UNIT 4  SCIENCE IN SCHOOL CURRICULUM

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4.1 INTRODUCTION

The National Curriculum Framework (NCF)-2005 provide sample scope for the holistic development of the learners. The NCF-2005 curriculum recommends various initiatives and approaches such as activity based learning, experiential learning, collaborative learning and so on. Also, the present curricular framework keeps learners as the key player of the teaching learning process. The present day curriculum and syllabus of school education is based on the NCF-2005. Keeping the relevance of NCF-2005, apart from discussing the various aspects of NCF-2005 with regard to science curriculum, the present unit will also touch upon the developmental stages of science education and changes in science curriculum advocated by NCF-2005. As we know, science has correlation with various other subjects like mathematics, social studies, art and music etc. Thus the unit will also discuss the correlation of science with other subjects citing different examples from secondary level.

4.2 OBJECTIVES

After going through this unit, you will be able to:

- explain the developmental stages of science education;
- describe various aspects of teaching science recommended in NCF-2005;
- discuss the recent changes in science curriculum
- explain the recent trends in science curriculum;
- differentiate curriculum of science at various stages; and
- explain correlation of science with other subjects.
4.3 HISTORICAL DEVELOPMENT OF SCIENCE EDUCATION IN INDIA

The famous scientist, C.V. Raman once said, “There is only one solution for India’s economic problems and that is science, more science and still more science”. As we know, the progress of any country has a close relationship with the development of science. Being a science teacher trainee, you should be familiar with the development of science education. The history of science has begun with the human existence i.e. homo sapiens have utilized basic knowledge of science for their existence while Palaeolithic’s tried to construct boats and houses apart from crude stone arms for hunting, which is recognised as a science activity. With the advent of human civilisation, people started to live in groups and science has influence on much of their activities. They also began to admire movement of heavenly bodies, invented mechanisms to calculate time, involved in metallurgical associated bustles, invented medicines and so on. During 600 B.C, science had grown as a theoretical entity. Excavations of Mohenjo-Daro, Harappa and Indus valley civilisations show the existence of town planning, drainage system etc. which require scientific skills and techniques. Aryabhatta, Brahmagupta, Bhsakara, Varahmihira, Atreya, Susruta, Charaka, contributed to the field of Mathematics, Medicine and Surgery. Thus we may conclude that, most of the ancient day activities involve various concepts and ideas of science.

Now we will briefly discuss the major developments in science education by categorising into three periods’ such as ancient and medieval period, modern period and period after independence.

4.3.1 Science Education during Ancient and Medieval Period

In India, there were tremendous developments in the fields like mathematics, astronomy, medicine, architecture and agriculture till 600 A.D. The medicine related knowledge was adapted from Rig-Veda (assumed to be written about 4000 years back), Vaisheskia (one of the Upanishads) discusses atom and formation of world, Sankhya philosophy resembles Darwinism and the Upa-Vedas discuss about various sciences. The ancient period followed a tradition of decanting knowledge from Guru to their best disciples. The two prominent ancient universities Taxila and Nalanda were emerged as part of the effort for institutionalising education. Thereafter, the invaders from various parts of the globe like west Asia and central Asia, played major role in nurturing science education apart from Arabic, Turkish and Persian languages.

4.3.2 Science Education during Modern Period

During British, newer branch of science; Modern Science was also introduced along with study of foreign language (English). In modern science, experiments were given prominence for acquiring knowledge. But they limited science education to the elite sections of the society. Thus the country couldn’t progress in scientific and technological development and secured a low position compared to western countries. During modern period, India followed the developmental process of science of western countries.
4.3.3 Science Education after Independence

The education system prevailing in the country was influenced by the England education system; but science education was not given much importance. The University Education Commission (1948), though primarily constituted for suggesting recommendations on higher education, emphasised inclusion of general science as a course in secondary level. The Secondary Education Commission (1953) advocated science subject, compulsory at both middle and secondary level and diversification of science subjects at senior secondary level. The All India Seminar on the teaching of science (1956) held at Tara Devi (Simla Hills) discussed the probable difficulties of incorporating science at senior secondary level and recommended a unique and uniform system of teaching science across the country. Under the chairmanship of late Shri Lal Bahadur Shastri, the Indian Parliamentary and Scientific Committee was set up in 1961 to study the problems of “Science Education in Schools”. In the 1963, the USSR experts of UNESCO planning Mission, visited India and suggestive measures were recommended to improve Science and Mathematics education. As a result, the Department of Science Education started pilot projects in preparing new textbooks and associated materials. The project was experimented in 20 schools in Delhi.

Thereafter, Indian Education Commission (1964-66) recommended the following measures for the improvement of science education:

- Science and Mathematics to be made compulsory subject during first ten years of schooling
- Teaching is to be related with agriculture in rural areas and technology in urban areas
- In lower classes, science should be taught by correlating it with environment.
- At higher classes, disciplinary approach is to be implemented
- Investigatory approach of teaching is advocated
- Science corner in lower classes and laboratory-cum-lecture room in higher classes should be created

Then, based on the recommendations of Indian Education Commission, the Ministry of Education and Social Welfare set up a committee to develop curriculum for 10+2 pattern and NCERT developed a document titled “The Curriculum for the Ten-Year School –A Frame work”. NCERT also prepared syllabi and textbooks which were adopted by CBSE. But the textbooks have invited lots of criticism for its theory dominated structure and limited scope for experimental activities. To review the same, Ishwarbhai Patel Committee was appointed in 1977. After that, based on the recommendations of Education Policy (1968), NCF-1975 was developed. Then NCF 1988 was developed based on the recommendations of Education Policy (1986) and was revised which resulted in NCF-2000. In 2005, the National Curriculum Framework was put into practice across the country. Based on NCF-2005, many state governments developed state-wise curricular framework and the same is being followed till today. In 2014, the central government appointed a committee to draft new National Educational Policy. The major recommendations of various NCFs have been discussed in the coming sections of this unit.
4.4 TEACHING OF SCIENCE AS RECOMMENDED IN NATIONAL CURRICULUM FRAMEWORK-2005

Until 1976, Indian constitution allowed state governments to take decisions on matters related to education and centre could only provide suggestions on policy issues. At the same time, the National Education Policy (1968) entrusted NCERT to develop Curriculum Framework and accordingly National Curriculum Framework-1975 was developed. In the year 1976, constitution amended to include education in concurrent list and as a result, for the first time, the country could evolve a National Policy on Education in 1986. NCERT was entrusted to develop curriculum framework. It was recommended that the curriculum should have a core component to be followed across the country. Thereafter, National Curriculum Framework for School Education (1988), Learning without Burden (1993) recommended various suggestions to improve school education. NCERT developed new National Curriculum Framework in the year 2005. The following aspects related to science education have been discussed in NCF-2005:

Criteria of Ideal Science Curriculum: What is the ‘nature of science’? As we know, the physical world is explored and understood with the help of science. The facts, principles and theories of science are used to explain the physical world. It is a fact that, science is an ever-expanding knowledge sphere; many of the established universal laws are subject to change based on new observations and experiments. Even then, it is concluded that, science in general is used to explain the environmental phenomenon and physical world around us. Science is also equated to technology; technology employs the various principles of science. The relation between ‘nature of science’ and technology help us in formulating the ‘vision of science education’. According to NCF-2005, good science education is one that is true to learner, true to life and true to science. Thus science education is intended to meet following criteria (validity) and science curriculum should adhere to it.

- **Cognitive validity** requires that the content, process, language and pedagogical practices of the curriculum are age appropriate, and within the cognitive reach of the learner (NCF-2005). For example, the basic concepts...
of electromagnetic induction have to be taught before introducing the electric

generator.

- **Content validity** requires that the curriculum must convey significant and
correct scientific and correct information. Simplification of content, which
is necessary for adapting the curriculum to the cognitive level of the learner,
must not be so trivialised as to convey something basically flawed and/or
meaningless (NCF-2005). What does it mean? The content transacted in the
curriculum should be significant and scientifically accurate. We teach
periodic table to learners just as an arrangement of elements. But it is
meaningless until you expose learners to the scientific basis of ordering
elements based on the atomic number (number of protons), electron
configuration, chemical properties, etc. Many more logical factors contribute
to the arrangement of elements in the periodic table and that must be
convinced.

- **Process validity** requires that the curriculum should engage learners in
acquiring the methods and processes that lead to the generation and validation
of scientific knowledge and nurture the natural curiosity and creativity of
the learner in science. Process validity is an important criterion since it
helps the learner in ‘leaning to learn’ science (NCF-2005). The curriculum
should engage learners in activities and experiments focusing the theory
“learning to learn” and thereby developing the cognitive skills, curiosity,
creativity and scientific knowledge. For example, chemical reaction is a
topic to be taught by demonstrating. At the same time learners need
opportunities to experience it. Thus the processes in science must be
demonstrated and experimented.

- **Historical validity** requires that the science curriculum be informed by a
historical perspective, enabling the learner to appreciate how the concepts
of science evolve over time. It also helps the learner to view science as a
social enterprise and to understand how social factors influence the
development of science (NCF-2005). The knowledge that, science and
scientific knowledge has historical evidence regarding its development and
curriculum should emphasise it. The efforts of scientists must be appreciated
by learners and they themselves have to emerge as scientists. For example,
while you teach different branches of science, you may explain the history
behind it.

- **Environmental validity** requires that science be placed in the wider context
of the learners environment, local and global, enabling him/her to appreciate,
the issues at the interface of science, technology and society, and equipping
him/her with the requisite knowledge and skills to enter the world of work
(NCF-2005). Science, technology and society are closely interrelated. The
growth and progress of science and technology should benefit each other.
The curricular learning experiences should relate to learners’ environment.
For example, learners study the concept of ‘cell’ but they are less concerned
about faulty batteries. People throw away obsolete batteries which has
harmful effects to both environment and human life as it contains harmful
chemicals. Thus, while teaching science the interrelationship among various
components must be taught.
Ethical validity requires that the curriculum promote the values of honesty, objectivity, cooperation, and freedom from fear and prejudice, and inculcate in the learner a concern for life and preservation of the environment (NCF-2005). For example while teaching the concept ‘nuclear bomb’; teachers must be able to develop qualities like empathy, sympathy, etc. in learners.

Science Curriculum at Different Stages: While developing the curriculum of various stages; the factors such as ‘general aims and objectives of science education’, content, pedagogical practices and mode of assessment must be considered. The various curricular activities recommended for primary, upper primary, secondary and senior secondary stages in the NCF-2005 are discussed in section 4.4.2.

Development of Inventiveness and Creativity: One of the major objectives of teaching science is to develop among the learners the spirit of inquiry and creativity. Hence, NCF-2005 recommends the following:

- Engage learners in learning activities, science fairs, experiments and projectwork, learners’ science congress, co-curricular activities etc. to promote curiosity, inquisitiveness and creativity.
- Organise science and technology fairs at local, district, state and national level with coordinated effort of national and state level agencies, non-governmental organisations and teacher associations.
- Develop experimental and technological modules along with text books and develop internal assessment mechanisms for evaluation.

Textbooks: Textbooks are the core medium of transacting curriculum and thus the following points must be taken into consideration:

- Promote extensive use of textbooks among learners and teachers. This also calls for universalisation of science education.
- Incorporate diverse learning activities in the textbooks. The field experiences of teachers must be considered while writing textbooks. Also ensure the participation of teachers, state and national agencies during preparation of textbooks.

Examination System: Learners are to be assessed at various stages of learning to ensure the attainment of educational objectives. The following assessment reforms are recommended in the NCF-2005:

- Internal assessment must be practised for experiments, learning activities and technological modules even for secondary and senior secondary board examinations.
- The theoretical examination should include questions to test critical understanding, experimental skills, enquiry procedures and competency to solve problems.
- To reduce stress, learners must have freedom to attend examinations at their own choice and time and the credits could be accumulated.

Teacher Empowerment: The future teachers are trained and shaped at the teacher education institutions. The quality of learner-teachers depends on the quality of teachers by whom they are trained. In such a scenario, the following are recommended for teacher education institutions;
The teacher training practices require a complete overhaul in training programme, pedagogic practices, curriculum and training of science teachers. Future science teachers must be oriented and given training in skills and competencies in science teaching.

- Teachers who have school teaching experience must be appointed as science teacher educators. Recruitment modalities must be modified to appoint qualified teachers.
- Qualified and trained teachers must be attracted and appointed at various levels of schooling. Academic autonomy could be provided to maintain the quality of teaching.
- Implement measures to practice peer interaction among teachers and exchange of teachers within and outside schools may be promoted.
- Discourage the practice of entrusting teachers with extracurricular duties, reward and honour best practising teachers with incentives and promotional schemes.

**Equity:** The disparity among poor and rich, caste inequalities, regional indifferences, etc. hinders the economic and cultural development. Each school subject should prepare learners fight against such anomalies. The following are suggested to maintain the equality and removal of discrepancies;

- Use science education as an instrument to build awareness and removal of caste issues, religious problems, gender divide, etc. This removes social–economic divide and bring in social transformation among people.
- Even though curriculum is context focused, it should provide scope to respect individual and diverse life styles.
- Implement suitable measures to sensitise teachers for a gender fair science education, both at pre-service and in-service stages.
- Use of ICT as a medium to promote science education and to reach the weaker and rural sections of the society thereby eliminating social divide of deprivation of education.

**Activities**
1) Compare the NCF-2000 and NCF-2005 and critically analyse the recommendations made on science teaching.
2) Collect views of your fellow teacher trainees about NCF-2005 and prepare a report.

**Check Your Progress**

**Note:**

a) Space is given below to write your answer.

b) Compare your answer with the one given at the end of this Unit.

2) “According to NCF 2005, the science curriculum should meet different criteria (validity)”. Discuss the statement.

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3) Discuss the recommendations of NCF-2005 made on teacher empowerment.

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4.4.1 Recent Trend in Science Curriculum

Today science is taught as ‘integrated science’ in secondary classes while at senior secondary level learners study science as disciplines such as physics, chemistry and biology. The syllabus at secondary level focus on themes like Food materials, The world of living, Moving Things, People and Ideas and Natural resources, etc. But disciplinary approach is followed at senior secondary classes. As we know, a variety of changes has been brought in school curriculum from time to time as result of various education policies and curricular frameworks such as National Education Policy (1975), National Curriculum Framework (1975), National Policy on Education (1986), National Curriculum Framework (1988), and National Curriculum Framework (2000 and 2005).

The NCF of 1975 recommended 10+2 pattern of school education with general education of 10 years; science as a core subject as activity based integrated subject till class X. The National Curriculum for Elementary and Secondary Education (NCESE) of 1988 also suggested general science as a core subject up to class X. The curriculum should be ‘learner centred’ aiming to develop abilities in cognitive, affective and psychomotor domain of the learners. The learning of science at secondary stage should help learners to develop the skills of problem solving and decision making along with comprehension of key concepts across various disciplines. The National Curriculum Framework for School Education (NCFSE), 2000 recommended teaching of science and technology in classes VI to X as single disciplines and disciplinary approach in senior secondary level. NCFSE also suggested to include ‘technology; in science courses as technology has influence on life in varied ways.

The committee constituted to outline National Curriculum Framework-2005 remarks on science education “looking at the complex scenario of education in India, three issues stand out unmistakably. First, science education is still far from achieving the goal of equity enshrined in our constitution. Second, science education in India, even at its best, develops competence but does not encourage inventiveness and creativity. Third, the overpowering examination system is basic to most, if not all, the fundamental problems of science education in India” The committee recommended various suggestions on science curriculum, pedagogy, content, examination, teacher training processes, etc. NCF-2005 reinstates the recommendations of NPE 1986; curriculum should have a common core and other components that are flexible. The following are the recommendations related to science education outlined in the NCF-2005.
Constructivist Approach of Learning: The NCF-2005 places learners at the centre of teaching–learning process. NCF remarks, the knowledge construction is an evolving process and learners constantly develop knowledge by actively participating and utilizing his/her previous experiences. The active participation of the learners in the teaching-learning process is a prerequisite for the construction of knowledge. Thus the ‘constructivist approach’ of learning is emphasised by NCF-2005.

Learner Centred Syllabus: The information load in syllabus is reduced by considering the report ‘Learning without Burden’ and thus age appropriate concepts are included in the syllabus. ‘Learner Centred’ syllabus has been recommended that would enable learners to develop problem solving skills, curiosity, inquisitiveness, etc. Food and Nutrition, Health, Population, Agriculture, Environmental Protection forms the essential components of syllabus. The Learner is expected to develop skills in process of science rather than acquaintance with content of science.

Pedagogical Shift: Pedagogy deals with strategies and practices concerning organisation of teaching learning activities in a classroom. The NCF-2005 has recommended extensive changes in various pedagogical aspects. Acquisition of knowledge by the learners is replaced with the approach of construction of knowledge by the learners themselves. While planning teaching-learning activities, the teacher has to consider the existing ideas of the learner and must facilitate, guide and support learners to construct new knowledge. In such classrooms, learners are the key players and such pedagogy is called ‘learner centred pedagogy’. Learner centred pedagogy is recommended by NCF-2005. Thus the teaching centred classrooms have been shifted to learner centred classrooms.

Assessment Mechanisms: The assessment of learners should include multiple assessment strategies like assessing learning activities, experiments, portfolios, presentations, project work, assignments, self-evaluation etc. The understanding and application level of learners must be assessed in place of testing the rote memorisation capabilities. The examination stress is reduced by implementing continuous and comprehensive examination (CCE). Continuous refer to assessment of learners throughout the academic year and comprehensive means assessment of overall aspects of learners including curricular, co-curricular and personality attributes.

Critical Pedagogy: NCF -2005 recommends sense of democracy in science learning through the critical pedagogy approach. Critical pedagogy is a learner centred pedagogy that considers the experience and perception of learners in the teaching-learning process thereby making learning fear free and independent for the learner. As we know, learners were considered empty slates to which the teacher was pouring factual informations. But today, the knowledge given by the teacher is critically analysed and learners construct their own knowledge. Teacher has to motivate and facilitate learners to construct knowledge in a democratic way.

Scientific Method and Scientific Inquiry: The learners must be engaged in challenging situations so as to develop the skill of inquiry and to arrive at reasonable answers employing scientific method. As learners explore answers to
problems, skills like observation, hypothesising, data collection, etc. are developed among them. Also the experience with problem solving situations helps learners to explore the world around them. Thus NCF-2005 advocates experiential learning in science classrooms.

**Diversity, Inclusion and Planning Teaching Learning Activities:** The classroom normally consists of learners having multiple skills, intelligence levels and learning styles. Also there are learners from different castes, religion, backward classes; learners with learning disabilities and learners who need special assistance. Since the classroom being diverse in nature, the teacher must plan teaching learning activities that suits the individual needs of the learners and promote meaningful learning of science.

**Use of Textbooks and Learning Materials:** Textbooks function as an important resource for knowledge construction. Textbooks should not be loaded with factual information’s rather should provide learners challenging situations to actively engage in learning processes and construction of knowledge. So textbooks and other learning materials should be used.

**Different Approaches and Strategies of Learning:** The NCF-2005 recommends different approaches and strategies for transaction of the curricular content to learners. The approach and strategies includes constructivist approach, 5E learning model, collaborative learning approach, problem solving approach, concept mapping, experiential learning, inquiry approach, cognitive conflict, analogy strategy, etc.

**Use of Information and Communication Technology:** Extensive use of various ICT resources and e-learning applications are advocated as a supplement of teaching-learning processes.

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**Check Your Progress**

**Note:**

a) Space is given below to write your answer.

b) Compare your answer with the one given at the end of this Unit.

4) Discuss the recommendations of various NCFs on science curriculum.

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5) Explain relevance of ‘critical pedagogy’ in learning of learners.

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Activity
3) How will you ensure the learning needs of learners in an inclusive science classroom? Suggest different approaches/strategies and prepare a report.

4.4.2 Science Curriculum at Various Stages

We have discussed the ‘criteria of validity’ of science curriculum, which forms the basis of curriculum of science at various stages of schooling. A brief discussion of curriculum at various stages is given below:

**Primary Stage (Classes I to V):** The curriculum of science at primary stage should focus on the following aspects:

- To develop cognitive and psychomotor skills by engaging and exploring nature, natural phenomena, hands-own activities, etc. This promotes the curiosity among learners as they slot in observation, classification, drawing inference, judging situation, estimation and measurements.

- To help learners to internalise human values, cleanliness, honesty, cooperation, truth, hygiene, social interaction, concern for life and environment, etc. Group activities, situations to engage in activities outside classroom, opportunity to interact with nature, plays, etc. is to be promoted.

- Primary stage emphasises language skills (3RC’s-Reading, Writing, Speaking) through science learning, as one of the ways. Care should be taken to transact teaching content in local language/mother tongue. The teaching learning process must be unstructured giving freedom to teacher to organise learning activities and accomplishment of overall objectives at primary stage.

- The practice of teaching science as “Environmental Studies” is to be continued but health education should find a prominent space. The criteria for selection of content should be meaningful, relevant and according to the interest of the learners.

- Even though teaching learning is unstructured, from class III onwards, a structured way is advocated and assessment should be continuous. Up to class II, formal assessment practice is not to be practiced. Formal periodic tests, judging based on grades are to be avoided and *no pass or fail system* is to be followed at the primary stage (Source: NCF-2005).

**Upper Primary Stage (Classes V to VIII):** The curriculum of science at upper primary stage should focus on the following aspects:

- Learners have opportunity to explore various elements of science and starts making sense of science in daily experiences and thus science education transit from environmental studies to elements of science and technology at the upper primary stage. Learners recognize science concepts through hands-own activities and experiments, even then not necessary to strictly follow the inductive approach of inquiry.

- The integrated approach of teaching is followed emphasising teaching science as a single subject. Emphasise teaching biographies of scientists
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and inventors to inspire learners and implement experiences to acquire different process skills. Apart from textbook knowledge, create opportunities to explore, discuss, and debate environmental issues, problems of health, drug related matters, etc.

- The problems that learners sense meaningful and significant (arrived through discussions in the classrooms in the presence of teacher, communication with elders, from newspapers, etc.) must be tested and experimented apart from simple experiments and hands-own activities.

- The practice of pass and fail and no detention policy to be avoided but steps may be implemented to organise periodic assessment of learners through unit tests, term tests, etc. The weightage on annual examination should be reduced and external examination must be discarded.

- The in-service teachers should prepare question papers that assess learners’ problem solving skills, data analysing skills, application of learned knowledge in various situations, solving numerical problems, etc. The tests should have both written and experimental components and open book examination may be promoted to think beyond mere recalling conceptual knowledge (Source: NCF-2005).

Secondary Stage (Classes IX and X): The curriculum of science at secondary stage should focus on the following aspects:

- Disciplinary approach (such as physics, chemistry and biology) is to be followed at secondary stage. In addition to learning definitions of science, teaching is bestowed with focus on comprehension and attainment of higher skills.

- Together with recognising theoretical knowledge, occasions are to be organised to experiment the same and project methods also may be emphasised. The curriculum should not be overloaded with teaching contents.

- The participation of learners in co-curricular activities is promoted by involving them in projects concerning local issues, environmental concerns, etc.

- The board examination should include questions that test the experimental knowledge and skills of learners (Source: NCF-2005).

Higher Secondary Stage (Classes XI to XII): The curriculum of science at higher secondary stage should focus on the following aspects:

- The option of either academic or vocational streams recommended by the NPE, 1986 may be reviewed to give chance to learners to select subjects of their interest and choice.

- The disciplinary approach of teaching may be followed with syllabus having gradual and steady flow of contents from that of secondary stage emphasising experiments, investigatory projects and technology. Nevertheless the syllabus should not be overloaded.

- The contents should be selected keeping in view the competence of learners, depth of the content, delimitations, etc. But core areas must be included. The contents must be systematically organised.
The theoretical aspects of syllabus should emphasize conceptual understanding, problem solving skills, and critical enquiry. Opportunities must be provided to test the theories with scope to interpret, hypothesise and develop results.

To develop awareness and impact of environmental concerns, microchemistry as a means for experimentation may be thought of as a branch of chemistry and biology. Similarly use of micro chemical techniques may be promoted.

Learners may be encouraged to participate in co-curricular activities such as debates, discussions, mathematics and science Olympiads, informal project works, etc. But it should not be considered for formal assessment.

Periodic assessment in curricular activities must be practiced to reduce the stress of annual examinations. The tests should contain questions to check experimental/technology skills of the learners. ICT must be widely used in whatever possible means to arouse enthusiasm and interest of learners (Source: NCF-2005).

**Activities**

4) Organise a debate on the topic “employing ICT for teaching-learning at higher secondary level”. Prepare the list of advantages and disadvantages.

5) Conduct an action research to find the difficulties of teachers in organising classrooms based on collaborative learning approach. Prepare a report on it.

**Check Your Progress**

**Note:**

a) Space is given below to write your answer.

b) Compare your answer with the one given at the end of this Unit.

6) Discuss the science curriculum recommended by NCF-2005 for higher secondary stage? How it is different from secondary science curriculum?

**4.5 CORRELATION OF SCIENCE WITH OTHER SUBJECTS/DISCIPLINES**

As we know teaching is an art that encompasses various skills and competencies. It requires expertise of teaching skills and knowledge in other subjects. A successful teacher would be able to integrate information scattered around in various subjects. This is the base of integrated teaching. Being a teacher trainee, you must be acquainted with correlation of science with other subjects for planning effective pedagogic strategies. Let us now discuss the correlation of science.
4.5.1 Types of Correlation

Correlation of science is considered in three ways as given below:

- Correlation with daily life or environment
- Correlation within different branches of science
- Correlation with other subjects

**Correlation with daily life or environment:** In everyday life we utilize various objects, articles, instruments, machines and so on. Have our learners ever thought where such instruments or objects come from? If you ask a secondary learner, how does pressure cooker work or can he explain the chemical reactions of battery used in torches? Probably few may answer. The interesting fact is, we do come across different science related objects and phenomena in our daily life but learners rarely notice science behind it. For example, when a stick is put in a glass tumbler filled with water, it seems bent; the stars twinkle, etc. are the result of the particular phenomena associated with light, called refraction. The water we use is formed by combining the elements hydrogen and oxygen in a particular proportion. Thus, in many of our daily life activities/environment the presence of science is found. Thus teachers should try to transact teaching concepts by correlating science with day to day activities.

**Correlation within different branches of science:** Life science, zoology, botany, physics, chemistry, physiology, agriculture, geology are the different branches of science. Are these branches correlated? Can we say chemistry is not involved in physics or vice versa? Of course not! Each branch of science is related. For example, while we study osmosis (Spontaneous net movement of water across a semi permeable membrane from a region of low solute concentration to a more concentrated solution) in biology, the concept of both physics and chemistry comes in. The composition of water is studied in chemistry and movement of particles in physics. Similarly, the concept related to eye is studied with the help of lenses explained in physics. Thus it is a fact that, knowledge is not separate rather it must be taught as unified entity. It is to be kept in mind that, subjects cannot be taught in isolation but through integrated approach.

**Correlation with other subjects:** Teaching can be made more meaningful as you understand the correlation of science with other subjects. Here in this section, we will discuss the correlation of science with other subjects separately.

**Correlation of Science with Mathematics:** Science and mathematics is closely related and thus we say science is incomplete without mathematics. In every branch of science mathematics occur in one way or the other in the form of numerals, symbols, formula, computations, etc. For example in physics, the topics like gravitation, motion, energy and power, heat and thermodynamics, waves and oscillations, electricity, magnetism, electric current, optics etc. employ mathematical symbols and calculations. In chemistry, structure of atoms, the laws of chemical combination, elements and compounds make use of mathematics equations, combinations and proportions. In biology and life sciences a large number topics uses the principles of mathematics. For example, the arrangement of human body structure, measurement of blood pressure and temperature involves mathematics.
Correlation of Science with Social Studies: Social Studies are concerned about historical events and happenings. Each discovery has a historical background. But such stories are not paid explained in science classrooms. For example, the stories of great scientists like Galileo, Pascal, Celsius, James Watt, Faraday, Alexander Fleming, A.P.J. Abdul Kalam, C.V Raman, etc are unknown to learners. The pain and struggle that the scientists put in to discover innovative theories/machines has to reach the learners to develop a sense of inquiry and motivation to pursue science. In geography, the evolution of different rocks and soils, movement of heavenly bodies, change of seasons, phenomena like earthquakes, landslides, eclipses, etc. are all related to science.

Correlation of Science with Language: The recent NCTE norms and standards on teacher education (2014) emphasize “language across the curriculum” with the view that language has importance in each subject. The theories and principles of science, discovered after series of experiments must be expressed in a language understandable to lay man/learner. Similarly, the same must be disseminated and propagated for the betterment of the country and to develop a civilized society. Thus language finds application at many places. The expressions, symbols, formulas, theories, etc. that appear in every branch of science utilize language to express it.

Correlation of Science with Art: Science and art are complimentary to each other. How is it so? A science teacher, while drawing diagrams, charts, pictures on the black board during teaching, need to know the basic skills of drawing such as orientation of the figure, measurements, color combinations and so on. At the same time, a professional artist has to have basic knowledge of length, angle, 2D and 3D images etc. to draw a picture. The same is the case with handcrafters, designers, beauticians, etc. In the case of musicians, they play attractive music with the help of principles of sound and waves learnt in physics and musical instrumentalist create beautiful rhythms applying the same principle.

Check Your Progress

Note: a) Space is given below to write your answer.

b) Compare your answer with the one given at the end of this Unit.

7) What are the types of correlations in science? Describe with examples.

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8) How is science correlated with life and environment? Give examples.

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4.6 LET US SUM UP

Present unit has discussed about the stages of development of science education in India. Discussion on place of Science in our ancient literature will help you in developing a sense of pride among your learners towards rich Indian Scientific contribution. Unit has explained in details about various aspects of teaching science suggested in National Curriculum Framework-2005. The issues of present days’ science education and common perceptions about present science curricula have been discussed at length, which will help you in overcoming the shortcoming and facilitating for motivating the learners towards science. The Science curriculum at different stages will help you in understanding the linear, spiral and thematic approach, which all are adopted in designing Science curriculum. You will able to help your learners in identifying the correlation of science with other subjects also.

4.7 UNIT END EXERCISES

1) Analyse the major curricular reforms made on science curriculum since National Curriculum Framework-1975 and prepare a report of it.


3) How will you teach science by integrating it with art at higher secondary level? Describe with examples.

4) Discuss the role of teacher in classrooms that follow constructivist approach of teaching-learning.

5) How far the recommendations of NCF-2005 have been implemented? Discuss.

4.8 REFERENCES AND SUGGESTED READINGS


4.9 ANSWERS TO CHECK YOUR PROGRESS

1) Refer to section 4.4.3

2) Cognitive validity, Content validity, Process validity, Historical validity, Environmental validity, Ethical validity- NCF-2005, mentions these criteria’s must be met by the science curriculum.

3) Some of the recommendations are; teacher training practices needs to be revised, teachers having school experience must be appointed as teacher educators, qualified teachers must be appointed at school level, etc.

4) Refer to section 4.4.1

5) Critical pedagogy is learner centred pedagogy. Today learners come to class with varied experiences and knowledge. In such a scenario, teacher must consider those experiences to bring a sense of democracy in the teaching learning process. The teacher’s role is to guide and motivate and thereby help learners to construct their own knowledge.

6) Refer to section 4.4.2

7) Refer to section 4.5.1

8) a) Electric kettle uses current to heat water. Current is a topic of science.
   b) Mangoes fall down due to gravity. Gravity is concept of science.