmes for active learning processes. The foundation curriculum is based on interdisciplinary areas, population, energy, land and air, global climate change, ecological balance and health. A large number of experiments using locally available materials have been designed. In addition, HBCSE takes keen interest in the promotion of excellence at the secondary and senior secondary stage by encouraging participation in international contests such Olympiads in different disciplines such as Mathematics, Chemistry, Physics, Astronomy, Informatics and others. The result has been good that India is among top 10 countries of the world in all the four subjects. Efforts are underway to be among the best three in the world.

The Indian experience from an autonomous body of the government point of view was presented by Dr. R.D. Shukla, National Council for Education Research and Training (NCERT), New Delhi on a topic ‘NCERT Experience in the field of science education’. The NCERT is an apex resource organization set up by Government of India to assist and advise the Central and State Governments on academic matters related to school education. The NCERT has been continuously facing challenges in bringing out educational reforms, universalization of primary education and others. This caters to approximately enrollment of 82 million at the primary level and about 25 million at higher secondary level with a population of 0.18 billion students. There are about 5 million teachers taking care of primary up to higher secondary levels. The estimated number of students opting for science at the
higher secondary is about 1.8 million boys and 800,000 girls. The NCERT is the organization with governmental support runs a large number of schools catering to all students from different sections of society whose parents are in employment with the Federal Government. It has developed its own curriculum with the advice of experts, syllabi, text books, instructional materials, laboratory manual and supplies for the benefit of children. It brings out popular books, organizes exhibition/contests at the district, state and national levels. It has its own talent search tests and rewards children with scholarships and fellowship for pursuit of science at the university level. It has developed audio-video materials for promotion of science education and to improve scientific and technological literacy. Many eminent scientists are associated in the writing of supplementary materials under the project ‘Reading to Learn’ in many topics, computers, space science, marine science, weather and environmental sciences and others. Despite all these efforts, there has been a concern in the falling enrollment of students in science career. Among the many reasons, career prospects, interest, weakness in teaching process and curriculum load have been identified for further strengthening. NCERT has been aware of its weaknesses and efforts are being made to rectify this with the help of the Academies and other organizations.

The African experience was expounded by Professor Joseph O. Malo, of the University of Nairobi in his presentation entitled ‘Trends and Challenges for Science Education in Kenya’. The problem Africa is facing is underdevelopment and science capacity building should address many prerequisites such as institutions for teaching and training, forums such as societies, associations, academies to provide exchanges, debates, workshops for the promotion and popularization of scientific subjects, physical facilities, highly trained individuals and an enabling environment. There must be a firm commitment to link S&T with the development objective to enhance quality of life of citizens. The globalization of economy carries technological innovations and this often times not always compatible with culture, social behaviour and environmental condition of different countries. The challenges are many, attitude to science and decreasing enrollment, particularly, girls opting out of science and mathematics streams, smaller number of graduating
from science and others. The immediate needs are teacher training programmes, constant curriculum reviews, generation of experimental materials, and mode of governance.

Another experience has been from Togo by Professor Edee K.A.B. Emmanuel. This clearly brought forth that a new major national effort to improve science education should be implemented since science brings order, harmony and balance to our lives. Every one can learn science and excellent teaching can be learned. Science, well learned, is a requirement for the work force of the 21\textsuperscript{st} Century as well as informed citizenship.

The experience of Turkmenistan was presented by Prof. A.G. Babaev and Ch. Murdov of the Desert Research Institute, Academy of Sciences of Turkmenistan. In the 1890 schools in Turkmenistan, one million boys and girls are educated through the medium of Turkmen, Russian and English languages. There are 14 institutes of higher learning covering branches like medical, polytechnic, agricultural, pedagogical and transportation. The Academy has international links in addition to institutional and personal exchanges. There are 14 institutions of higher learning covering branches like medical, polytechnic, agricultural, pedagogical and transportation. The Academy has international links in addition to institutional and personal exchanges.

Prof. K. Ahamad Malik of DSMZ, Germany brought to the attention of some of nationwide programmes that focus on issues related science teaching, learning and even research at school in Germany. These essentially addressed to encourage the young and motivate them to take up the career in science. The programme in ‘Jugend Forscht Competition’ in Germany attracts a large number of young people. In addition, laboratory programmes are available to those interested and successful students.

The Indian National Science Academy (INSA), New Delhi organized a two day seminar on the topic ‘Science Education Programme – Trends and Future Initiatives’ during May 16-17, 2002 at INSA, New Delhi. The seminar was mainly based on ‘experience sharing’ in science education bringing together those responsible for improving curricula, science textbooks,
educationists, teachers from both the formal and non-formal sector, those responsible for the professional development of teachers of science, those involved in assessment in science education and also those interested in science popularization and dissemination of science.

The Seminar was attended by 65 participants from 39 organisations, both government and non-government, who also displayed their initiatives in this area in the form of posters, science kits and books. Broadly seminar focused on science teaching (changing emphasis for teaching; professional development for teachers) and science contents in different branches of science; assessment in science education; science popularization and dissemination.

Participants were of the view that scientific institutions should adopt high schools and colleges, providing them requisite assistance. While mentioning about 5-10 centers for R&D in science education, the participants felt more are required. Besides the parents need to be sensitized about the career opportunities in science, the need for massive programme of teachers training and also how good were the testing tools in spotting talent, lack of reading materials and difficulty to produce good text books were needed to be tackled.

The suggestions at the end of two-day interactive seminar are given below:

INSA, to have a dedicated website on science education in the country that would also help in networking individuals and organizations through knowledge exchange and experience sharing for the improvement of science education with special emphasis on taking science to the masses, and encouraging the participation of women towards careers in science. This would focus on issues such as experience sharing, towards improving science education in the country, information on use of experimental materials and inquiry based learning modules. Strategies would then be identified and implemented based on shared experiences.

A collective meeting of all the science Academies of the country held in October, 2002. The meeting of October 24-25, 2002 is an outcome of the above meeting. India needs to overhaul its science education and improve its
quality in general. Particularly, it must have a system designed broadly to suit its own needs and yet cater to different multicultural and multilingual needs that are unique to the country. Science education must reach the masses, the underprivileged and especially the girl child. Science education must evoke the natural curiosity of the child, the wonderment for Nature. For this, the education and its tools should be fashioned to the environment in which the child lives. The child should be encouraged to find its own answers with textbooks being only a guide. Concepts must be introduced and field trips and outdoor activities to learn must be encouraged. At the school stage itself, there should be spotters to identify special talents for science and these must be further supported. The quantum of practical laboratory work, fieldwork must be substantially increased. To aid learning by inquiry more ‘exploratory’ methods must be incorporated into the curriculum. A large number of experiments, kits and multimedia teaching aids should be created using as far as possible locally available materials with accompanying do-it-yourself books.

Activities must be designed in full harmony with the child’s environment and from this environment more detailed concepts of scientific truth must be got and understood. This would sensitize the child to its environment and help to solve niggling problems at a later date but makes the whole exercise of learning all the more interesting and invigorating. The do-not-touch mindset that is taught in the present system ought to change. Encouragement must be given to ask questions, understand the history of science, find how science is so entwined in their daily lives, feel the excitement for science and understand that there remains a lot to be still done.

Curriculum at school and college level including university level must be periodically assessed and any resistance to change should be suitable thwarted. Textbook writing by senior scientists and teachers must be encouraged. The general quality of textbooks should be raised taking heed to the environment in which the child or student finds themselves in. Mathematics should be taught at all levels and must be mandatory for all science subjects or their
combinations. Making mathematical constructs rather than with pen and paper should be encouraged.

School teacher training programmes must be increased all over the country and they should be given an opportunity to understand more recent developments taking place in their subject disciplines. This would help them to imbibe the same excitement in their students and raise the level of teaching. Spotters among teachers must be encouraged to spot talent early in each school at all district levels. The media, parents and students should be sensitized as to the various career options and job situations available to students coming out science streams. This would encourage more students to science and reverse the alarming trend of lack of interest for basic sciences.

All kinds of possibilities to encourage and popularize science such as mobile vans, science centers, interactive exhibits, workshops and activity centres for children should be supported financially. Role of journals, popular science magazines in spreading the scientific temper among citizens must be more aggressively encouraged. Incentives for promoting science education in the country on a larger scale should be given. All science Academies must come together for the sake of improving the quality of science education in the country and play a more active role in the process of raising the scientific temper of the people of this country. The Academies should be a watchdog, leading the way for governmental policy issues that concern science education and help to change an outdated system III. Conclusions:

The two-day Asian Regional IAP Seminar on the Generation of Experimental Materials and Learning Modules for Science Education provided a meeting place for interactive discussion and deliberation on the various initiatives taken by the Academies in the different countries in this region. There is certain unanimity in views expressed by different countries. The Science Education is for all. Science education is important in the economic development of the country and to sustain the quality of life of every citizen. The development of science should be an organized social activity with equal participation from science educators, children and society in which they live in. Though science is international in character, no unique model of science
education is applicable. Models should evolve depending on the geographic location, environment, technological development and nature of societies in the different regions. Scientific literacy among citizens is another important feature and this can be accomplished through participation of the media with governmental and non-governmental support.

The difficulties and constraints experienced by different countries in the administration of science education in schools are very similar. These pertain to overcrowded classes, inadequate number of trained teachers, lack of teacher training facilities, absence of continuing education programme for in-service teachers, non-availability of teaching materials (especially training facilities, absence of continuing education programmes for in-service teachers), non-availability of teaching materials (especially laboratory experiments), inadequate contact hours (teacher-students) and others. Another aspect is the populace to be educated. The children come from different regions (rural, urban and remote areas), economic factors (deprived and non-deprived) language groups.

The design and development of science curriculum in different countries had certain commonalities. The topics of teaching relate to health and hygiene, environment (flora and fauna) pollution, weather and climate, agriculture (plants and their usefulness) and others.

The science teaching, however, should be linked to performing experiments and observations of results followed by classification of facts. The experiments chosen should make use of locally available materials and cost-effective.

Much has been said and written by many participants about the declining number of and disappointing lack of diversity among school and college children taking science as a career. Among the several reasons advanced, it is recognized that science is not an attractive career in relation to medicine, business, information technology and others. It is possible to rectify this misconception by proper science education and wide range of application of science in different professional activities. This meeting brought forth an important feature of outsourcing science education. This involves the necessity of good number of science parks,
science museums, mobile library, mobile science laboratories, availability of popular and attractive books/monographs/leaflets, utilization of audio and visual media presentation enabled by IT, science contests and exhibitions at rural/district/state and national levels and others.

It emerged from the meeting that there is a gender bias in science education in this region. Very few girl children take science as a subject of study. Efforts should be made to involve them in science learning and technology. It is recognized once a good number of girls take up the science profession; it will have a multiplier effect since they inculcate science in their children.

2.2.9 Measures taken by Indian National Science Academy in the area Capacity Building in Science.

INSA is continuing its efforts in the area of science capacity building through its interaction with NCERT, UGC and other national bodies for the promotion of science education. Many activities such as publication of popular books/monographs in different science disciplines, multimedia preparation, providing interlinks between institutions, creation of website of different organizations in the country describing their activities and experiences in science education and others. INSA strongly believes in the creation of an enabling environment for extensive and intimate interaction among scientists, students, educators and government administrators towards capacity building in science. The Academy would fulfill its obligation to IAP in bringing up a document comprising of the outcome of the other regional seminars from African, Latin American region (which is not yet received) along with the Asian seminar (presently enclosed). The Academy is presently considering a proposal to be put up before IAP for the establishment of a Virtual Centre for Science Capacity Building. The Centre would be a storehouse for a large number of experiments that are useful for school science education evolved in different regions, and the teaching experiences in science and mathematics at different level.
2.2.10. Recommendations of Curriculum by the Secondary education Commission.

The Secondary Education Commission realized that there was a great need for providing Technical Education in the country. Therefore, it recommended Multipurpose Scholls. It also made recommendations regarding the diversification of the secondary stage in education. A core curriculum at the Higher Secondary stage was also recommended.

2.2.10.1. Curriculum at the Middle Stage.

The Secondary Education Commission divided the schools which cater generally for the pupils of the age group of 11 to 13. The second category includes High Scholls and Higher secondary, a four-year course. The age-range of pupils in High School will approximately be 14 to 16 and in Higher secondary School 14 to 17.

The middle school stage is a continuation of primary school stage. Since the special function of curriculum at this stage is to introduce the pupils ‘in a general way’ to certain broad fields of human knowledge and activity, It should include language and literature, social studies, natural science and mathematics. Language will include Mother tongue, Hindi and English.

2.2.10.2. Curriculum at the High and Higher Secondary School Stage.

At the high school stage, the special abilities and interests of pupils take a definite form and so a lot of choice should be given to them to choose the subjects from a wide variety. The Secondary Education Commission gives justification for the inclusion of the following various subjects:

i) **Mother-tongue and other language (Hindi or English):** These are essential to meet the requirements of the pupils for daily communication and inter state communication.

ii) **Social studies and General Science:** These are of general nature with the purpose of explaining the social and physical forces that shape the lives of the people.
iii) *The Elective Groups:* These are Humanities, Sciences, Technical, Commercial, Agriculture, Fine Arts and Home Science. These seven groups would provide enough scope for full freedom of choice for pupils with different aptitude. It will begin from Class X, and this is the right time for the differentiation of curriculum.

### 2.3 Historical Development of Physical Science Curriculum in India.

A national curriculum framework was designed in 1975 to translate the avowed policy into action. It was suggested that, at the secondary stage, the science syllabus could be bifurcated under the titles *Physical science,* covering physics and chemistry, and the *Life sciences,* covering botany, zoology and human physiology. An alternative was to offer science as a single integrated subject where concepts are developed as units without violating the parameters of the various disciplines. At the senior secondary stage, however, science could be offered as ‘discipline-wise’ courses in the academic stream. The new curriculum elicited the criticism that the content of the science and mathematics courses prescribed for Classes IX and X were inordinately taxing on the students. In June 1977, a Review Committee under the chairmanship of Ishwarbhai J. Patel was appointed to examine the syllabus and textbooks recommended by the National Council of Educational Research and Training (NCERT). The Committee suggested the restructuring of the scientific concepts taught in Classes IX and X. The members also proposed that students be given the option of choosing from two equivalent courses in the secondary stage. The first alternative was to offer the study of science as a single subject encompassing its various disciplines, while the second alternative was to offer a discipline-wise science course consisting of biology, chemistry, and physics, etc. Schools affiliated to the Central Board of Secondary Education (CBSE) gave their students an opportunity to pick a course of their choice from these alternatives. The authorities, however, soon realized that the two courses were not being perceived as constituting a choice between equally rewarding options. It was observed that students who had opted to take the ‘discipline-wise’ science course received preferential treatment while securing
admission to the higher secondary stage. Thus the spirit underlying the Review Committee’s recommendations was practically undermined. The CBSE schools therefore abandoned these initiatives and returned to ‘discipline-wise’ study of science at the secondary stage, as was the practice in all other schools.

2.3.1. General framework

Indian schools follow an education system that has its genesis in the recommendations of an Education Commission appointed by the government in the year 1964. The first ten years of schooling are devoted to eight years of elementary education comprising five years of primary a three years of upper primary education, followed by two years of secondary education. The students then undergo two years of higher secondary education to complete school. This format is popularly referred to as the ‘10+2 pattern’ of education.

The Indian Parliament adopted the recommendations of the Education Commission as its National Policy on Education (NPE) in the year 1968. The highlight of the recommendations was that science and mathematics were, for the first time, made subjects for compulsory study for all pupils as part of general education during the first ten years of schooling. In this context, the Commission went on to recommend that:

- In the lower primary classes, science teaching should be related to the child’s environment. The Roman Alphabet should be taught in Class IV to facilitate understanding of internationally accepted symbols of scientific measurement and the use of maps, charts and statistical tables.

- At the higher primary stage, emphasis should be on the acquisition of knowledge and the ability to think logically to draw conclusions and to make decisions at a higher level. A disciplinary approach to the teaching of science will be more effective than the general science approach.

- A science corner in lower primary schools and a laboratory-cum-lecture room in higher primary schools are minimum essential requirements.
• At the lower secondary stage, science, taught in terms of disciplines like chemistry and biology, would help students to grasp the distinct pursuits possible within the broader spectrum comprising ‘science’. Such an approach would pay long-term dividends in this age of super-specialties. Experimental approach to the learning of science should, moreover, be stressed.
• Science courses at an advanced level may be provided for talented students in selected lower secondary schools along with the necessary facilities of staff and laboratory.
• Science teaching should be linked to agriculture in rural areas and to technology in urban areas. But the levels of attainment and avenues to higher education should be the same in both types of schools.

2.3.2. National Policy on Education, 1986

A new educational policy was developed in 1986, nearly eighteen years after the NPE was formulated and implemented. Fresh assessment was necessitated by widespread belief that the system in prevalence neither met the needs nor fulfilled the aspirations of the people. The 1986 policy reposed faith in the conviction of its predecessors that science and mathematics should continue as compulsory subjects in the first ten years of school education. Indeed, the teaching of science needed to be further perfected as virtually all aspects of growth and development in the modern era had their basis in scientific knowledge and as such, societies needed citizens literate in science and technology at various levels to ensure overall progress.

Towards this end, the policy further enunciates:
• Science and mathematics will remain as core subjects in the first ten years of school education.
• In order to develop scientific temper and to attain other goals, it is necessary to define the objectives to be fulfilled through science education.
• Involvement of community, non-government and voluntary agencies are required to pool resources by establishing networks among...
different institutions. Efforts should be made to generate manpower at the grassroots level to spearhead the implementation of the ideas stated in NPE.

- Programmes with exclusive focus need to be evolved for the educationally backward schools and states in the country. They need to be designed to eliminate disparities and attain equal status for women. Education of scheduled castes, tribes and other educationally challenged sections of society, besides rural, remote and neglected regions of the country require innovative and culture specific approaches. The challenges are manifold and need to be addressed with a certain degree of sensitivity and with the sense of immediacy they merit.

- To attain universal enrolment and to pre-empt dropouts, improvement in both the environment as well as the quality of education imparted are to be treated as a quintessential ongoing process. The learning process, being neither uniform nor mechanical, allowances need be made for individual students who may differ from the majority. Teaching and learning of science should be so designed as to respect the basic rights of each and every student. Science education at the elementary level should not overwhelm children with loads of information but should instead aim to open their hearts and minds to the joy of learning.

- Science education will be extended to the vast numbers who have remained outside the reach of formal education. This is to be borne in mind while planning for non-formal systems.

- Science and mathematics curricula for the secondary level should help inspire conscious internalization of a healthy work ethos. This will provide valuable manpower fuelling economic growth even while moulding ideal citizens who can adapt effortlessly to a society based on science and technology.

- Science curriculum for general education will be implemented in pace-setting schools with sufficient scope for innovation and experimentation.
Science up to Class X should be treated as a combined subject. The laws and principles of science, operating in the environment, should be used for creating desired teaching/learning situations. The learning and teaching of science should be so prioritized as to lay greater emphasis on an activity-oriented methodology.

2.3.3 AIMS OF TEACHING SCIENCE

The general aim of science education is to help develop well-defined abilities in cognitive and affective domains, besides enhancing psychomotor skills. It helps to foster an uninhibited spirit of inquiry, characterized by creative, innovative and objective approaches. Educational programmes are designed to help unravel the mysteries of the inter-relationship between science and day-to-day life, health, agriculture, industry, and indeed, the individual and the universe. Scientific wisdom, knowledge and skills are ammunitions that instill confidence and inspire the individuals to challenge existing beliefs, prejudices and practices. They work as a liberating force and serve as a reliable tool in one’s search for truth, harmony and order in different aspects of life.

In Classes I and II *Environmental studies* is wholly devoted to the fundamentals of science. In Classes III to V however, *Environmental studies* branches into two sections: one dealing with science and the other with history and geography that are taught together under the title *Social studies*. The objectives of teaching science at the primary stage are:

- To learn about flora and fauna, natural resources, the sources of energy and so on, through interaction with the immediate environment;
- To sharpen observation, inculcate the spirit of exploration; and
- To develop concern, sensitivity and the ability necessary for the preservation and protection of physical and natural resources.

At the upper primary stage, namely Classes VI to VIII, the student is expected to consolidate and strengthen the abilities acquired during the primary stage. The objective is to develop an understanding of the nature of
scientific knowledge; certain physical, chemical and biological facts and their relationship to their manifestation in nature and in daily life.

The student should be enabled to develop the capacity to use science to help solve problems and arrive at the right decisions. Pupils are also expected to develop the skills required to operate ordinary laboratory/science equipment, and to design simple experiments to seek and find explanations for natural phenomena. At this stage, science education should help the pupil develop an understanding and appreciation of the joint enterprise of science and technology and the inter-relationship of these with other aspects of society.

School education comes to a close with the secondary stage comprising Classes IX and X. The aim of teaching science at this stage is primarily directed towards the learning of key concepts that span all disciplines of science. At the secondary stage, the pupil should be enabled to develop a more profound understanding of the basic nature, structure, principles, processes and methodology of science, with special reference to its relationship with agriculture, industry and contemporary technology. The teaching of science at this stage should help pupils develop insights in health and environment. Greater emphasis needs to be placed on precision and accuracy while handling laboratory equipment and while engaged in procedures such as quantitative measurement, collection, presentation, analysis of data, and drawing inferences.

2.3.4. CONTENT OUTLINE

At the primary stage science is taught under the umbrella of Environmental studies. The contents are thematically organized into chapters titled: Things around plants; - Animals and us; our body and Food, health and weather. The syllabus concludes with a chapter titled: Man, science and environment.

Science education imparted to the students at the upper primary stage ought to form part of a smooth and seamless transition from the
‘environmental studies approach’ to a more formal study of science. With this as the guiding principle, efforts have made to formulate content and approach.

Accordingly, the organization of concepts in Class VI is somewhat similar to those of the lower primary. In Class VII and VIII, subject matter is dealt with at greater length. Themes like Science in everyday life; Things around us; Changes around us; Measurement; Separation of substances; The living world; The living body; Air, water and energy; Balance of nature and The universe, make up the course material that engage the students at Class VI. This is followed in Class VII and VIII by more subject oriented themes such as Mechanics; Heat; Electricity; Magnetism; Carbon and its compounds; Metals and non-metals; Life processes; Evolution, etc., Interdisciplinary topics like Health, Nutrition and Agriculture also constitute integral part of the subjects taught at this stage.

Science, at the secondary stage, is introduced around ten themes, such as: Matter, nature and behaviour; Motion; Force and energy; Ways of living; Human beings; World of work; Energy; Food and health; Environment; Natural resources and the universe. The time allotted for teaching science at primary, upper primary and secondary stage is 15%, 12% and 13% respectively of the total instructional time.

### 2.3.5. MAIN PROBLEMS

Some of the pressing problems facing India with regard to science education can be summarized as follows:

**Curriculum load**: There is substantial pressure emanating from parents and the general public alike who feel that the school curriculum is excessive and needlessly taxing. It is widely believed the students are stressed out and this has in turn affected their normal all round development. The problem of curriculum load is a complex one and has its roots in many related issues. NCERT is presently revising the national cur- ERT curriculum framework in an effort to resolve this contentious issue.
Preparation of teachers: Pre-services preparation and in-service training of teachers are major problems experienced during implementation of the curriculum. Given the huge number of teachers and geographical character of the country, management of in-service programmers is an intimidating prospect. Efforts are being made to address the problem through direct intervention at the institutional level as well as through distant mode I (and through tele-conferencing). A collaborative mechanism is being evolved by agencies like the National Council of Educational Research and Training (NCERT), National Council for Teacher Education (NCTE), Indira Gandhi National Open University (IGNOU), along with State Councils of Educational Research (SCERT) and District Institutes educational of Education and Training (DIET).

Methods of assessment: The attitude, approach, criteria and yardsticks adopted to assess and evaluate performances in the field of science are woefully inadequate. It in fact is emerging as a major stumbling block in efforts to improve the quality of the education system in India. Unfortunately, queries considered unlikely to rise at examinations are considered irrelevant and ignored by both staff and students. Methodologies adopted to assess performances are hardly conducive to the development of problem-solving skills among the pupils. To make matters worse, instruction is mainly assessment-driven in the country. Little or no significance is attached to the assessment of practical work, resulting in utter neglect of practical work in school education.

2.3.6. RECENT REFORMS

The latest reforms implemented in India are listed below:

Improvement of science education in schools:

To improve the quality of science education and to promote scientific temper, a centrally sponsored scheme: ‘Improvement of Science Education in Schools’ has been operational since 1987-88. Under the scheme 7-100% assistance is provided to the states/union territories (UTs) for provision of science kits to upper primary schools, upgradation of science laboratories and
library facilities in senior/secondary schools and training of science teachers. The scheme also provides for assistance to voluntary organizations for undertaking innovative projects in the field of science education.

Environmental Orientation to School Education:

A centrally sponsored scheme by this name was initiated in 1988-89. The scheme envisages grants to states and union territories for various activities including review and development of curricula of several disciplines at primary, upper primary and secondary levels. The objective is increase awareness about environmental issues. Review of textbooks on ‘environmental studies’ at primary and upper primary levels are undertaken with a view to update and enhance their quality. Strategies for imparting environmental education at upper primary level are worked out. Teaching and learning materials are being developed. Efforts are underway to organize innovative activities with a view to enrich the work experience so the teaching staff. To achieve these objectives, the scheme also has plans to seek out voluntary agencies for help and assistance.

Computer literacy and studies in schools:

The Department of Electronics, in collaboration with the Ministry of Human Resource Development, initiated a pilot project, ‘Computer literacy and studies in schools’ (CLASS) from the school year 1984-85. The LASS project was modified and converted into a centrally sponsored scheme from 1993-94. The aims of the projects are:

- To provide pupils with an understanding of computers and their use;
- To provide hands-on experiences;
- To ‘demystify’ computers to young school goers;
- To familiarize pupils with a range of computer applications and with the computer’s potential as a controlling and information processing tool. Meanwhile, the Information Technology Action Plan (1988), which makes significant provisions for integrating computers into the schooling process, has been adopted by the Government. As a consequence, the Ministry of Human Resource Development has launched a new school-computing programme CLASS 2000 from March this year. CLASS 2000 has the following three components:
• Computer literacy in 10,000 schools;
• Computer-aided learning in 1,000 schools;
• Computer-based education in 100 Smart Schools will become model centers for others.

NCERT developed the Blue Print for Smart Schools upon which the concept of computer-based education would develop. NCERT is committed to providing all possible on-line and off-line support to the above venture.

2.3.7. INNOVATIVE USES OF NON-SCHOOL RESOURCES

In order to promote and popularize science education, several out-of-school activities (using non-school resources) like science exhibitions, science clubs, debates, essay writing and quiz competitions are being organized by the NCERT, the Department of Science & Technology CERT, (DST), the National Council of Science Museums (NC- uncle NCSM), the Ministry of Non-Conventional Energy Sources (MNCES) and many voluntary organizations, such as: Vikram Sarabhai Science Centre, Ahmedabad; Homi Bhabha Centre of Science Education, Mumbai, etc.

NCERT has been pioneering exhibitions in India. It has been organizing national level science exhibitions every year since 1971. The national level science exhibition is the culmination of a series of exhibitions organized at school, district, regional and state level every year. At the beginning of the school session every year, NCERT circulates to all states/UTs the main themes and sub themes of the state-level science exhibitions for a particular year. In keeping with the central and state govern- government’s emphasis on improvement of educational facilities in rural areas and for economically weaker sections of the society, the main theme of national and state-level science exhibitions are infused with a distinct bias towards the felt needs of rural India. The social aspect of science and relevance of science and technology for development are some other criteria, which are given due consideration in determining the themes. The NCERT also provides de- RT detailed guidelines to the states for organization of exhibitions and outlines the criteria for evaluation of exhibits and the selection of judges.
The financial and academic support for the organization of science exhibitions are mainly provided by the NCERT and the state governments concerned. A list of exhibits selected for display at the National level with brief synopsis about each exhibit, a book titled ‘Structure and Working of Science Models’ containing details about some selected exhibits and publicity folders about the science exhibition are published every year by the NCERT.

The National Council of Science Museums (NCSM) organizes a number of activities like demonstration lectures, mobile science exhibitions for rural schools, science quiz, science seminars, science fairs, Nature Study and Environment Awareness Programs. NCSM operates and contributes to science education of children at a mass level through its four museums located at Calcutta, Bangalore, Mumbai and Delhi, besides utilizing a number of regional centres situated in different parts of the country. NCSM has set up 301 school science centres in the states of West Bengal, Assam, Tripura, Andhra Pradesh, Kar- Karnataka, Madhya Pradesh, Haryana, Punjab and Rajasthan. The centre develops kits and teaching aids, conducts its hobby camps, popular lectures, exhibitions, etc.

Vigyan Prasar (an autonomous organization under the Department of Science & Technology) has established a network of Science Clubs (VIPNET) throughout the country to strengthen the science club movement and to coordinate with other existing clubs and agencies. Vigyan Prasar also contributes to learning of science through its Homepage started in September 1996. It offers daily science news pertaining exclusively to Indian science and technology (S&T) along with archived news, links to other related sites, an online popular science magazine, Com.Com, which features interviews with eminent scientists, S&T development stories and articles on topical S&T themes.

Vikram Sarabhai Community Science Centre, Ahmedabad, conducts a mobile exhibition known as ‘Science Circus’. In this project, all materials required for demonstration, participatory events as well as slides, a special bus takes vents around films, etc. At any chosen venue, these are
displayed for the benefit of the public. Most of these activities are related to the prescribed curriculum while some others demonstrate the application of science in daily life.

The National Council is organizing national Children’s Science Congress every year for Science and Technology Communication (NCSTC). In this programme, children in the age group of 10-17 years, take up scientific projects related to local issues. They work under the supervision of the teachers/science activists and report their findings at school/block or district level Congresses. Select projects are presented at the state and national levels.

The National Bal Bhavan has been contributing towards enhancing the creativity among children in the age group of 5-16 years especially from the weaker section. It was established in 1956 and now operates throughout the country through its fifty-three affiliated state Bal Bhavans. There is a library as well as National Children’s Museum. It regularly organizes programmes wherein children can pursue activities of their choice such as in environment, astronomy, photography, science-related activities, etc. These experiences are enjoyable and memorable for the children, especially as they are predominantly from disadvantaged backgrounds. Thematic and general workshops are also organized regularly for teachers, trainers and adults in science activities.

2.3.8. NCERT’S EFFORT TOWARD A NEW CURRICULUM

We have had the opportunity to observe and analyse the strengths and weaknesses of the National Policy on Education that is in prevalence since 1986. With the benefit of hindsight we can safely conclude that we need to critically scrutinize and revamp the content, process, and approach to education, in general, and science education, in particular. Greater dynamism needs to be infused into the school curriculum in order to enable it to respond to the fast changing priorities and long-term developmental goals of the nation. A number of important developments have taken place since the last
revision of school science curriculum and these are bound to decisively influence the formulation, design and development of science curricula.

- Firstly, our understanding of ‘how students learn science’ has changed significantly. From process approach to science education, we have moved constructivist approach.
- Secondly, last two decades have seen emergence of a new taxonomy of practical skills, which is now internationally accepted and widely used. These aspects have to be taken care of in design of learning materials for children as well as in the technology of teaching and assessment.
- Thirdly, and probably the most significantly, development has taken place in the area of information technology. This is not only likely to considerably influence the end product, but also hugely impact the content and process of science education.

The National Council of Educational Research and Training has already started the process of revising the national curriculum framework. In the first phase, a document entitled ‘National Curriculum Framework for School Education–A Discussion Document’ has been brought out in January 2000. This document provides a curricular framework for all stages of school education. It has been evolved through a variety of strategies—by looking into theoretical and research materials, consulting and discussing various issues with faculty members, eminent educationists and experts.

In the second phase, workshops/meetings at national/ regional levels are being organized for extensive and intensive discussion in order to evolve consensus on various issues raised in the document. The document has been made available to all the stakeholders in education, i.e. other national and state-level institutions, school boards of education, state councils of educational research and training, directorates of education, parent/teacher associations, professional associations of teachers and teacher educators, and eminent educationists and educators. Their suggestions and responses will help enrich the final document. In the third phase, based on the guidelines provided in the new Curriculum Framework, syllabi, textbooks and other
instructional materials for all stages of school science education will be designed and developed.

The progress and development of science and technology in India and the enormous potential it holds for the future have been comprehensively summarized by Prof. R.A. Mashelkar, Director-General of Council of Scientific and Industrial Research in his Presidential address delivered at eighty-seventh Indian Science Congress, Pune, on 3 January 2000 as follows:

Let me sum up by recalling the new Panchsheel of the new millennium that we should launch in the year 2000.
It is simply:
_ Child-centred education;
_ Woman-centred family;
_ Human-centred development;
_ Knowledge-centred society;
_ Innovation-centred India.

These principles, if put into practice, will help India to acquire a scientific temper, edge towards a ‘learning community’, realise national dreams of being a ‘knowledge society’ and leave behind memories of underdevelopment.

2.4. HISTORICAL DEVELOPMENT OF SCIENCE EDUCATION IN TRIPURA

Tripura is one of the seven states in the north-eastern part of India located between 22 degree and 56 minutes and 24 degree and 32 minutes north latitude and between 90 degree and 09 minutes and 92 degree and 20 minutes east latitude. It is bounded on the north, west, south and south-east by Bangladesh whereas in the east it has a common boundary with Assam and Mizoram. Tripura’s physical feature differs from the north to south. It is a land of high hills, hillocks, and interspersed with river valleys. On its north, it has four valleys that have been separated by hills with heights of about 1,000 meters. On its south, it has open forested land spread over a wide range of area. The climate of the state is hot in summers and cold in winters with the temperatures ranging from 35°C to 10°C. Tripura receives an average rainfall of 2,100 mm. Due to the sufficient and well-distributed rainfall; the state has
an ideal composition of land mass and water that houses a large variety of flora and fauna here. A wide variety of plant and orchid species are found in the forests of Tripura. Sal (Shorea robusta) is an important product of the forests here.

2.4.1 Brief History of Tripura

The history of the region is mentioned in epic Mahabharata. It was ruled by the Manikya dynasty from the 14th century. The Manikyas, who supposedly belonged to the Indo-Mongolian group, ruled over this area independently even at the time when most parts of the Indian subcontinent were under British rule. The rulers of the state had a good relation with the British during that time and the later helped Tripura to protect itself from the Nawabs of Bengal to take over the state. After the independence of India, an agreement to merge Tripura with the Indian Union was signed by the Regent Maharani on September 9, 1947. This state became a union territory of the country without legislature from November 1, 1956 and a ministry was formed on July 1, 1963. On January 21, 1972, Tripura got its statehood. Accessing Tripura was difficult until when Maharaja Bir Bikram made an airport in Agartala. Rabindranath Tagore is said to have had a very deep touch with this state. The two famous novels by the Nobel laureate, namely, the Visarjan and Rajasri were based on the legends of the Manikyas.

2.4.2 Districts of Tripura

Tripura has 4 districts: Dhalai, North Tripura, South Tripura and West Tripura

2.4.3 Brief History of Education in Tripura

The territory of Tripura has had a very long continued history dating almost from pre-historic times but strangely no information is available on the administration of education in the territory up to the mediaeval times. It is only towards the last quarter of the nineteenth century that we get some information about the state of education prevalent in the territory but that too helps to form a very poor idea about this affair. The report about the education in Tripura as found in the Bengal Administration Report for the year 1874-75 shows that the prospect of education in Tripura was far from bright and very
little attention was paid to its improvement. The Report observes that “with an estimated population in the plains and in the hills of nearly 75,000 souls, there are about 103 boys undergoing instruction at the two existing schools. The school at Agartala has been in difficulty for the want of funds, which, however, were supplied by the Rajah, at the close of the year.” (Bengal Administration Report, 1871-75, Pp. 31-32). During the next year, two more schools were opened and in all 173 boys were on the rolls but ‘only one-half’ were regular in their attendance. Obviously, opening of two schools in a year does not indicate any good prospect.

The number of schools on 31st March, 1879 was 25 against 18 on the same date in 1878 and 6 in 1877; the number of pupils attending schools was 700 against 430 in 1878, and 186 in 1877. With the exception of the schools at Agartala all the institutions are Elementary Vernacular Pathsalas. Of the 700 pupils, 30 are the sons of Thakurs, 52 Tipperahs, 232 Manipuris and the remainder (388) Bengali Hindus and Mussalmans. Of 57 girls attending schools, three were Tipperahs and 54 Manipuris.” The number of students, as revealed in the above mentioned report shows that of all communities, the Manipuris were most eager to get their children educated, and the Muslims followed their trail. And it happened so that during the next year all the 64 pupils attending the existing four girls’ schools were Manipuris. But as no real interest was evinced by the State Officials in education, the number of pupils began to decrease from 700 in 1878-79 to 668 in 1879-80 and further to 647 in 1880-81, though the number of schools was raised from 28 to 31 at the end of the year 1880-81. This was due to the fact that the teachers were most irregularly paid and there was hardly any supervision of schools which was left with an officer on a salary of Rs. 20 per month.

Due to this lack of interest the number of schools came down to 27 and number of pupils to 609 during the next year. “The caste question had also an unfortunate effect on education as in consequence of the dispute the headmaster of Agurtollah School, the most important institution of the kind in the State, gave up his appointment and his place was still vacant at the close of the year.” During the next two years the state of education further deteriorated;
the number of schools came down from 28 in 1882-83 to 15 in 1883-84 and of these for girls from 6 to 2. The number of pupils decreased from 692 to 441. The report states that “the reasons assigned are that these institutions are indifferently looked after and irregularly supported.”

The state of education, prevalent in the State during this period, would be more evident from the fact that “with the exception of the schools at the sub-divisions, all the rest are mere Pathshalas and there was not even a single school in the State raised to the standard of an entrance school. During the next year it was again observed that the highest standard of education imparted in the English and / vernacular schools of the State correspond to those fixed for the minor and vernacular scholarships examinations under the Government rules.”

The full fledged Education Deptt. came into existence in Tripura from 1952. Education Deptt. is one of the largest departments in the Government of Tripura. There were 1042 teaching staff and 460 educational institutions in 1952. But in 1979 the total teaching staff rose to 9532 and the number of educational Institutions/sharply stepped up to 2009. The Education Department was tri-furcated into Education (School), Education (Higher) and Social Welfare and Social Education Department in 1979. The increase size of Education Deptt. in form of new, institutions and responsibilities necessitated the tri-furcation of the Deptt. At last the Education (School) Deptt. was bifurcated again into Education (School) and Education (Sports and Youth Affairs) Department in 1989. Thus for smooth running and proper development of all sectors of education, the Deptt. of Education was fragmented into four Departments and that marked the emergence of Education (School) Deptt. The total teaching staff at present is 33,294 in 3152 Schools.
2.4.4 OBJECTIVES OF EDUCATION (SCHOOL) DEPTT.

- Universal Elementary Education for children belonging to the age group 6-14.
- Universal retention in elementary school with Zero drop-out.
- Providing quality Education of a satisfactory level for developing competencies in the children to compete successfully in all India competitions.
- Provision of Primary Schools within a walk able distance of 1 Kemp. from the habitation with adequate physical facilities.
- Provision of upper primary schools within a distance of 2 k.m from the habitation.
- Provision of high school within a distance of 4 k.m. and H.S school within a distance 6 k.m. from habitation.
- Provision of Education Guarantee Scheme (EGS) Center for those habitations where schools are not viable.

2.4.5 ADMINISTRATIVE SET UP OF EDUCATION (SCHOOL) DEPARTMENT

Education (school) Department is headed by a Cabinet Minister. He is assisted by Commissioner, Secretary, Addl. Secretary and Joint/Under Secretary. The Directorate of School Education is headed by Director of School Education and assisted by one Addl. Director, 2(two) Joint Directors, 3(three) Dy. Directors, one School Meal Officer (SMO), 3(three) Officers on Special duties, one Project Officer, One Accounts Officer, 2(two) Senior Research Officer (SRO) one for Statistics & Survey and another for planning, one Joint Director, SCERT and several other District
and Block Level Officers. Director of School Education is the Chief Executive Head of the Deptt. and is assisted by the officers at the Directorate Level. The present set up of Educational Administration of Tripura at the School Education Directorate, District and Block Level are as follows:

2.4.5.1 Administrative system of Education Department of Tripura
2.4.5.2 Administrative system of School Education
Department of Tripura

- Education Minister
  - Commissioner
    - Chief Secretary
      - Addl. Secretary
        - Director of School Education
          - Addl. Director of School Education
            - Joint Director of School Education
              - Dy. Director of Education
                - Administrative Officer
              - School Meal Officer (SMO)
                - A.O
              - Senior Research Officer (SRO)
                - Planning Officer
                - Statistical Officer
2.4.5.3 Education Administrative Structure of District Level

District Level

- West District
  - District Education Officer / Sub.Div. Educational Director / District School Inspector / District Planning Officer / Officer In Charge of Finance

- South District
  - District Education Officer / Sub.Div. Educational Director / District School Inspector / District Planning Officer / Officer In Charge of Finance

- Dholai District
  - District Education Officer / Sub.Div. Educational Director / District School Inspector / District Planning Officer / Officer In Charge of Finance

- North District
  - District Education Officer / Sub.Div. Educational Director / District School Inspector / District Planning Officer / Officer In Charge of Finance

2.4.5.4 Education Administrative Structure of Block Level

Block Level

- Inspector of School
  - Dy. Inspector of School (Mid Day Meal)
  - Dy. Inspector of School
2.4.5.5 Education Administrative Structure of Circle Level

![Circle Level Diagram]

2.4.6 Tripura Board of Secondary Education

Tripura Board of Secondary Education started its functioning in the year 1973, is a statutory body of the Government, which conducts the school Examinations in the state. The School examinations conducted by the board, every year are:

- Higher Secondary (HS: +2) Examination - for XII Class
- Madhyamik Pariksha (10 class examination) - for X Class

Tripura schools are run by the state government or by private organizations, including religious institutions. Instruction is mainly in [[Bengali language | Bengali]] or [[English language | English]], though Kokborok and other tribal languages are also used. Secondary schools are affiliated with the [[Council for the Indian School Certificate Examinations | CISCE]], the [[Central Board of Secondary Education | CBSE]], the [[National Institute of Open Schooling | NIOS]] or the Tripura Board of Secondary Education. Under the [[10+2+3 plan]], after completing secondary school,

2.4.7 Administrative Setup of School Education

Education (School) Department with this administrative set up is in constant endeavor to attain the objectives as discussed earlier. For this purpose the question of budgeting with maximization of benefits is very material to consider. Budget for last 4(four) years are given below:-
Table No.2.4.7.1 Budget Provision of last four years in Education

<table>
<thead>
<tr>
<th>Year</th>
<th>Budget estimate (Rs.in crores)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001-2002</td>
<td>Rs. 371.87</td>
</tr>
<tr>
<td>2002-2003</td>
<td>Rs. 383.86</td>
</tr>
<tr>
<td>2003-2004</td>
<td>Rs. 420.20</td>
</tr>
<tr>
<td>2004-2005</td>
<td>Rs. 456.48</td>
</tr>
</tbody>
</table>

Strategy

In order to achieve the objectives of the Department, 2(two) main schemes namely State Plan and Centrally Sponsored Scheme comprising a host of schemes are being implemented in addition to other program/activities.

Table No.2.4.7.2. State Plan(Centrally sponsored other programme or Scheme activities)

<table>
<thead>
<tr>
<th>* Construction Ministers</th>
<th>* Financial Assistance to Sanskrit Scholars</th>
<th>*Prime Ministers to Sanskrit Scholars</th>
<th>Gramodaya</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>*Prime Ministers to Sanskrit Scholars</td>
<td>Gramodaya</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*Prime Ministers to Sanskrit Scholars</td>
<td>Gramodaya</td>
</tr>
<tr>
<td>* Supply of Equipments Pool of Resource</td>
<td>* Operation Black Board Scheme (OBB)</td>
<td>* Non Lapsable Pool of Resource</td>
<td>central (NLPCR)</td>
</tr>
<tr>
<td>* Stipend &amp; Scholarship</td>
<td>* National Programme of Nutritional Support to Primary Areas</td>
<td>* Member of Parliament</td>
<td>Areas</td>
</tr>
<tr>
<td>local Development</td>
<td>support to Primary Areas</td>
<td>Nutritional Support to Primary Areas</td>
<td>Areas</td>
</tr>
<tr>
<td></td>
<td>Education (NP-NSPE)</td>
<td>Nutritional Support to Primary Areas</td>
<td>Areas</td>
</tr>
<tr>
<td></td>
<td>(MPLAD)</td>
<td>Nutritional Support to Primary Areas</td>
<td>Areas</td>
</tr>
</tbody>
</table>

90
* Starting of new streams * Strengthening of State * Children’s Day
in H.S (+ 2 stage) Schools. Council of Educational Koishore Mela, Research and Training Rabindra Nazrul (SCERT) Utsav, Mother Tongue Day.

- **No of Institution as on 30-09-2003 (Source State Survey and Statistics):**
  - a. Primary / Junior Basic : 1776 ( A.D.C. managed 1232 )
  - b. Middle (Upper primary) : 1001
  - c. High : 410
  - d. Higher Secondary (+2 stage ) : 242
  - e. Number of EGS centre: 1939
  - f. Number of Bridge Course Centres: 200

- **No. of Stream in H.S ( +2 stage ) :**
  - a. Science : 96
  - b. Arts : 242
  - c. Commerce : 83

- **No. of Schools newly started / up-graded :**

<table>
<thead>
<tr>
<th>Type of School</th>
<th>2001-02</th>
<th>2002-03</th>
<th>2003-04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pry/J.B. (I-V)</td>
<td>21</td>
<td>31</td>
<td>251</td>
</tr>
<tr>
<td>Middle (VI-VIII)</td>
<td>21</td>
<td>35</td>
<td>550</td>
</tr>
<tr>
<td>High (IX-X)</td>
<td>22</td>
<td>11</td>
<td>01</td>
</tr>
<tr>
<td>H.S. (+2 stage)</td>
<td>07</td>
<td>06</td>
<td>04</td>
</tr>
</tbody>
</table>

- **Type-wise number of Teacher :**

<table>
<thead>
<tr>
<th>Type of School</th>
<th>2001-02</th>
<th>2002-03</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pry/J.B. (I-V)</td>
<td>9,327</td>
<td>1,998</td>
</tr>
<tr>
<td>Stage</td>
<td>Total</td>
<td>Women</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Middle (VI-VIII)</td>
<td>7,022</td>
<td>1,864</td>
</tr>
<tr>
<td>High (IX-X)</td>
<td>8,529</td>
<td>2,242</td>
</tr>
<tr>
<td>H.S. ( + 2 stage : XI-XII )</td>
<td>9,392</td>
<td>3,289</td>
</tr>
<tr>
<td>Total</td>
<td>34,270</td>
<td>9,393</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stage</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pry /J.B. (I-V)</td>
<td>1 : 23</td>
</tr>
<tr>
<td>Middle (VI-VIII)</td>
<td>1 : 20</td>
</tr>
<tr>
<td>High (IX-X)</td>
<td>1 : 23</td>
</tr>
<tr>
<td>H.S. ( + 2 stage : XI-XII )</td>
<td>1 : 23</td>
</tr>
</tbody>
</table>

2.5 Conceptual Analysis of Science Curriculum

2.5.1 The meaning and concepts

The term curriculum is commonly understood to mean a course of studies, because the original Latin word (currere) meant a course run to reach a certain goal. The earlier accepted aim of education was also confined to the acquisition of knowledge only and, as such, curriculum was identified with the items of knowledge imported through instruction in the institutions. But the modern idea of education has undergone a revolutionary change and its aims are now much wider in concepts, meaning and functions. The modern world is a scientific world and the modern civilization is a scientific civilization. The modern scientific developments have made the world much smaller. Events in today’s world are happening much faster and the society is also changing rapidly with time. In such a context, it is imperative that the concepts and meaning of education will change with the passage of time. Education is now considered a most dynamic social process and the concept of curriculum as a whole has also acquired a wider connotation.
The modern concept of curriculum is that it should cater for the all-round development of the learners. The Dictionary of Education defined curriculum as a body of prescribed educative experiences under school supervision, designed to provide an individual with the best possible training and experience to fit him for the society of which he is a part or to fit him for a trade or profession. In fact, according to the current concept, the curriculum includes the totality of experiences that the learners receive through all types of activities in and outside the classroom. The task of curriculum construction involves the selection of right experiences for the learners which will lead to attainment of educational objectives. It includes not only the course content, resources and materials for the purpose, but also guidelines on the methods and approaches to the teaching of the subject. According to Cunninghamham, “curriculum is the tool in the hands of the artist to mould his material according to his ideals in his studio.” Thus, curriculum is the instrument in the hands of the teacher, the artist to give shape to the materials, the students.

Curriculum evolves from life itself and, as such, curriculum planning should be life-centered. A curriculum must also conform to the needs of the state and the society. At the same time it should be flexible and dynamic since our modern society is fast changing with time. The curriculum should give more importance to the immediate needs of the individuals as well as the society and provide for their future needs too. We know that the psychological developments in a child are not abrupt but a continuous process. Therefore, whenever we are concerned with curriculum construction for any particular stage, we must see that it is continuous with the previous stage and is linked to the next stage. The young learners should be given continuous, connected and sequential science experiences from the primary stage to the high or higher secondary stage of school education. Care should be taken in organizing the course content so that the learners understand the basic scientific concepts, principles and definitions and see their application in everyday life. The methods and approaches for imparting science education should also develop in the learners the power of observation, critical thinking and scientific attitude. The approaches should be inbuilt in the curriculum structure to lead the learners through instruction and experiences, to develop the right interest.
and appreciation, and also the skill and ability to apply their knowledge of science in everyday life situations. The science contents as well as the approaches should enable the learners to use their knowledge in solving their individual as well as social problem.

2.5.2 Concept of Science curriculum construction

A curriculum should be flexible and broad-based to change according to the needs of the child and the society. Since the exposure a learner is subjected to, in or outside the school, ultimately has to benefit the society at large, curriculum should therefore be to live and move in a society and as such the curriculum must be related to his social environment. The curriculum on any subject should enable the learner to distinguish between right and wrong, good and bad. Thus, while preserving the best in his traditional and culture it must also enrich the cultural level of the society and the social environment. A well-planned curriculum helps the learner become socially adjusted in the society.

A curriculum is not just a list of theoretical statements. It must be activity-centered to be effective and interesting to the learners and must encourage creativity. It must satisfy the specific ability of each individual learner and lead him towards attainment of excellence in his skill. Science is a subject to be the curriculum for first hand experience through laboratory work or field-trips. A well-designed curriculum has well-organised, well-graded, continuous, and practically attainable course content.

The science curriculum must conform to the aims of teaching science and must consider the age, stage as well as interest and abilities of the children for whom the curriculum is being framed. It should indicate the desirable behavioral changes expected of the learners as the final outcome of the curriculum. Each subsequent unit or item of knowledge must have link and relationship with preceding or item of the contents. The contents should be organized in order of difficulty. But this does not mean that acquisition of knowledge is the only purpose of the curriculum. As already explained, the process aspect of science must be given equal, if not more, weightage than the product aspect. Without the development of the values of learning science,
science education will not only fail in its purpose, but may also become detrimental. A good and well-planned curriculum should develop in the learners the power of thinking. It must also provide for the study of the contributions and sacrifices of the scientists of the world. The learners should be in a position to appreciate the sufferings of the great men of science while working for the benefit of the mankind. The curriculum must also provide opportunity for productive utilization of leisure time of the learners and adequate locally relevant items of scientific activity to be pursued by the learners as hobbies.

2.5.3 Approaches to Curriculum Planning

The following table represents the extremes of some approaches to curriculum planning and formation.

<table>
<thead>
<tr>
<th>One Extreme</th>
<th>Other Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated</td>
<td>Disciplinary</td>
</tr>
<tr>
<td>Child-centered</td>
<td>Teacher-centered</td>
</tr>
<tr>
<td>Flexible</td>
<td>Structured</td>
</tr>
<tr>
<td>Process-based</td>
<td>Content-based</td>
</tr>
<tr>
<td>Conceptual</td>
<td>Factual</td>
</tr>
</tbody>
</table>

2.5.4 Approaches to Curriculum Organisation

The various approaches to curriculum organization are:

i) **Topical approach**

In this approach, the content of topic selected will be explained in detail in the same class. Once completed the topic will not be studied at any other class. For example, topics like electronics, polymers etc. appear only in class X. This method is suitable for higher classes. The disadvantages is that this approach may lead to atop sided syllabus with bias heavily for or against some subject and may not lead towards a sequential and coherent presentation of content

ii) **Logical approach**
In this approach the topics in the syllabus would be arranged in an orderly pattern using some logical principles like simple to complex. This could be applied to the topics in the same class or it could be spread over some classes. For example, the topics on modern physics are the last in any textbook because it is abstract and complex.

**iii) Psychological approach**

The approach calls for the arrangement of topics of the syllabus on the basis of psychological principles like law of readiness, reinforcement of accepted behaviour, and motivation for further learning. The selection of topics and learning experiences should be on the basis of mental and intellectual level, interest and stage of child.

**iv) Subject-catered approach**

This is other words can be called factual or discipline-centered approach. Every fact or concept introduced adds to the overall development of a subject. The curricular projects like the PSSC, BSCS, CBA and CHEM study in USA were all subject oriented. In all of them the curriculum is based on the acquisition of facts and concepts by students followed laboratory work subject wise.

**v) Activity- catered approach**

The best way to learn science is by ‘sciencing’ or ‘doing’. This approach envisages the science curriculum to be ‘process oriented’. Here the curriculum is ‘student- centered’ and emphasis is on student learning. This approach is used in the Hessian curriculum of the Federal Republic of Germany, which put the onus on teacher to teach any topic keeping in mind four important criteria,

i) An experimental is used

ii) Instruction should be based on problem solving

iii) Observation and interpretation of result is a part of the activities
iv) Fact and principles taught should be relevant to the individuals needs and those of society.

vi) Integrated approach

Science is usually taught as three separate subjects: Physics, chemistry and Biology by three separate teachers. Most concepts of science are interrelated among Physics, chemistry and Biology. The integrated approach aspires to present a coherent view of science by coordinating various branches of science. The NCERT’s science text-books are presented in an integrated approach.

vii) Concentric approach

In this approach topics will be organized in such a way that it finds a place in different classes of a course in progressive manner. The content wick be gradually presented from simple to complex as the class increases. This method is particularly applicable in the lower classes.

2.5.5 Science Curriculum in India

The Secondary Education Commission Report (1952-53) pointed out the following drawbacks in the school curriculum in India as follows

i) The curriculum is narrow in conception.
ii) It is bookish and theoretical.
iii) It is overcrowded but not providing rich and significant contents.
iv) It lacks practical experiences and other activities and hence leads to lopsided development of child’s personality
v) It does not cater to various needs and capacities of the adolescents.
vii) It is bereft of technical and vocational subjects
vii) It is dominated by examinations
viii) It is cut off from the life around the child.

2.5.6 Defects in the Existing School Science Curriculum
The science curriculum of India is a subject centered curriculum which is considered to be jumbling of facts from different branches of science in an unorganised and unpsychological manner (R.C. Das, 2003). The country is persisting with the subject-centric curriculum because it is well known that what we need is an activity-centered curriculum.

The present science curriculum suffers from the following defects:

1. The science curriculum is subject-centered and topical. Our science curriculum is loosely packed with varied topics from physics, chemistry and biology and termed as general science. It acquisition of knowledge and pays very little attention to the applications to daily life.

2. It is not in conformity with the aims and objectives of science. The curriculum is confined to the cognitive domain and mostly to the knowledge specific objective.

3. It is examination ridden. The examination system continues to be terminal and tests are memory oriented. Hence students and teachers give importance to some topics and completely ignore some others. The experiences in the teaching-learning process are all directed towards the examinations securing marks.

4. The curriculum does not provide for a variety of experiences and activities. The teachers usually uses lecture or lecture demonstration method of teaching. Science club, science hobbies do not find a place in our curriculum. Hands on experiences on the laboratory are very rarely provided.

5. It is cut off from the real life of the child and does not satisfy either vocational requirements or need of society.

6. It is not built on sound psychological principles and does not take into account individual differences. The gifted and backward students are completely neglected.

**2.5.7 Needed Action to Improved Science Curriculum in India**

According to the Secondary Education Commission recommended that the curriculum should be based on
1. totality of experience
2. variety and elasticity
3. relationship to community life
4. training for leisure
5. integration and correlation

The reorientation of science curriculum should be done keeping in mind the following criteria:

- The topics chosen should be in conformity with the aims of science teaching and should be able to achieve objectives under all the three domains i.e. cognitive, affective and psychomotor.
- The curriculum should be flexible enough to cater to different groups of students rural, urban and gifted/average/slow learners. It should be able to provide experiences depending on individual differences.
- Provisions should be made in the curriculum to provide experiences which lead not only to the ‘mastery of the subject’ but also to the mastery of the ‘processes of science’ and ‘skills of science’. Students should be taught ‘how to think’ rather than teaching them ‘what to think’.
- Curriculum should provide a variety of experiences that leads to the all round development of the child i.e., interests, attitudes, skills in addition to knowledge.
- Curriculum should be ‘activity-centered’ as far as possible and dependence on single textbook must be done away with.
- The curriculum should be based on sound psychological basis and along a logical axis.
- The curriculum should be integrated with the condition between different subject evidence and application with life highlight.

The syllabus should be flexible so the teacher can frame their own experience keeping local needs resources and materials in mind.

2.6 Objectives of Science Curriculum
The Science Curriculum at the elementary school level contains basic concepts in science education, health and environmental education, and some aspects of sustainable development of local resources. The curriculum also emphasizes mental and manual science skills, values, and attitudes. It aims at bridging the gap between children’s science knowledge and their daily conduct, thus making science more relevant to their life in the 21st century and to their aspirations for further education. The topics of the curriculum fall within six themes in all the grades: **plants and their habitats - animals and their habitats - man and his health - matter and energy - the earth and the universe - man and the environment.**

The content and objectives of the science curriculum for the elementary level were innovated in accordance with contemporary developments in science-technology-society and the new outlook in educational development in Lebanon. Besides that, the items were selected and organized using the criteria of interdependence, balance, sequence, and comprehensiveness. Thus, the curriculum would tend to the abilities, needs, and interests of the students.

A science curriculum is an integrated system of content, objectives, instruction, and evaluation. The basic approach in the present curriculum is to involve students actively in the learning process. This requires, in turn, an optimum balance between theoretical presentation of knowledge and practical science activities within and outside the classroom. In addition, modern individual and cooperative learning methods, the use of educational technology facilities, and coordination of science with other subject matter areas, particularly during the first cycle in the elementary school, are recommended.

The instructional objectives for the first and second cycles were stated in terms of the well known taxonomy of educational objectives. Thus, the cognitive achievement of students could be measured by objective tests. In other words, behavioral objectives could help students to recognize what is required of them in examinations.

The achievement of mental scientific skills by students is usually measured by objective tests. However, the acquisition of manual skills, values,
and attitudes are normally evaluated by observation of student behavior over an extended period of time and follow up.

### 2.6.1 ELEMENTARY LEVEL - FIRST CYCLE

**OBJECTIVES**

At the end of the first cycle, students are expected to be able to:

- Recognize the various aspects of growth and development in plants, animals, and children.
- Describe some natural habitats and the specific living organisms in them.
- Name the senses, their organs and functions, and mention the general functions of the human body.
- Classify animals and the food we eat into suitable groups.
- Observe animals, plants, and phenomena in the environment, and arrive at proper inferences based on observation and experience.
- Communicate orally, in writing, and by symbols.
- Acquire proper health and environmental personal habits.
- Name sources of heat energy, relate changes of state to heat, and infer the effects of force on objects.
- Measure length, temperature, and time by suitable devices.
- Carry out guided simple experiments and practice problem solving within the context of what is studied.
- Develop self-confidence through individual activities, exploring environment, and beginning to understand the organization of human body.
- Develop cooperation, respect, and positive interaction with others through team learning.
- Orient their inherent curiosity into interesting science activities.
ELEMENTARY LEVEL - FIRST CYCLE

CONTENTS

First Year

1) Plants and their Habitats
   - Plants in the children’s environment.
   - Germination of seeds.
   - Growth of plants and their needs.
   - Protection of plants.

2) Animals and their Habitats
   - Animals in the children’s environment.
   - Places where animals live.
   - Growth of animals and their needs.
   - Care of domestic animals.

3) Man and his Health
   - Growth and needs of children.
   - The senses: organs, functions, and importance.
   - Protection of sense organs.
   - Personal cleanliness, dental care.

4) Matter and Energy
   - Importance of the sun for the Earth.
   - Effect of clouds on sunlight.
   - Role of air in moving objects.
   - Role of water in moving objects.
5) **The Earth and the Universe**
- Concept of daylight.
- Concept of night.
- Concept of day.
- The four seasons and their features.

**Second Year**

1) **Plants and their Habitats**
- The garden and its components: an organized habitat.
- Taking care of a garden.
- Seasonal plants (a simple notion).
- Role of greenhouses.

2) **Animals and their Habitats**
- Similarity, difference, and variation among animals.
- External features of mammals, birds, reptiles, frogs and fish.
- Respiration in some animals.
- Benefits of some animals.

3) **Man and his Health**
- Principal parts of the human body.
- Our body movements.
- Care of eyes, hands, and mouth.
- Food groups: their sources and importance.
- Examples of traditional Lebanese cuisine.
- Natural food and industrialized food.
- Clean vegetables and fruits.

4) Matter and Energy
- Examples of nonliving things: sand, clay, pebbles, water, etc.
- Properties of sand and clay in water.
- Water cycle in nature (a simple notion).
- The states of matter.
- Role of push and pull in moving objects.

5) The Earth and the Universe
- Apparent movement of the sun.
- Movement of shadows during daylight and in relation to the sun.
- Determining time: periods of daytime.
- Reading the time on a clock.

Third Year
1) Plants and their Habitats
- Principal parts of a green plant.
- Basic components of a habitat.
- Examples of natural habitats: the forest, the desert, the sea.
- Plants which grow in the forest, in the desert, in the sea.
2) **Animals and their Habitats**
   - The forest, the desert, the sea: natural habitats for animals.
   - Animals which live in the forest, in the desert, in the sea.
   - Sea pollution and its effect on food resources.
   - Children’s responsibility in protecting the environment from pollution.

3) **Man and his Health**
   - General functions in the human body.
   - General notion of the systems which carry out these functions.
   - Basic factors of healthy growth and development.
   - Protecting the body to keep healthy.
   - Protection from accidents, first aid.

4) **Matter and Energy**
   - Sources of heat.
   - Heat and its relation to changes of state.
   - Principal properties of solids, liquids, and gases.
   - Capacity of liquids.
   - Transfer of heat between hot and cold bodies.
   - Temperature.
   - Devices for moving objects easily.
   - Concept of force: pulling, pushing, and raising objects.
   - Magnets and the movement of some bodies.
5) **Earth and the Universe**

- Sources of the moonlight.
- Phases of the moon.
- The lunar month.
- Temperature and its relation to weather.
- Formation of winds.
- Weather observation instruments, weather forecast.
- Erosion of rocks: role of moving water.

**2.6.2 ELEMENTARY LEVEL - SECOND CYCLE**

**OBJECTIVES**

At the end of the second cycle, students are expected to be able to:

- Identify the principal groups of living organisms and their nutrition modes, and distinguish their reproduction patterns.

- Recognize the various systems in the human body, name the organs, explain their functions and activities, and describe nutrients and state their importance.

- Infer the role of cells in living organisms.

- Describe and apply some ways of protection from diseases, and precaution from accidents.

- Name the components of a natural habitat and state the characteristics of fresh water habitats, and describe man-environment interaction.

- Give a simple description of the water cycle, the oxygen cycle, the carbon cycle, and state the importance of each one.

- Name the various forms of energy, describe transformations and uses of energy in everyday life, and also
describe propagation of sound and light, and the flow of electricity and heat.

- Name simple machines and explain their characteristics and everyday uses.

- Identify the solar system and its members and define the movements of the earth.

- Explain, with simple examples, the relation of science to industry and agriculture, and summarize the importance of sustainable development of resources and energy in Lebanon.

- Give examples of chemical reaction between familiar substances.

- Identify some survey, measurement, and information recording instruments.

- Carry out observations by using devices and instruments, and do scientific classification on the basis of one or two criteria.

- Carry out experiments and explain their results, plan experiments and control the variables, state expectations of what will happen in an experiment or in nature and compare them with the actual results.

- Develop a sense of beauty by observing the beauty and order in nature.

- Interact positively with the family and society by taking responsibility to keep oneself healthy and to protect the environment.

- Develop objectivity, honesty, and persistence in science activities.

- Develop science interests and a desire for excellence

**ELEMENTARY LEVEL - SECOND CYCLE**

**CONTENTS**
Fourth Year

1) **Plants and their Habitats**
   - Common wild plants in Lebanon
   - Freshwater habitats
   - Plants which grow in freshwater on the banks
   - Flowering plants
   - The conifers: cedar, pine, and cyprus
   - Non-flowering plants: mushrooms
   - Principles of plant classification
   - Role of plants in the conservation of topsoil
   - Pollution of freshwater and its consequences.

2) **Animals and their Habitats**
   - Wild animals in Lebanon
   - Freshwater animals
   - Vertebrates
   - Non-vertebrates
   - Principles of animal classification
   - Social insects: bees and ants.

3) **Man and His Health**
   - Support and movement systems: skeleton and muscles
   - Care and safety of the skeletal and muscular systems
   - Food pyramid, maintaining a balanced diet
   - Malnutrition and its consequences.

4) **Matter and Energy**
- Examples of matter
- Properties of matter
- Measurement of mass
- Mixtures and water solutions
- Magnets: shapes, attraction and repulsion
- Electric charges: production by friction, attraction and repulsion
- Sound and some of its properties.
- Propagation of sound
- How we hear
- Effect of noise on our health.

5) The Earth and the Universe
- Soil and its kinds
- Clay and its uses in crafts.
- Factors which cause soil erosion.
- Sandstone and limestone.
- Fossils in sandstone and limestone.
- Breakdown of rocks and formation of soil.
- Formation of subterranean water reservoirs.

Fifth Year

1) Plants and their habitats
- Patterns of nutrition in plants.
- Needs of green plants for producing food materials for growth and reproduction.
- Photosynthesis (a simple notion).
- Respiration in plants.
- Oxygen and carbon cycles in nature (a simple notion).
- Benefits of plants to man.
- Adaptation of plants to their habitats.

2) Animals and their Habitats
- Patterns of nutrition among animals.
- Decomposers and their role in nature.
- The food chain in a habitat.
- Adaptation and behavior among animals.

3) Man and his Health
- Nutrients: kinds, sources, functions.
- Role of water in the human body.
- Digestive, respiratory, circulatory systems and their functions.
- Protection of these systems, immunization.
- Food safety, food preservation, role of food technology.
- System of information on the labels of manufactured food.

4) Matter and Energy
- Sources of light.
- Solar spectrum, the colors.
- Passage of light through media.
- Propagation of light, reflection, refraction.
- How we see. Safety precautions.
- The electric battery, the electric
current.
- Flow of electric current through various bodies.
- Components of a simple electric circuit.
- Series and parallel circuits.
- Light and magnets from electric current.
- Protection from electric currents.
- The air: components, pollution.
- Composition of water and a notion about elements and compounds.

5) The Earth and the Universe
- The solar system and its members.
- The Earth and its spheres.
- Atmospheric pressure: the barometer.
- Factors which modify the surface of the Earth.
- The water cycle and its relation to weather.

Sixth Year

1) Plants and their habitats
- Structure of green plants: plant cell, transport tubes.
- Parts of a complete flower.
- Sexual reproduction in flowering plants.
- Vegetative reproduction and its importance in agriculture.
- Man’s role in the reproduction and hybridization of
plants.

2) **Animals and their Habitats**
   - The animal cell.
   - Reproduction in animals and aspects of adaptation.
   - Man’s role in the reproduction and hybridization of animals.
   - Interdependence of plants and animals in a habitat.

3) **Man and his Health**
   - Structure of human body: cells, tissues, organs, systems.
   - Nervous system, the skin and the urinary system.
   - Start of human body maturity.
   - The human body: a coordinated system.
   - Benefits of medical technology.
   - Effects of smoking, alcohol, and narcotics on our health.

4) **Man and Environment**
   - Definition of natural environment and its components.
   - Interaction between man and environment.
   - Importance of natural reservation parks.
   - Sustainable development of resources in Lebanon (a simple notion)
   - Insecticides and their effect on the environment.
   - Various aspects of pollution in Lebanon and its consequences.
5) **Matter and Energy**
- Familiar chemical compounds: acids, bases, salts.
- Chemical reactions between familiar substances.
- Law of conservation of mass in chemical reactions.
- Weight and its measurement.
- Simple machines and their uses.
- Some compound machines.
- Work and power.
- Technical instruction sheets.
- Information recording and preservation equipment.
- Energy: forms, transformations, importance.
- Rules of safety and maintenance in the use of machines.
- Sustainable development of energy sources (a simple notion).

6) **The Earth and the Universe**
- Movements of the earth around the sun.
- Consequences of the movements of the earth.
- Movement of the moon around the earth and its consequences.
- Satellites and space ships.

2.6.3 **Science Curriculum achievement Objectives**

2.6.3.1 **Level 1 and 2 Achievement objectives**

Nature of science

*Students will:*

Understanding about science
Appreciate that scientists ask questions about our world that lead to investigations and that open-mindedness is important because there may be more than one explanation.

Investigating in science
Extend their experiences and personal explanations of the natural world through exploration, play, asking questions, and discussing simple models.

Communicating in science
Build their language and develop their understandings of the many ways the natural world can be represented.

Participating and contributing
Explore and act on issues and questions that link their science learning to their daily living.

Living world
*Students will:*
Life processes
Recognise that all living things have certain requirements so they can stay alive.

Ecology
Recognise that living things are suited to their particular habitat.

Evolution
Recognise that there are lots of different living things in the world and that they can be grouped in different ways.

Explain how we know that some living things from the past are now extinct.

Planet Earth and beyond
*Students will:*
Earth systems
Explore and describe natural features and resources.

Interacting systems
Describe how natural features are changed and resources affected by natural events and human actions.

Astronomical systems
Share ideas and observations about the Sun and the Moon and their physical effects on the heat and light available to Earth.
Physical world

*Students will:*  
Physical inquiry and physics concepts  
Explore everyday examples of physical phenomena, such as movement, forces, electricity and magnetism, light, sound, waves, and heat.  
Seek and describe simple patterns in physical phenomena.

Material world

*Students will:*  
Properties and changes of matter  
Observe, describe, and compare physical and chemical properties of common materials and changes that occur when materials are mixed, heated, or cooled.  
Chemistry and society  
Find out about the uses of common materials and relate these to their observed properties.

2.6.3.2 Level 3  Achievement objectives

Nature of science

*Students will:*  
Understanding about science  
Appreciate that science is a way of explaining the world and that science knowledge changes over time.  
Identify ways in which scientists work together and provide evidence to support their ideas.  
Investigating in science  
Build on prior experiences, working together to share and examine their own and others’ knowledge.  
Ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations.  
Communicating in science  
Begin to use a range of scientific symbols, conventions, and vocabulary.  
Engage with a range of science texts and begin to question the purposes for which these texts are constructed.  
Participating and contributing
Use their growing science knowledge when considering issues of concern to them.
Explore various aspects of an issue and make decisions about possible actions.

Living world

_Students will:_

**Life processes**
Recognise that there are life processes common to all living things and that these occur in different ways.

**Ecology**
Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced.

**Evolution**
Begin to group plants, animals, and other living things into science-based classifications.
Explore how the groups of living things we have in the world have changed over long periods of time and appreciate that some living things in New Zealand are quite different from living things in other areas of the world.

Planet Earth and beyond

_Students will:_

**Earth systems**
Appreciate that water, air, rocks and soil, and life forms make up our planet and recognise that these are also Earth’s resources.

**Interacting systems**
Investigate the water cycle and its effect on climate, landforms, and life.

**Astronomical systems**
Investigate the components of the solar system, developing an appreciation of the distances between them.

Physical world

_Students will:_

**Physical inquiry and physics concepts**
Explore, describe, and represent patterns and trends for everyday examples of physical phenomena, such as movement, forces, electricity and magnetism, light, sound, waves, and heat. For example, identify and describe the effect of
forces (contact and non-contact) on the motion of objects; identify and describe everyday examples of sources of energy, forms of energy, and energy transformations.

Material world

*Students will:*

Properties and changes of matter

Group materials in different ways, based on the observations and measurements of the characteristic chemical and physical properties of a range of different materials.

Compare chemical and physical changes.

Chemistry and society

Relate the observed, characteristic chemical and physical properties of a range of different materials to technological uses and natural processes.

2.6.3.3 Level 4  Achievement objectives

Nature of science

*Students will:*

Understanding about science

Appreciate that science is a way of explaining the world and that science knowledge changes over time.

Identify ways in which scientists work together and provide evidence to support their ideas.

Investigating in science

Build on prior experiences, working together to share and examine their own and others’ knowledge.

Ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations.

Communicating in science

Begin to use a range of scientific symbols, conventions, and vocabulary.

Engage with a range of science texts and begin to question the purposes for which these texts are constructed.

Participating and contributing

Use their growing science knowledge when considering issues of concern to them.
Explore various aspects of an issue and make decisions about possible actions.

Living world

*Students will:*

Life processes
Recognise that there are life processes common to all living things and that these occur in different ways.

Ecology
Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced.

Evolution
Begin to group plants, animals, and other living things into science-based classifications.

Explore how the groups of living things we have in the world have changed over long periods of time and appreciate that some living things in New Zealand are quite different from living things in other areas of the world.

Planet Earth and beyond

*Students will:*

Earth systems
Develop an understanding that water, air, rocks and soil, and life forms make up our planet and recognise that these are also Earth’s resources.

Interacting systems
Investigate the water cycle and its effect on climate, landforms, and life.

Astronomical systems
Investigate the components of the solar system, developing an appreciation of the distances between them.

Physical world

*Students will:*

Physical inquiry and physics concepts
Explore, describe, and represent patterns and trends for everyday examples of physical phenomena, such as movement, forces, electricity and magnetism, light, sound, waves, and heat. For example, identify and describe the effect of forces (contact and non-contact) on the motion of objects; identify and
describe everyday examples of sources of energy, forms of energy, and energy transformations.

Material world

*Students will:*

Properties and changes of matter

Group materials in different ways, based on the observations and measurements of the characteristic chemical and physical properties of a range of different materials.

Compare chemical and physical changes.

The structure of matter

Begin to develop an understanding of the particle nature of matter and use this to explain observed changes.

Chemistry and society

Relate the observed, characteristic chemical and physical properties of a range of different materials to technological uses and natural processes.

2.6.3.4 Level 5

Achievement objectives

Nature of science

*Students will:*

Understanding about science

Understand that scientists' investigations are informed by current scientific theories and aim to collect evidence that will be interpreted through processes of logical argument.

Investigating in science

Develop and carry out more complex investigations, including using models.

Show an increasing awareness of the complexity of working scientifically, including recognition of multiple variables.

Begin to evaluate the suitability of the investigative methods chosen.

Communicating in science

Use a wider range of science vocabulary, symbols, and conventions.

Apply their understandings of science to evaluate both popular and scientific texts (including visual and numerical literacy).

Participating and contributing
Develop an understanding of socio-scientific issues by gathering relevant scientific information in order to draw evidence-based conclusions and to take action where appropriate.

Living world

*Students will:*

Life processes
Identify the key structural features and functions involved in the life processes of plants and animals.
Describe the organisation of life at the cellular level.

Ecology
Investigate the interdependence of living things (including humans) in an ecosystem.

Evolution
Describe the basic processes by which genetic information is passed from one generation to the next.

Planet Earth and beyond

*Students will:*

Earth systems
Investigate the composition, structure, and features of the geosphere, hydrosphere, and atmosphere.

Interacting systems
Investigate how heat from the Sun, the Earth, and human activities is distributed around Earth by the geosphere, hydrosphere, and atmosphere.

Astronomical systems
Investigate the conditions on the planets and their moons, and the factors affecting them.

Physical world

*Students will:*

Physical inquiry and physics concepts
Identify and describe the patterns associated with physical phenomena found in simple everyday situations involving movement, forces, electricity and magnetism, light, sound, waves, and heat. For example, identify and describe
energy changes and conservation of energy, simple electrical circuits, and the effect of contact and non-contact on the motion of objects.

Using physics
Explore a technological or biological application of physics.

Material world

*Students will:*

Properties and changes of matter
Investigate the chemical and physical properties of different groups of substances, for example, acids and bases, fuels, and metals.
Distinguish between pure substances and mixtures and between elements and compounds.

The structure of matter
Describe the structure of the atoms of different elements.
Distinguish between an element and a compound, a pure substance and a mixture at particle level.

Chemistry and society
Link the properties of different groups of substances to the way they are used in society or occur in nature.

2.6.3.5 Level 6 Achievement objectives

Nature of science

*Students will:*

Understanding about science
Understand that scientists’ investigations are informed by current scientific theories and aim to collect evidence that will be interpreted through processes of logical argument.

Investigating in science
Develop and carry out more complex investigations, including using models.
Show an increasing awareness of the complexity of working scientifically, including recognition of multiple variables.
Begin to evaluate the suitability of the investigative methods chosen.

Communicating in science
Use a wider range of science vocabulary, symbols, and conventions.
Apply their understandings of science to evaluate both popular and scientific texts (including visual and numerical literacy).

Participating and contributing

Develop an understanding of socio-scientific issues by gathering relevant scientific information in order to draw evidence-based conclusions and to take action where appropriate.

Living world

*Students will:*

Life processes

Relate key structural features and functions to the life processes of plants, animals, and micro-organisms and investigate environmental factors that affect these processes.

Ecology

Investigate the impact of natural events and human actions on a New Zealand ecosystem.

Evolution

Explore patterns in the inheritance of genetically controlled characteristics.

Explain the importance of variation within a changing environment.

Planet Earth and beyond

*Students will:*

Earth systems

Investigate the external and internal processes that shape and change the surface features of New Zealand.

Interacting systems

Develop an understanding of how the geosphere, hydrosphere, atmosphere, and biosphere interact to cycle carbon around Earth.

**2.6.4 Objectives of the Secondary School science curriculum:**

During the last few decades, the conceptual framework of physics has undergone a drastic change and this should be reflected in the high school physics curriculum. Similarly, in chemistry, the stress hitherto laid on memorization of facts, formula, processes and compound should give place to an emphasis on the unifying concepts in the subject. It is
necessary to highlight the applications of chemistry in industry and daily life and its growing importance in our developing economy. Again the present content of school course in biology is traditional in nature. The concept of biology as a method of inquiry by means of accurate and confirmable observations, quantitatively and mathematically analyzed, and controlled experimentation should be impressed on the minds of young learners. Earth sciences should be introduced in secondary school, geology and geography being taught as an integrated subject. There are also many areas in chemistry, physics and biology to which certain topics in the study of earth sciences can be naturally related.

In the objectives of secondary science curriculum it is defined that the pupil should be engaged in scientific activities, that they may realize the impact of science on the modern society. They should be encouraged to investigate scientific problems individually or in groups. They should be placed in situations where they can generalize and deduce. Their thirst for undertaking responsibility can be met by engaging them in work of projects, science club, science fair, etc. They should be encouraged to take active part in arranging science exhibitions, discussion, or debates on scientific topics, field trips or visits to places of scientific interest. Such experiences in the field of science enable them to learn science through activities appropriate to their age and ability. Due to maturity in skills, many pupils of this stage are keen to repair science apparatus and equipment or to improve apparatus. They should be given an opportunity to do so. The teacher’s attitude towards them is an important factor which determines his ability to control these senior pupils. The teacher should work with them in the laboratory or in outdoor activities or engage some of the pupils to perform simple demonstrations before the class. Special talents in science should be given facility and guidance to flourish in the field of their interest.

2.7 Process of Curriculum Evaluation:
The multiple educational evaluation models and definitions developed by evaluation theorists reflect the diversity of ideas and approaches towards educational evaluation. The diverse meanings and definitions of the evaluation concept includes viewing evaluation as an assessment of the worth or merit of some educational objects (Stufflebeam, 2000a, 2000b; Trochim, 2006); assessment of the achievement of objectives which is also known as the Tylerian view of evaluation (Madaus & Stufflebeam, 2000); and proving the success or failure of a programme. According to Madaus and Stufflebeam (2000) these are the conventional views of evaluation. As the field of evaluation continued to develop, Cronbach (1963) pointed out that the evaluation process should be focused on gathering and reporting information that could help guide decision-making in an educational programme and curriculum development. Nonetheless, while the models differ in many of their details, the decision to choose an evaluation model depends on a few important factors such as the evaluation questions, the issues that must be addressed, and the available resources (Madaus & Kellaghan, 2000).

This paper begins with clarifying the position of curriculum evaluation in the curriculum development model (Oliva, 1992). Curriculum process evaluation focuses on instructional activities in the teaching and learning process. A study on the teaching and learning of Science in English (TeSME) programme was conducted in year 2005. In this evaluation study, the process dimension of the CIPP (Stufflebeam, 2000) forms the basic framework. The process-improvement evaluation aims to detect strengths and weaknesses in the instructional process and to suggest constructive feedback about how things might be improved.

### 2.7.1 Curriculum Evaluation

Curriculum evaluation is seen as a sub model and the final component in the curriculum process in Razali Arof’s (1991) and Oliva’s (1992) curriculum development model. Oliva’s (1992) curriculum model conceptualised four main components – curriculum goals, curriculum
objectives, organisation and implementation of the curriculum, and evaluation of the curriculum. Figure 2.7.1 shows the feedback line in which information obtained in the evaluation component would provide useful data for each of the components of the Curriculum Model.

![Curriculum Model with Feedback Lines](image)

**Figure 2.7.1: Curriculum model with all feedback lines**

(Oliva, 1992: 478)

Oliva (1992) points out that to consider students’ achievement in their cognitive, affective and psychomotor learning as the effectiveness of the curriculum is not accurate. This is because, according to Oliva (1992), the primary purpose of curriculum evaluation is to determine whether the curriculum goals and objectives are being successfully carried out or not. In addition, Oliva (1992) asserts that in the course of the instructional process, there are other questions curriculum planners would like to know, too. Questions suggested by Oliva (1992:479) that are relevant in the context of this study are:

i. whether the curriculum is functioning while in operation

ii. if the best material is being used and following the best methods

iii. whether the programmes are cost-effective – whether we are getting the most for the money spent

It is the consensus of most curriculum developers that once a developed curriculum is implemented in schools, appropriate evaluation procedures shall be devised to examine the effectiveness of the curriculum in achieving the aims, goals and objectives of the curriculum. Feedback obtained shall also include any unintended outcomes so that information about the curriculum can provide useful data to enable further modifications in the curriculum, if necessary. A new curriculum once implemented in schools is in progress until
a time when the need arises it will not be terminated. Therefore, since a curriculum is ongoing, curriculum evaluation, teacher evaluation and programme evaluation are seen as the main components of process evaluation (Print, 1993).

2.7.2 Process Evaluation

Process evaluation aims to gather information to expound on the internal dynamics of how a programme operates. According to Print (1993:188), ‘Process evaluation examines the experiences and activities involved in the learning situation i.e. making judgements about the process by which students acquired learning or examining the learning experience before it has been concluded’. Concurrent with this view, Patton (1990) asserts that process evaluation focuses on how something happens. Thus, process evaluation includes the evaluation of instruction, the teachers’ teaching and the students’ learning (Patton, 1990). Teacher evaluation includes conducting evaluation on teachers’ instructional methods, student-teacher interaction, classroom interaction, teachers’ characteristics, teachers’ performance in the classroom and other dynamics of the teaching-learning situation. This type of evaluation is carried out with the intention to help teachers enhance their performance in the teaching and learning process (Print, 1993).

Viewing curriculum as a process (Mednick, 2006; Smith, 2000), it is essentially observing what actually happened and how these elements interacted to make meanings within the classroom (Smith, 2000). Inside the classroom there are a number of elements such as teachers, students, classroom environment and knowledge which are constantly interacting with each other (Huitt, 2003). Figure 2 depicts McIlrath and Huitt’s (1995) and Huitt’s (2003) model of instructional process which identifies the major categories of variables that are related to school achievement.
Huiitt (2003) explains that the category of Teacher Behaviour consists of all the actions a teacher would make in the classroom and includes three additional subcategories: Planning, Management, and Instruction. Planning refers to the preparations a teacher does to interact with students in the classroom. Management refers to class control and Instruction is the activity all of the actions students would make in the classroom.

Consequently, curriculum process evaluation intends to delineate, obtain and provide useful used by the teacher in guiding student learning. Student behaviour includes information (Stufflebeam, 2002) about what is going on in the classrooms so that decision alternatives can be made to maintain or to modify or even to eliminate the instructional strategies. In the CIPP model, Stufflebeam (2000b) notes that process evaluation is an ongoing check on a programme’s implementation which has three main objectives:
i. to detect or predict defects in the procedural design or its implementation during stage
ii. to provide feedback about the implementation of the planned activities
iii. to maintain a record of the procedure as it occurs.

In short, process evaluation aims to monitor, document and assess programme activities. Hence, this study was focused on the classroom process component. In relation to this study the process evaluation of the Revised Lower Secondary Science Curriculum taught in English will investigate the implementation at the school level. The study investigates if the instructional methods used in the classroom conform to the learning objectives, learning activities and learning outcomes as stipulated in the Curriculum Specifications handbook produced by the Ministry of Education, Malaysia. Procedural barriers, unintended outcomes, unanticipated issues that may arise in the particular situation will also be identified.

Figure 2.7.2.2: Components in Curriculum Process Evaluation

In summary, based on the discussion above, Figure 3 shows the relationship between the component “Curriculum process evaluation and Instructional Evaluation” in a curriculum process evaluation. Instructional evaluation focuses on the activities in the teaching and learning process. During instructional evaluation, the examination of the teacher’s performance,
teacher’s teaching-learning strategies, students’ learning opportunities, learning activities and learning experiences in class, and the teaching materials used are the main variables in providing useful feedback for improvement.

### 2.7.3 Purpose of the Evaluation

The following section is the argument for doing an evaluation study on the implementation process of the TeSME programme. Patton (1990) advocates that ‘implementation evaluation’ (Patton, 1990:104) is imperative for monitoring and getting feedback about the programme as to whether it is running effectively or not and what kind of intervention is needed before evaluating the outcomes of the implemented programme. Evaluators need to know what produced the observed outcomes in order to decide on what intervention ought to be taken to improve the programme. Hence, implementation evaluation informs researchers what is going on in the programme, how the programme has developed, and how and why the programme has or has not deviated from the objectives as planned (Patton, 1990).

In the context of this study, the focus was on the planned Lower Secondary Science Curriculum and its implementation in schools using English as the medium of instruction. During planning at the instructional level, teachers are expected to interpret the curriculum plan to create the instructional plans. The teachers themselves specify the instructional objectives and hence, decide methods of delivery and teaching strategies that are suitable for their learners. Moreover, Sowell (1996) asserts that the instructional curriculum that is actually used in classroom often varies from the planned curriculum due to various factors such as student responses or the learning environment. Hence, the study sought to evaluate the instructional process in the classroom and the learning experiences of the students as anticipated in the goals and objectives of the planned curriculum.

The study also investigated the unintended outcomes that might arise in the instructional process. According to Sowell (1996) the experiential curriculum is the one perceived, experienced and internalised by students. The experiential curriculum is in consonant with Doll’s (1992) ‘unplanned,
informal and hidden curriculum’. Ornstein and Hunkins (2004:12) assert that the unplanned, informal curriculum deals with social-psychological interaction among students and teachers, especially their feelings, attitudes, and behaviours.

The purpose of the process evaluation is to identify and monitor continuously various elements of programme operation. The process evaluation approach provides information about what is actually occurring and to determine why certain events are happening and what the impacts of the programme are on the people involved and on the educational institution. Similarly, Parlett and Hamilton’s illuminative model (cited in Madaus & Kellaghan, 2000; Patton, 1990 & Pang, 2005) primarily concerns about the description and interpretation of an innovation. It involves three main stages: the observation of on-going events, transactions and background information; then making further inquiries to refine data collected and lastly, to seek underlying principles, spot patterns of cause and effect and suggest alternatives to the planned activities. Therefore, in the evaluation of the teaching of Science in English, the illumination of unintended outcomes would be useful for the improvement of the implementation.

The Patton’s Utilization-Focused Evaluation (1997) emphasises the use of the evaluation findings which orchestrates with the fundamental concern of this study. Patton’s motto is to ‘focus on intended use by intended users’ Patton (1997:20). This evaluation research was designed to gather information about the classroom process and to use the evaluation findings for making improvements in the classroom teaching and learning process. Hence, a feedback session in the form of an oral presentation for the Science teachers in the school was carried out where I shared the findings, showed some theories and video clips about teaching techniques that could be applied in the classrooms. This approach is also consistent with the generic goals of evaluation which is to provide "useful feedback" to a variety of audiences (Trochim, 2006).

Evaluation research does not aim to discover new knowledge like basic research and it does not aim for truth or certainty like the basic sciences. It
aims to study the effectiveness with which existing knowledge is used to inform and guide practical action to help improve the quality of a programme. Clarke (1999:12) cites Chen’s (1996) fourfold typology which explains that process-improvement evaluation aims to detect strengths and weaknesses in programme processes, with a view to making recommendations for altering the structure, or adjusting the implementation, of a programme. Consequently, this process will help staff identify implementation problems and to make formative evaluation decisions to rectify the activities concerned (Stufflebeam, 2000b, 2003).

Therefore, my role in this evaluation research is to investigate the teaching of Science in English in the lower secondary classes with the specific intention of weighing up their strengths or weaknesses and providing feedback about how things might be improved. In order to find out how, what and why the teachers were teaching the way they do in their Science classrooms, a qualitative approach was used.

2.7.4 Methodology

A qualitative evaluation research was undertaken to investigate the teaching and learning of Science in English. Holliday (2002:24) says, ‘Getting into qualitative research is very often about grasping opportunities which address a good idea or longer-standing preoccupation’. Qualitative research allows one to find out the social realities in the natural settings. Qualitative researchers feel that human behaviour is always bound to the context in which it occurs and therefore, behaviour must be studied holistically, in context, rather than being manipulated. By employing qualitative methods in this educational research, it enables me to investigate teachers’ and students’ attitudes, beliefs and preferences and to investigate the setting (i.e. in the classroom). My intention was to observe the science teachers make meanings in their science lessons i.e how the science teachers are coping with their task and why they are adopting the instructional strategies in their natural setting (i.e. the science classroom). This concurs with the characteristics of qualitative
research emphasized by Bogdan and Biklen (2003:42) - ‘naturalistic, inductive and the concern with process and meaning’.

Then, I wanted to talk to the teachers in order to understand their reasons and beliefs in their instructional methods in science classes. Holliday (2002:1) says that ‘qualitative research presents a statement about reality and social life that has to be continually argued and reaffirmed’. Similarly, Patton (1990:420) asserts that qualitative methods are used to look for ‘What actually happens to people in the program? What they say about what happens to them?’

2.7.5 Participants

The participants of this research were five lower secondary Science teachers and their students. Four men teachers and a lady teacher willingly agreed to allow me to observe and to video record them teaching in their respective Science classes for a period of approximately six months. They gave full cooperation in the semi-structured interviews and discussions which were conducted individually. The students were interviewed using semi-structured interview protocol. The other participants involved were the Head of Science and Mathematics Department, the Principal and three English language teachers.

2.7.6 Instruments

The data were obtained through video recording the Science lessons, field notes, document analysis, semi-structured interviews and opinion questionnaires for the participants and students. Consent from the five main participants was obtained through an agreement made in a consent form. The teachers and students were assured that their participation is kept anonymous.

2.7.7 The Findings

This case study provides an in-depth understanding of how, what and why the lower secondary Science teachers were teaching Science in English in the rural school context. Although the findings are not representative of all the other lower secondary Science teachers in the rural schools in Sabah,
nevertheless, the study has shed light on issues identified in a rural school context.

**Figure: 2.7.7 Summary of Research Finding**

The flow chart in Figure 4 begins with the research questions that ask if the science teaching and learning instructional methods conform to the teaching methods that are suggested in the Science Curriculum Specifications handbook prepared by the Ministry of Education, Malaysia. Here the results show that it did not. Therefore, is it because of the use of English language that has resulted in teachers using particular teaching methods? In the findings, the teachers use a lot of bahasa Malaysia to teach in their Science class. English language was only used for giving simple instructions in class and when the teacher was reading the text in the textbook or the LCD screen. The findings reveal that the lessons observed in this case study were ‘traditional’ in nature that includes lecturing, telling and using worksheets to conduct a
Science lesson. The lessons observed did not portray characteristics of effective Science lessons that were enacted by research studies conducted by researchers such as Tytler (2001), Muijs and Reynolds (2001) and Weiss, Pasley, Smith, Banilower and Heck (2003). Even though the teachers did employ multiple semiotics resources in their Science teaching and learning process, there were no observations on students engaged in active participation in science investigations. Therefore, students were not encouraged to express their own ideas and pose questions, and students were not challenged to develop higher order thinking skills and to think laterally.

2.7.8 Implications

This research investigated why things were going on the way they were and whether the practices observed need improvement. Through conducting a case study, I was able to produce detailed information of classroom teaching and learning process. I began the study with broad questions but as the classroom observation progress new themes and new knowledge of variables gradually unfolded. The main aim is not so much about finding out how things really are but to see how teachers interpret and perceive the teaching and learning of Science in English in their classroom. Although a single case study cannot provide a sound basis for an effective instructional approach to integrate English language and science content learning, this study and other similar findings elsewhere would suggest a practical guide for teachers to teach science literacy skills and the contents simultaneously. More importantly, Fullan (1991:132) points out that it is essential that the introduction of an innovation to the teachers should begin from ‘the concrete to the abstract, from practical procedures and activities to a discussion of underlying principles, rather than the other way round as is the more frequent order’.

Firstly, Science teachers in the rural school lack professional development exposure in teaching Science in English. Therefore, classroom observations and video recordings methods should be used so that all the Science teachers would have an opportunity to critically view and comment on their instructional processes during subject department meetings. Through
open discussions based on observations and video recordings, teachers would be able to learn from each others strengths and weaknesses. As Fullan (1991:131) advocates that the degree of a successful change in schools is ‘strongly related to the extent to which teachers interact with each other and others providing technical help’. In addition, viewing video recordings of best practices and reinforcing with collegial discussions will also enlighten teachers the effective ways of dealing with students from different backgrounds.

Secondly, a review of instructional approaches for teaching Science in English to English language learners can be adapted for the teaching and learning context in this case study. More importantly, it aims to extract the practical ideas that can be adapted to the current situation in this case study, giving respect to generally accepted principles of effective teaching and learning Science. Based on the characteristics of the teachers, students and school environment in this case study, an integrated approach of rigorous science instruction and explicit instruction of academic literacy is deemed necessary. Supported by theories, research findings and the realities of the instructional situation, some practical recommendations are made for improvement in the teaching and learning of Science in the rural school. These recommendations focused on the basics of integrating science instruction with language instruction in the following aspects:

i. Teaching the linguistic structures of science
ii. Using Multiple Science Semiotics Resources
iii. Using bahasa Malaysia

Consideration of the cultural and linguistic experiences that students bring to science learning helps teachers to plan their instructional methods to suit the students’ needs. Lack of this understanding, thus applying substandard instructional approaches in classroom teaching may hinder efforts taken to achieve this goal. This study has also brought awareness to the teachers about teaching Science based on Lemke’s way to ‘talk Science’ (Lemke, 1990) in a Science classroom using the multiple semiotic resources: linguistics, visuals, gestures and experiments. Therefore, instructional approaches and ways to make learning science more meaningful that were
identified hopefully would not only generate an effective classroom atmosphere in a rural setting but also improve the general level of achievement for the majority of the students in Sabah.

2.7.9 Conclusion

The main purpose of this study is to look into what was happening in the science classrooms in a rural school and how were the Science teachers executing their duties in line with the new policy change of using English to teach Science in their context. At the same time, the research investigated why things were going on the way they were and whether the practices observed need improvement. Ellis (2004) clearly delineates the gap between theory and practice in the classroom. The main aim is to make research accessible to practitioners. In relation to this study, my hope is to look for practical pedagogical solutions for science teachers teaching in their classroom. Therefore, we must first engage in conceptual evaluation in order to identify research problem (Ellis, 2004:35). In order to find the best classroom practice, there is a need to investigate the teaching and learning process in the classroom, listen to teachers’ and students’ views. Hence, a qualitative case study approach was chosen because the intention of this research matches aptly with the two major elements of case studies. This study also brings awareness to educators that classroom research is an important activity for teachers to improve their instructional approaches.

2.8 Models of Evaluation of Science Curriculum:

Work related to study of curriculum based on well-designed and objectively specified model or approaches of evaluation made its beginning in the 1950s with the pioneering efforts of R.W. Tyler (1949) at the University of Chicago. Since then professional literature on the topics of curriculum evaluation has continuously grown. At present one can find at least half of a dozen books which refer to different models of evaluation. Perhaps one of the most comprehensive overviews of the various models has been given by Stenhouse (1975). In the present section a brief description of seven different models have been presented. However, wherever possible the investigator has
referred to the original writings of those who have propounded the different models.

2.8.1 Objective Model

The model proposed by Tyler (1949) is known as “Objective Model”. It is one of the best known models of curriculum evaluation. He designed the model primarily to evaluate the achievement level of either an individual student or a group of students. His model also has pointed to some other relationships that play a crucial role in the educational context and that pose important tasks for evaluation. The full and systematic study of the relationship between educational objectives, learning experiences and examination of achievement as spelt out in his model bring us closer to the overall notion of curriculum evaluation. A good deal of work has been done with the help of Tyler’s model. The model deals with a variety of aspects of an educational programme and describes many different activities that are included in the learning experiences which may, rightly, be the concern of curriculum evaluation. But, all these details and the model itself have been developed within the context of an objective based curriculum model. Consequently the model does not deal with the unplanned or unintended events in planning and implementation of teaching learning process.

2.8.2 Traditional Model

The traditional model treats the problem of evaluating a curriculum project or teaching style as the same kind of research as an experiment in agriculture and botany (Lowton.1978). The traditional model regards evaluation as a process of pre-test, teaching programme and post-test. This model is helpful to indicate whether the programme in the experimental group is superior or not to that in the control group which had not been exposed to the new programme. The main limitation of this model lies in the fact that it ignores the fundamental differences among human beings. Human beings perform differently when under observation but plants do not. The unintended consequences are very important in any situation involving human-beings.
specially children. Hence traditional or classical model is in many cases undesirable, sometime not even practicable.

2.8.3 Illuminative Model

This model received detailed attention by Parlett and Hamilton (1974). The primary concern of illuminative evaluation is with description and interpretation rather than interpretation and prediction. Illuminative model emerged to over come the feeling of inadequacy and unreality associated with the traditional model. Stenhouse (1975) and others called for an approach to curriculum which is descriptive and ongoing rather than going for rigorous concentration on precise prediction. Such an approach which is enlightened, pragmatic and which is able to discern the significant figures of the course can be called illuminative model in evaluation. In this process of evaluation the instructional system interacts with the learning milieu that is “the social-psychological and material environment, in which student and teacher work together”. This interaction is considered crucial for illuminative evaluation. Crucial to the approach is that the focus of attention is on the action. The evaluator is not attempting to control the situation he is studying; he does not try to hold it still while he looks at it. In this regard, he is like an anthropologist or an historian rather than like a laboratory psychologist.

2.8.4 Decision-Making Model

MacDonald (1974) in England has developed “decision-making model”. In this model, evaluation is inevitably concern with power in education. This model is concerned with three types of political decision-making processes, namely, bureaucratic, autocratic and democratic. Therefore, evaluation in this perspective must be related to a particular political stance as the evaluator can neither fully escape allegiance to a particular political stance nor can be completely value-free. Finally as MacDonald (1974) himself as observed this would result in a very complex process of collecting information including judgments which enable the decision makers to make a more rational choice. The model therefore, highlights the fact that, when evaluation basically
involves rational judgments for either selecting a particular curriculum or improving it, the judgment itself will necessarily be influenced by the evaluating agent, his affiliation to a specific political decision making process and the concomitant assumptions and values.

2.8.5 Case Study of Portrayal Model

One of the methods widely used in curriculum evaluation is the case study approach. Case study can be defined as an in-depth study, which is concerned with pertinent aspects of a particular unit or situation. The unit under study may be a person, an episode in a person’s life, a group of persons, a specific process or a culture. It is an intensive examination of a unit but treating the unit as a whole. The case study is applicable to serving multiple audiences, making research results more easily understandable and accessible. Even though case study has come to remain as an essential tool in curriculum evaluation, the model has own limitations. First of all, this model is not applicable to the evaluation of a general programme. Also the findings cannot be directly generalized and developed so as to make it applicable to other situations.

2.8.6 Research and Development Model

This model has initially borrowed from the engineering and defence industries. It is also called ‘industrial or factory model’. According to this model all curriculum development should begin with research. The industrialist must know what he is trying to produce; the school must know what kind of differences in pupil behaviour will be achieved. Here the evaluator’s task is seen to lie in the progressive requirement of objectives, translating these objectives into specific measurable behavioural objectives, and the development of an appropriate test instrument to measure how far they have been attained in practice. There remain a number of objections to this kind of evaluation model. The main focus of the research and development model is on the improvement of educational output. Hence the evaluation can reasonably be limited to the measurement of these outputs in terms of
improvements in pupil performance. But nowadays the emphasis in evaluation tends to shift from the product to the improvement of the learning process as a whole.

2.8.7 Teacher as a Researcher or the Professional Model

Stenhouse (1975) has suggested that evaluation should move away from the product and process model of curriculum towards a research model. He rejects the product model of curriculum which is based on output specified as behavioural objectives. The process model emphasizes quality of ‘input’ rather than measuring ‘output’. In the “teacher as a researcher model the teacher is a professional person indulging in “research-based teaching”. The teacher is a investigator. The concern of the teacher as a researcher is to find out whether the curriculum advances knowledge or not. It is a probe through which to explore and test hypothesis and not a recommendation to be adopted One of the problem of this model is that of role conflict. In particular, the teacher has to be both a teacher and a participant observer in his own classroom. It is extremely difficult and in some schools it may be impossible.

2.8.8 An overview of the models of evaluation

It can be noticed that the models greatly differ from one another not only in terms of scope and meaning but also in their methodological implications. The models after all, have been developed under different contexts and may be even to achieve different purposes One can find that newer models have come in order to overcome the inadequacies of the earlier ones or to accommodates newer perspective with respect to the process of education itself. For instance, the illuminative model came essentially to overcome the felt inadequacies of the traditional or experimentation model. Also the traditional concept of ends means description of the educational process was found to be narrow and thus paved the way for postulating more comprehensive models. A few examples of this model are given by Stenhouse (1975). MacDonald (1974) adds yet another dimension pointing out the role of political power groups as crucial in making decisions about content as well as form of curriculum. Whether
overall assessment coupled with recommendation for improvement should be the focus of evaluation or the endeavour should essentially emphasizes diagnosis and prescription through case study is another controversial point in this connection.

It should be finally recognized that any effort to indulge in a comparative analysis and appraisal of different models even with the noble purpose of arriving at a grand model will not only be difficult but also not worthwhile. One has to accept that pluralism of perspective regarding curriculum, as is the case with respective to the education process itself, is a reality. It is in line with this view that one of the UNESCO (1976) documents explicitly mentions that “the development of a single set of criteria for curriculum evaluation to all countries may neither be possible nor be desirable owing to the variety of conditions which obtain in the different countries of the world”. It has been rightly suggested that each countries should evolve its own set of criteria for curriculum analysis and evaluation.

2.8.9 Framework adopted in the present study

It has been pointed out that an appropriate framework for evaluation will have to be based on a critical overview of various models of evaluation on one hand and the basic parameters of evaluation that relevant with respect to curriculum in practice on the other. Such a framework would essentially consist of specification of the aspects or components of the curriculum to be brought under study and specific procedures to be adopted in analysis and interpretation. An attempt is made in the present section to briefly indicate the framework which was developed by Prof. M. B. Biswas, in 1986 for curriculum evaluation, adopted in the present investigation for evaluating the secondary physical science curriculum in Tripura. The evaluation framework adopted in the present study is given below
Diagram 2.8.9.1: Evaluation Framework

The framework has been conceived to consist of two major dimensions namely, structural features and operational features. Structural features refer to the various aspects of the curriculum in practice, namely, objectives, content, implementation and assessment that have been brought under the study. Operational features refer to specific techniques and procedures along with the sources of data which have been employed in the study for procuring relevant evaluative evidence about the different aspects of the curriculum. In fact, the operational features would necessarily be linked to the details of the various aspects of the curriculum brought under study. It would, therefore, be pertinent to discuss in greater detail the components specified under structural as well as operational features of the evaluation framework. Details regarding the structural features have been provided under four sub-heads namely, objectives, content, implementation and assessment.

**Structural Features of the Evaluation Model**

Available literature on curriculum evaluation reveals that there is no one way of categorizing the total field of curriculum into different components or aspects. For instance, in ‘Curriculum in Transaction’ (NCERT, 1978), four basic elements have been identified namely:

1. Objectives
2. Content Matter and Materials
3. Methodology
4. Evaluation
The ‘Curriculum for ten year school’ (NCERT, 1975) puts forth the view that the basis elements of curriculum are those concerned with:

1. The general objectives of education at particular stages
2. Subject wise instructional objectives and content
3. Course of studies and time allocation
4. Teaching-learning experiences
5. Instructional aids and materials
6. Evaluation of learning outcomes

Skager and Dave (1977) have divided the components of curriculum into the following major sub-components:

The four major components that have been chosen for study in the present investigation can be presented diagrammatically as in Diagram 2. The four major components of curriculum specified in diagram 2 in are not independent from one another. In fact each of them has a continuous and dynamic interface with the other components.

**Diagram 2.8.9.2: Four Components for Study**

A) Objectives

The clarification of objectives is a vital aspect in curriculum presentation. Curriculum is an operational document translating educational objectives into
practice position. Again it is educational objectives which satisfy certain criteria for education. These objectives again become the criteria by which content is selected and organized, materials are outlined and prepared, instructional procedures are developed and tests and examinations prepared. Taking into consideration the vital place of objectives in curriculum the present study included the evaluation of the objectives of curriculum itself as one aspect of evaluation.

B) Organisation of Curricular Content and Materials

The next logical step in curriculum evaluation is to go into the component of curricular content—selection of content and the organization of content and materials which constitute the devices for achievement the objectives. It is evident that curriculum organization is closely interlinked with the choice of the content materials and its practices. It is through these devices that the general objectives are translated into specific and behavioral objectives. The organization of the content is linked with the organization of specific objectives. The organization of content stems from the structure of the discipline and the ways of thinking the particular discipline embodies. It is also based on theories of knowledge which justify the integrations of disciplines within the curriculum. This further guides the author of textbooks to plan lessons more directly for the realization for specific objectives. Thus curricular content must be organized with a view to providing as well as appropriate adequate scope, sequence and integration for achievement of objectives. Therefore the present study considers to curricular content and organization as one of the components of evaluation with a view to examining their adequacy and appropriateness. The specific aspects which have been chosen for study in the present investigation have been presented in the Diagram 2.8.9. 3.
Diagram: 2.8.9.3: The Specific Aspects Chosen for study

C) Curriculum Implementation

Curriculum implementation is another major component in any curriculum study. When a final decision is made to introduce new materials, methods and procedures in the schools, the role of research or of evaluation becomes even more important in maintaining the quality and effectiveness of curriculum which are not determined solely by the curriculum materials. They are in fact, largely, determined by the interaction among various factors such as planning and preparation for implementation, how curriculum used by teachers and students and under what conditions it is used. Thus proper implementation necessarily demands proper preparation of teachers and provisions of necessary facilities. When a new curriculum is implemented, the general expectation is that its effectiveness will increase with passage of time. Teachers will gain experience and will get adjusted to the new content or teaching methods. Students may also become aware of what they are expected to learn from a new curriculum. Lewy (1977) differs with this view and points out that in some cases, however, a new curriculum that proved effective and feasible to implement in the earlier stages of tryout and field trial may turnout
to have inadequate feasibility once it is implemented throughout the system. Hence it is essential to investigate the condition or the situations under which the curriculum is being implemented. The present study aims at surveying mainly the existing status and conditions under which the present physical science curriculum for secondary education is being implemented in the secondary/higher-secondary schools of Tripura.

**D) Assessment Procedure**

Assessment is regarded as the process of appraising pupils’ achievement in different field of educational experiences which include both scholastic and non-scholastic areas. The existence of certain predetermined objectives of education is considered as a prerequisite for the purpose of evaluation. It would be worthwhile to examine whether the procedure or technique adopted by the teachers or schools bears any meaning at all for measuring the expected outcome or the assessment made by the teacher can help teachers can help the children in future learning or vocation. In view of the vital role of assessment procedure and techniques, the present study has considered it as a major component for investigation.

**2.8.10 Conclusion**

Any conceptual model or framework of evaluation includes in it certain assumptions, stated implicitly regarding the nature of curriculum itself, its content, organization, and implementation and so on. Thus it may appear that adoption of a predetermined model would bias the investigation in drawing inference about any particular curriculum in practice. It is therefore necessary to caution oneself that a conceptual model is only a device that guides the investigator in his choice of the procedures to be employed in that regard. One may not fully agree with Gordon (1967) when he declares that the function of evaluator is not to judge the curriculum and take sides in arguments about its worth but to reveal internal inconsistencies of the curriculum. However, it is needless to say that the purpose of evaluation is to effect improvement in practice rather than rigid application of any model and defending the concepts implicitly specified by the model. Accordingly, the present study has
employed an approach which will adopt external as well as internal criteria for analyzing and examining the secondary physical science education curriculum in Tripura.
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