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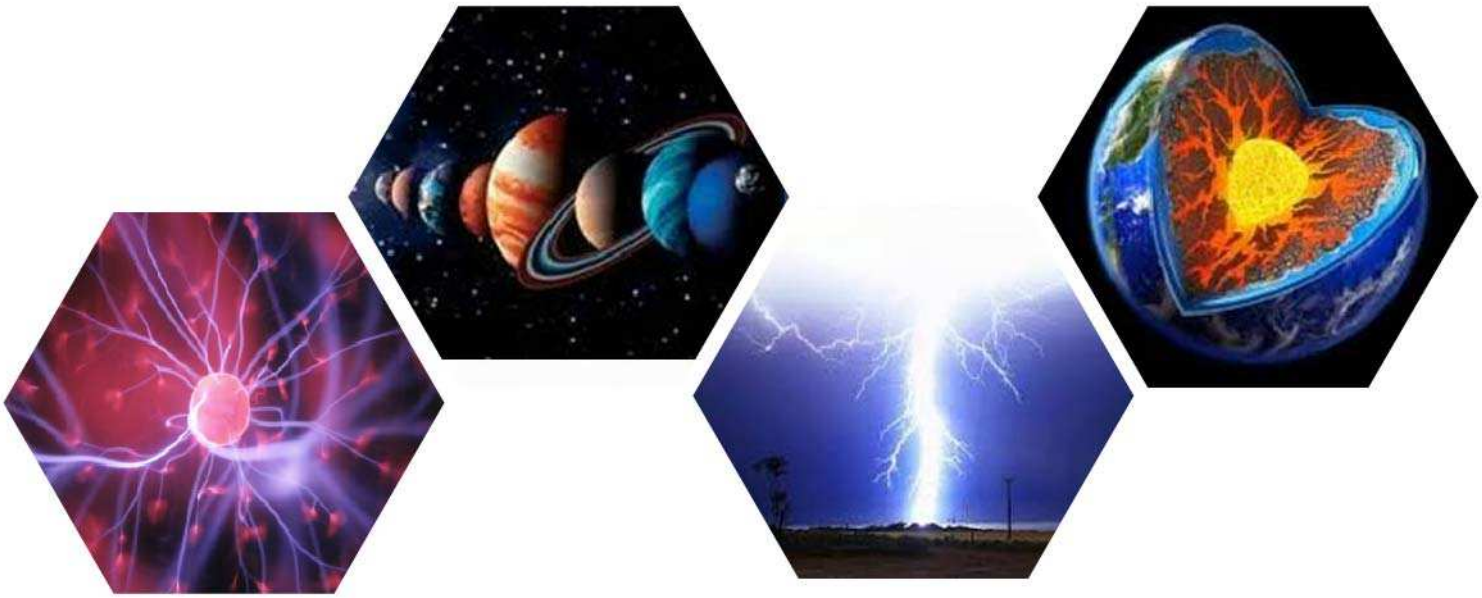
BABA MOHAN DAS COLLEGE OF EDUCATION

SELF LEARNING MATERIAL - B.Ed. 1st YEAR

PEDAGOGY OF PHYSICAL SCIENCE



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Contents

Overview of the Course

As we are dealing with the pedagogical aspects of Physical Science, we must gain all the knowledge that is necessary for effective teaching of this subject. A teaching-learning process consists of several stages beginning from planning, execution to the evaluation stage. The teaching-learning process will be successful only if each of these stages is meticulously addressed. This paper tries to acquaint the student teachers with the necessary knowledge related to teaching Physical Science subject. It encompasses an in-depth view of the concept, methods and strategies essential for the planning, transaction and evaluation in teaching Physical Science.

The first block introduces the nature and objectives of teaching Physical Science. This understanding lays the foundation for further understanding of all other concepts under this paper. The second block discusses the approaches and strategies for learning Physical Science. Physical Science is a skill-oriented subject and requires a hands-on approach for understanding and applying it. The different approaches and strategies that are useful in making Physical Science learning effective are introduced across this block. The third block consists of knowledge related to Curriculum and Learning Resources in Physical Science. The units under this block cover the essential aspects of selection and organization of content in a Physical Science Curriculum. The learning resources, both the traditional and modern are introduced giving prominence to ICT which is the need of the day. The last block concentrates on all the aspects of planning for teaching and assessment in Physical Science. This is an important block since it digs into the basics of a teaching process. Planning the teaching is the most important phase in the teaching process. It expands from planning the unit to planning the lesson and along the way planning the assessment. The intricacies of planning are discussed along this block.

Detailed browsing of this material will prepare a student-teacher to confidently apply the teaching-learning strategies that are needed for effective teaching of the Physical Science Subject.

Block 3 : Curriculum and Learning Resources in Physical Science

Unit 1 : Selection and Organization of Content in Physical Science

Unit Structure

3.1.1. Learning Objectives

After completing this Unit, the student teachers will be able to

- List the principles involved in the selection of content in Physical Science;
- Explain the different principles one needs to follow while selecting content in Physical Science;
- List the principles involved in the organization of content in Physical Science; and
- Explain the different principles one needs to follow while organization content in Physical Science.

3.1.2. Introduction

Science is a very important subject in each individual's life since it is nothing but the individual's life itself.So, it is the utmost duty of the educationists to make necessary knowledge of science available to everyone through education. Selection and organization of content in Physical Scienceis an important process as science is a very vast subject and it is very important to select the content meticulously so that the learner is introduced to all the essential topics and can build on this knowledge in the future.Science being the basis for inventions, one has to have sound knowledge of its basics to ensure exhaustive usage of its usefulness. Hence in this Unit, we shall discuss how effectively content can be selected and organized in teaching and learning Physical Science.

3.1.3. Learning Points and Learning Activities

3.1.3.1. Selection of Content in Physical Science

Exercise - 1

List the knowledge and behavioural outcomes that you would expect of your pupils after learning the Physical Science Subject

You would have surely mentioned that at the end of learning the Physical Science Subject your pupils will be able to think rationally, be able to apply the knowledge gained in class in their day to day life etc. To gain these outcomes, the content of Physical Science needs to be selected and organized scientifically and psychologically. In the following

paragraphs let us look into the aspects that need to be paid attention to while selecting content in Physical Science.

The selection of the content or subject matter or topics for the curriculum of Physical Science and the particular stage or level is a very important yet difficult and tedious task.

Criteria for the Selection of Subject-matter or Content of the Curriculum
According to Ornstein &Hunkins (1998), the selection of subject matter for curriculum employs the seven criteria below.

1.Self-sufficiency: To help learners attain maximum self-sufficiency most economically is the main guiding principle of subject matter or content selection (Scheffler, 1970) as cited by Bilbao et al. (2008). Although the economy of learning implies less teaching effort and less use of educational resources, students gain more results. They can cope up with the learning outcomes effectively. This criterion means that students should be given a chance to experiment, observe, and do field study. This system allows them to learn independently. With this principle in mind, when the students return, they should present outputs from the activity.

2. Significance: The subject matter or content is significant if it is selected and organized for the development of learning activities, skills, processes, and attitudes. It also develops the three domains of learning namely the cognitive, affective and psychomotor skills and considers the cultural aspects of the learners. Particularly, if your students come from different cultural backgrounds and races, the subject matter must be culture-sensitive. In short, select content or subject matter that can achieve the overall aim of the curriculum.

3. Validity: Validity refers to the authenticity of the subject matter or content you selected. Make sure that the topics are not obsolete. There is a need to check regularly the subject matter or contents of the curriculum and replace it if necessary. Do not wait for another 5 years to change it. Modern curriculum experts are after current trends, relevance and authenticity of the curriculum; otherwise, the school or the country becomes obsolete.

4. Interest: This criterion is true to the learner-centered curriculum. Students learn best if the subject matter is meaningful to them. It becomes meaningful if they are interested in it. However, if the curriculum is subject-centered, teachers have no choice but to finish the pacing schedule religiously and only teach what is in the book. This approach explains why many fail in the subject.

5. Utility: Another criterion is the usefulness of the content or subject matter. Students think that a subject matter or some subjects are not important to them. They view it as useless. As a result, they do not study. Here are the questions that students often ask: Will I need the subject in my job? Will it give meaning to my life? Will it develop my potentials? Will it solve my problem? Will it be part of the test? Will I have a passing mark if I learn it? Students only value the subject matter or content if it is useful to them.

6. Learnability: The subject matter or content must be within the schema of the learners. It should be within their experiences. Teachers should apply theories in the psychology of learning to know how subjects are presented, sequenced, and organized to maximize the learning capacity of the students.

7. Feasibility: Feasibility means the full implementation of the subject matter. It should consider the real situation of the school, the government, and society, in general. Students must learn within the allowable time and the use of resources available. Do not give them a topic that is impossible to finish. For example, you have only one week left to finish the unit but then, the activities may take a month for the students to complete. Thus, this requirement is not feasible.

Principles of selecting the content in Physical Science.

1. Principle of Utility (Practical) Value: The significance of any subject matter lies in its practical utility. The content should be included in the curriculum if it is useful

a) in everyday life
b) in the study of other subjects now or future
c) in understanding the scientific and technical progress
d) in providing common ground for a fairly good number of vocations
e) in understanding and appreciating the role played by science in the development of civilization in its various aspects in commerce, trade, heavy industry, engineering, physical and social sciences and other branches of knowledge.
f) in the realization of the artistic and aesthetic value of science
g) in inspiring the pupils by acquainting them with the biographies of scientists and the history of discoveries and inventions in science
h) in rendering help for future research work in the field of sciences.

2. Principle of Preparatory Value: According to this principle, the content in the curriculum of Physical Science should –

a) Be helpful to prepare the pupils for leading their future life smoothly
b) Also, prepare them for further advanced education
c) Help the child in adjustment and prepare him/her for full and effective adult life.

3. Principle of Disciplinary Value: Science has disciplinary value as it disciplines and trains the faculties of mind like faculty of reasoning and thinking, faculty of imagination, concentration, memorization, inventiveness etc. Training of mind depends largely on methods of teaching adopted by the teacher. If a topic is taught in an effective, logical and psychological manner, it will create some mental habits. Hence the content which is selected needs to have a scope where the teacher can be effective in training a pupil to be disciplined.

4. Principle of Flexibility and Elasticity: The development in the subject and research report on this field also accepts the necessity of periodical changes in the curriculum of science. Thus the curriculum should be flexible and broad-based enough in accordance with the needs of society. The curriculum should also be reviewed and modified frequently to shape it according to the latest developments of the subject and the changing requirements of a dynamic society.

5. Principle of Cultural Value: Science has played an important role in the advancement of culture and civilization. Some topics of science are very helpful in the development of habits having cultural value. For example habit of logical reasoning and thinking, co-operation with others, sympathy towards needy, accuracy in any work, tolerance and appreciation towards scientific literature and artistic things. There are certain ideas and facts of science that form an integral part of the modern culture and civilization of our society. Therefore, while

selecting topics for the curriculum of science, the cultural value of the content should be taken into account and be given due weightage.

6. Principle of Child Centeredness: In the curriculum construction, the framers should give proper weightage to the needs and requirements, interests, abilities, capacities and age level of the child for whom the curriculum is constructed. The content should meet the physical, intellectual, social and emotional needs of the child. From the psychological point of view also it must be so because the school and the curriculum are meant for the child and not the child for the school and curriculum.

7. Principle of Community Centeredness: The content should be relevant to the needs of the community and society. It should make the child ready to enter the scientific age in society. The child should be able to understand the problems and needs of society and take part in the development of society.

8. Principle of Correlation: While organizing the content of the curriculum, one must be careful to seek the maximum correlation of the content.

a) with life activities of pupils
b) with the other branches of science
c) with other subjects of school
d) with particular experiences of the work experience

9. Principle of integration: It should integrate the child's needs and abilities on one hand and also the needs of the nation on other hand. It should facilitate total experiences for a child, such that a child can lead individually a satisfied and socially useful life.

10. Principle of Modernization: The science curriculum should be traced according to the latest developments of the topics in the field of science and in accordance with the modern world. This is a must for the curriculum makers so that we may not lag in the scientific and technological race. The new thought process and emerging trends in school science should be allowed to play its due role in the choice of content for the Physical science curriculum.

Check Your Progress - 1

1. List the aspects which we need to pay attention to while selecting the content in Physical Science.

3.1.3.2. Organization of the Content in Physical Science

Now that you have understood how to select the content for Physical Science, let us see how to organize this content meaningfully.

Exercise - 2

Discuss with your friends and write below, what you think are the essential aspects that need to be kept in mind while organizing Physical Science content.

On discussing I am sure several aspects such as the difficulty level of content, the level of pupils, the importance of the selected content etc must have crossed your mind. Now let us look at these aspects in detail.

After the selection of subject matter, it requires proper order and arrangement. The arrangement of topics demands some questions to be seriously answered, such as

1. When and where should a particular topic be introduced?
2. What topic would be most suitable after a particular topic?
3. How much portion of the topic should be taught keeping in view-
    a. Particular age and level of pupils?
    b. The age group of pupils?
4. What should be done before and after the topic?

These requirements can be satisfied in a psychological, logical and scientific way. So, the subject matter should be organized based on certain psychological principles. The following principles and methods help organize and arrange the curriculum materials.

1. Principle of Logical and Psychological Order: For the organization of content/topics in Physical Science, two important aspects require to be considered i.e. Psychological and Logical. The psychological organization considers the organization of content according to the development of the mind of the pupil, his needs, interests, abilities etc. The logical organization takes into account the systematization of knowledge. Logical reasoning maintains a proper sequence of topics while psychological reasoning throws light on the power of understanding of the pupils at a certain level and the practical utility of the topic in their daily life. The combination of both these approaches makes the content useful to the pupils.

2. Principle of Activity: Topics that carries greater scope for practical work should be given preference for inclusion in the Physical Science curriculum. Content that has scope for activities like counting, computing, measuring, weighing, drawing graphs, tabulating, observing, experimenting should be included in the curriculum. The emphasis should be on "Learning by Doing" The content should be so arranged to merge the activities with the interests and level of pupils.

3. Principle of Individual Differences: There are individual differences among pupils. There is a wide difference in their interest, aptitudes, intelligence, abilities, capacities and experiences. Hence the content selected should be so organized as to cater to every type of pupil There should be scope for individual teaching in the curriculum to satisfy the needs of individual pupils.

The following points need to be kept in mind while organizing the content to cater to individual differences

a) The content of the curriculum should be so arranged that the difference in the abilities of the pupil may not be ignored. There should be ability-grouping for the pupils. The pupils of almost the same intelligence may be kept in one group.
b) There may be a grouping of topics in the curriculum.
c) Provision of the differentiated assignment should be there.

4. Principle from empirical to rational: According to this principle, the most evident and familiar things should come at the beginning of the topics. General ideas and theories should be rationalized later on. It is similar to proceed from " known to unknown' or "from particular to general" or from " concrete to abstract". It is always a safe approach to begin with what we see, feel and experience than with what we argue, generalize and explain. The learning of scientific knowledge begins from observation, experience, intuition and induction. It is accomplished gradually through deduction.

5. Principle of Gradual Increase in Difficulty Level: In the organization of content the maxims 'from easy to difficult' and 'from simple to complex' should be followed. The organizers of the curriculum have to keep in mind the mental level, age level, abilities and capacities of pupils in the arrangement of topics/content material of the curriculum. It should suit the mental capacity and development of the age-group of that class. In the organization of curriculum for any particular level or grade, only these topics should be included which are within the comprehension of learners, in order of their difficulty level.

6. Principle of Correlation: A new piece of knowledge is not an isolated fragment. The division of the curriculum is made only for the sake of convenience for the teachers and authors. There is a close connection between the different branches of knowledge and between the different branches of the same subject. To correlate Physical science with other aspects and subjects the following need to be kept in mind

i) The physical, social and cultural environment of the pupils
ii) Day-to-day life activities of the pupils
iii) Nature and structure of the other subjects and possibilities of seeking correlation with them
iv) Nature and structure of the topics/contents of the different branches of sciences

7. Principle of teacher's views and experiences: The teachers must have definite say in the selection and organization of curriculum material. There should be a good representation, participation, and contribution of experienced and academically well-equipped teachers in the whole process of curriculum construction. An experienced teacher knows well the abilities, interests, needs, aptitudes and mental abilities, capacities and levels of pupils of a particular stage. Hence a teacher's involvement in the organization stage of the curriculum will prove very useful.

8. Principle of Topical Arrangement: Topical arrangement is based on the unity of the topic i.e. a topic is taken as a unified unit. It implies that a topic should be completed in all respect at one stage at a stretch. It should be finished with its all possible aspects, entirely before the next topic is taken. This approach is based on the principle that a topic is an unbreakable unit it is to be taught and learnt as a whole. It emphasizes continuous and elaborate teaching of a specific topic. The topic such as taught becomes a basis for the next topic to be taught.

9. Principle of Spiral/Concentric Arrangement: This arrangement is based on the assumption that knowledge extends and widens as a spiral or concentric circles. Thus beginning from a nucleus, the horizon of knowledge goes on extending and widening. It is based on the principle that a topic cannot be given an exhaustive treatment at the first stage. To begin with, a simple presentation of the topic is given and further knowledge is imparted in further years. Elementary knowledge is given in the introductory years, something more is taught is the following year, again something more is added in the subsequent years and so on. This process goes on from year to year and from class to class.

Check Your Progress - 2

1. List different aspects which we need to pay attention to while organizing the content in Physical Science.

3.1.4. Let us Summarise

- **Criteria for the Selection of Subject-matter or Content of the Curriculum**

According to Ornstein &Hunkins (1998) the selection of subject matter for curriculum employs the seven criteria below.

1. **Self-sufficiency:** This criterion means that students should be given a chance to experiment, observe, and do field study.
2. **Significance:** The subject matter or content is significant if it is selected and organized for the development of learning activities, skills, processes, and attitudes.
3. **Validity:** Validity refers to the authenticity of the subject matter or content you selected.
4. **Interest:** This criterion is true to the learner-centered curriculum. Students learn best if the subject matter is meaningful to them.
5. **Utility:** Another criterion is the usefulness of the content or subject matter. Students only value the subject matter or content if it is useful to them.
6. **Learnability:** The subject matter or content must be within the schema of the learners. It should be within their experiences.
7. **Feasibility:** Feasibility means the full implementation of the subject matter. Do not give them a topic that is impossible to finish.

- **Selection of the Content in Physical Science**

1. Principle of Utility (Practical) Value
2. Principle of Preparatory Value
3. Principle of Disciplinary Value
4. Principle of Flexibility and Elasticity
5. Principle of Cultural Value
6. Principle of Child Centeredness
7. Principle of Community Centeredness
8. Principle of Correlation
9. Principle of Integration
10. Principle of Modernization

- **Organization of the content of Physical Science**

1. Principle of Logical and Psychological Order
2. Principle of Activity
3. Principle of Individual Differences
4. The principle from empirical to rational
5. Principle of Gradual Increase in Difficulty Level
6. Principle of Correlation
7. Principle of teacher's views and experiences
8. Principle of Topical Arrangement
9. Principle of Spiral/Concentric Arrangement

3.1.5.Answers to 'Check Your Progress - 1 and 2'

Check Your Progress - 1

1. Selection of the Content in Physical Science

1. Principle of Utility (Practical) Value
2. Principle of Preparatory Value
3. Principle of Disciplinary Value
4. Principle of Flexibility and Elasticity

5. Principle of Cultural Value
6. Principle of Child Centeredness
7. Principle of Community Centeredness
8. Principle of Correlation
9. Principle of Integration
10. Principle of Modernization

Check Your Progress - 2

1. Organization of the content of Physical Science

1. Principle of Logical and Psychological Order
2. Principle of Activity
3. Principle of Individual Differences
4. Principle from empirical to rational
5. Principle of Gradual Increase in Difficulty Level
6. Principle of Correlation
7. Principle of teacher's views and experiences
8. Principle of Topical Arrangement
9. Principle of Spiral/Concentric Arrangement

3.1.6. Unit end Exercises

1. Elaborate on the criteria to be followed while selecting the content of the curriculum.
2. Explain the principles to be followed while selecting content in Physical Science
3. Write a short note on the following
   a. Principle of Utility (Practical) Value
   b. Principle of Disciplinary Value
   c. Principle of Flexibility and Elasticity
   d. Principle of Child Centeredness
   e. Principle of Community Centeredness
   f. Principle of Correlation
   g. Principle of Integration
4. Explain the principles to be followed in organizing the content in Physical Science.

3.1.7. References

1. R.N. Patel, 'Teaching of Science', Himalaya Publishing House
2. B.R. Ramachandraiah and C. Rajanna , 'Pedagogy of Science',
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Block 3 : Curriculum and Learning Resources in Physical Science

Unit 2 : Approaches for Curriculum Construction in Physical Science

Unit Structure

3.2.1. Learning Objectives

After learning through this Unit, the student teachers will be able to

- Explain the Approaches to Curriculum Construction – Subject Centred Approach, Behaviourist Approach, Constructivist Approach;
- Explain the Integrated Approach for Curriculum Construction;
- Explain the Disciplinary Approach for Curriculum Construction;
- Explain the Interdisciplinary Approach for Curriculum Construction;
- Explain the Topical Approach for Curriculum Construction;
- Explain the Concentric Approach for Curriculum Construction;
- Explain the Logical and Psychological Approach for Curriculum Construction; and
- Explain the Unitary Approach for Curriculum Construction.

3.2.2. Introduction

In the previous unit, we have discussed the important principles to be followed while selecting and organizing the curriculum.Along with the principles we also need a framework through which these principles can be put into action. Approaches in curriculum give us a direction and a way of doing, creating,designing and thinking about the curriculum.Based on various aspects that influence a learner the curriculum needs to be meticulously constructed to bring about the best learning among learners. Physical Science being a vast subject has scope for adopting various approaches based on the need of the content, learner and the learning situation. In this unit we shall discuss various approaches for Curriculum construction in Physical Science.

3.2.3. Learning Points and Learning Activities

3.2.3.1. Approaches for Curriculum Construction in Physical Science

Exercise - 1

Analyze the Topic 'Light' into subtopics and assign them to be taught in different classes of secondary school (i.e. 8^{th}, 9^{th} and 10^{th} standard). What is the basis you have used to assign the topics to different classes? Give reasons

Sub Topics	To be learnt in the Class (8^{th}, 9^{th} and 10^{th})	Reason

I am sure you have analyzed the topic into subtopics and have assigned them to different classes based on the difficulty of the topic, age level of the pupil, the complexity of the content or any other basis which you must have found correct. While constructing a curriculum in Physical Science one has to pay attention to various aspects which can lead to qualitative learning among the pupils. Hence let us discuss the approaches one can follow in the construction of the Physical Science curriculum.

A. Subject Centred Approach

The basic assumption in a 'subject-centered curriculum' is that knowledge, which is objective and universal can be transmitted directly from those who have acquired the knowledge to those who have not. The teacher transmits subject knowledge to students through classroom instructions. The lecture is the most commonly used method to communicate subject knowledge to students. Students generally memorize the subject content provided by the teacher/textbook. The teacher is considered to have all the right knowledge. Examinations test the content knowledge of students. While designing a syllabus under a subject-centered curriculum, experts select the content which is most important or worth teaching in schools. The debate continues to this day as to which knowledge is relevant and useful for students. The curriculum developers and teachers who view learning solely as the acquisition of subject matter may have difficulty in planning student's learning beyond recall or comprehension level. Mere recall of skills does not by itself directly change a student's understanding and analytical ability.

B. Behaviourist Approach

Behaviourist psychologists view learning as a change in behaviour and learning objectives are defined in terms of behavioural change. Knowledge is the capability for action, identified as the 'successful performance of tasks.' For example, within the behavioural context student's ability to define dispersion of light falls as her knowledge. The only way to determine whether or not students 'know' or 'do not know,' something is to see how they behave in certain situations.

The behaviourist approaches to learning are based on the following assumptions:

- Learning requires a change in the learner's behaviour which can only be gauged by what the learner does.
- Real competence comes only with extensive practice. The stimulus-response connection is strengthened with practice.
- The learning is strongly influenced by the feedback that tells the system when responses are correct and when they are wrong.
- Skilled performance requires that responses to stimulus be conditioned in such a way that a particular stimulus, automatically generates the specific response.
- The total learning of a student with respect to a complex task is a summative accumulation of specific expected learning outcomes associated with that task.
- Most complex skills are hierarchical in structure and can be broken down into simpler tasks.

The competency-based curriculum, criterion-referenced curriculum, and mastery learning and programmed learning are all based on behaviourist theories of learning. These approaches assume that large/complex tasks can be broken down into small/simpler tasks and these can be sequenced in order from simple to complex. The competency-based and programmed curriculum uses these assumptions. In a competency-based curriculum, terminal competencies are defined in behavioural terms. These are then sub delineated into sub-competencies. A competency-based curriculum (minimum levels of learning) has been developed in India and some other countries.

In behaviourist curriculum, teachers are instrumental to implement a curriculum developed by curriculum developers. Teachers do not question the 'ends or means of the curriculum.' The behaviourist curriculum does not take into consideration the learner's experiences, context and cognitive predispositions. Learners are treated as passive receivers of knowledge and teacher as a transmitter of knowledge. Chalk and talk isa common method of teaching. Learners memorise, recite or study their lessons silently without questioning. Childhood is viewed as preparation for adulthood within society. The education aims at developing such knowledge and skills which will be helpful for students to serve the society in their adult life.

C. Constructivist Approach

For 'constructivist curriculum' developers, it is the learning environment and experiences, that are of crucial importance and can be generated by taking into consideration the context of a learner as well as the teaching-learning environment. The curriculum must engage learners with stimulating experiences by arranging a suitable learning environment.

'Constructivist curriculum' is based on the following assumptions:

- Knowledge is actively constructed, invented, created, or discovered by learners. It is not passively received and stored by learners.
- Knowledge cannot be separated from the process of meaning-making or knowing or learner's experiences. It is based on the learner's conceptual structures and prior experiences.
- Learners are constantly constructing and reconstructing their cognitive structures, both as a result of newly acquired knowledge and as a result of their reflection on previously acquired knowledge.
- Social interaction with peers and adults in a cultural context is extremely important in an individual's construction of knowledge.
- Concept formation progresses from concrete to abstract slowly.
- Learners have different learning styles, and teaching-learning should accommodate these.
- The teacher in the constructivist curriculum is the provider of the learning environment and a facilitator of learning.

Check Your Progress - 1

Explain the merits and limitations of subject centred, behaviourist and constructivist approaches of Curriculum Construction with special reference to Physical Science

3.2.3.2. Approaches for Curriculum Transaction and Organization

A. Integrated Approach

Integrated Approach to the curriculum is a way to teach students that attempts to break down barriers between subjects and make learning more meaningful to students. In its simplest conception, it is about making connections. The integrated approach aspires to help pupils obtain a coherent view of science by establishing numerous links between the various branches of science. Integrated science integrates the perspectives of sub-disciplines such as biology, chemistry, physics and earth/space science. Through this integration, teachers expect students to understand the connections between the different sub-disciplines and their relationship to the real world. The integrated curriculum requires accessing knowledge from all of the traditional subjects without labeling them as such. Also, an integrated curriculum adds problem-solving real-world application and social consciousness to the learning process, making it a more comprehensive way of educating and learning.

Characteristics of Integrated Approach

- Encourages focus on basic skills, content, knowledge as a whole.
- Higher-level thinking and reasoning and lifelong learning.
- Structures learning around themes, big ideas and meaningful concepts.
- Provides connections among various curricular disciplines
- Provides learners opportunities to apply the skills they have learned.
- Encourages active participation in relevant real-life experiences.
- Captivates motivates and challenges learners.
- Provides a deeper understanding of content
- Offers opportunities for a smaller group and individualized instruction
- Accommodates a variety of learning styles/theories i.e. social learning theory, cooperative learning, intrinsic motivation and self-efficacy
- The knowledge of subjects is given in the integrated form.
- It is activity-oriented and experience-centered.

B. Disciplinary Approach

In this approach different branches of science are treated as separate disciplines namely Physics, Chemistry, Botany, Zoology, Microbiology and the content is treated for covering all aspects fully. It provides the pupil a sound knowledge of the fundamentals of various sciences and is more practical.

Characteristics of Disciplinary Approach

- Each subject is taught as a separate discipline.
- Instructional material is closely related.
- Helps in having in-depth conceptual knowledge of the subject.
- The teaching is largely based on content.
- The purpose of the disciplinary approach is to prepare specialists, scientists etc

C. Interdisciplinary Approach

It is a curriculum in which subject matter boundaries are ignored, all subjects are being taught in relation to broad areas of study and in relation to one another as mutually associated with some genuine life relation. Curriculum integration can be described as an approach to teaching and learning that is based on both philosophy and practicality. It can generally be defined as a curriculum approach that purposefully draws together knowledge,

skills, attitudes and values from within or across subject areas to develop a more powerful understanding of key ideas.

Characteristics of the Interdisciplinary Approach

- Many disciplines are included in one subject
- Scope to get more expertise in academic subjects
- Links with more related disciplines
- Justifies unity of knowledge
- Appreciates the beauty and significance of related disciplines

D. Topical Approach

In this method, a particular topic is started in a particular grade and finished over there only. Thus, a topic marked for a particular grade must not be touched in other grades. The selected topic becomes the centre of correlation. It is the opposite of the concentric method. The concentric method involves the breaking up of a topic into suitable portions, whereas the topical method aims at keeping it intact. In the topical method, a topic is taken as an unbreakable unit. It is based on the principle that any topic when begun should not be left half done. It should be finished in its entirety before the next topic is taken.

'Topical method' is more a system of arrangement of subject matter than a method of teaching. Its adoption depends on a suitable organization of the syllabus. The topic is to be taught at a stretch, without a break or a gap. The other approach to this method is that a topic is selected and is made the basis of many other topics. The selected topic becomes the centre of correlation.

Merits of Topical method

1. Continuous teaching of a topic not only saves the student from divided attention but may ensure their full and wholehearted concentration on the topic. A natural link and sequence will exist in the day-to-day work in the classroom. The student's complete attention, ability and capacity will be directed exclusively to the topic under study for a sufficiently long time.
2. When a topic is treated as a centre for other topics, it facilitates the learning process. It illustrates the advantage of correlation.

Limitations of Topical Method

1. Keeping psychological reason in view, it will be foolish to take a topic like area in grade 4 and try to finish in at one stretch. The student may be able to understand the elementary portion, but will certainly not be able to attempt its most difficult question.
2. The interest of the student may go away within a month if we focus only on a particular topic.
3. This method does not provide any opportunity for the year to year revision.

E. Concentric Approach

This approach implies breaking up of topic into different subtopics and the portion is allotted to different grades. This is a system of organising a course rather than a method of teaching. It implies the widening of knowledge just as concentric circles go on extending and widening. It is a system of arrangement of the subject matter. In this approach, the study of the topic is spread over many years. It is based on the principle that the subject cannot be given an exhaustive treatment at the first stage. To begin with, a simple presentation of the subject is given and further knowledge is imparted in the following years. Thus, beginning

from a nucleus, the circles of knowledge go on widening year after year and hence the name concentric method.

A topic is divided into many portions which are then allotted to different classes. The criterion for allotment of a particular portion of the course to a particular class is the difficulty of portion and power of comprehension of students in the age group. Thus, it is mainly concerned with year to year teaching but its influence can also be exercised in day-to-day teaching Knowledge being given today should follow from the knowledge given yesterday and should lead to teaching on the following day.

Characteristics of Concentric Approach

1. The subject matter is introduced in the increasing order of difficulty.
2. It is based on the mental ability and capabilities of students at that level.
3. It satisfies the psychological needs and interests of students.
4. There is continuity in learning of a particular topic through the levels.

Merits of Concentric Approach

1. This approach of organization of subject matter is decidedly superior to that in which one topic is taken up in a particular class and an effort is made to deal with all aspects of the topic in that particular class.
2. It provides a framework to the course which is of real value to students.
3. The system is most successful when the teaching is in the hand of one teacher because then he can preserve continuity in the teaching and keeps his expanding circle concentric.
4. It provides the opportunity for revision of work already covered in a previous class and carrying out new work.
5. It enables the teacher to cover a portion according to receptivity of the learner.
6. Since the same topic is learnt over many years so its impressions are more lasting.

F. Logical and Psychological Approach

These are the two different views in the construction of the Physical Science curriculum. While the former advocates the organization of content the latter advocates the organization according to the development of the mind of the child. It demands that the content should be organized in a logical order depending upon the fundamental process and modes of thinking.

Psychology throws light on the use of a topic for the student from an academic as well as practical point of view. It takes into consideration the power of understanding and grasping of pupils in a particular age level group. The order in which topics are to be taken will largely depend on its findings. The construction and organization of curriculum according to the principles of psychology means that the content should be so organized that it would create interest in the students and motivate the learning. Psychological principles of learning such as reinforcement, applications of scientific principles, functional relationships and association with pupil's experiences and interest should be considered carefully in the psychological organization of the physical science curriculum.

The content should be organized in a logical sequence. The logical organization produces desirable learning outcomes. This approach calls for arranging the concepts logically. There should be a link between chapters. The sequence should be based on reason.

The order of the concepts should have reasons behind them. The subject matter is organized in a continuous and increasing order, based on the logical order of the content.

G. Unitary Approach

The subject matter for the entire course is conveniently classified into different units and discussed fully once in some grade or other. So in this approach, the entire curriculum is divided and organized into units, sub-units, topics or lessons. Lessons are related to each other from basic level to advanced level, subject to experimentation and revision.

Characteristics of Unitary Approach

1. It organizes a body of facts, process, closely related to one another.
2. It contributes to an easy understanding of the course
3. It presents the principle and process as a group in a definite form.
4. The outcomes of the study are definite such that it is clear to both teachers and pupils.
5. It makes teaching and learning purposeful and intelligent.

Since instructional materials are closely related to each other, they are easily retained.

Check Your Progress - 2

1. Which are the different Approaches one can follow in the construction of a Curriculum in Physical Science?
2. List the characteristics of Integrated Approach
3. What is Interdisciplinary Approach?
4. What is the basis of the Unitary Approach?

3.2.4. Let us Summarise

- **Approaches for Curriculum construction in Physical Science**
  - **Subject Centred Approach:**The basic assumption in 'subject-centered curriculum' is that knowledge, which is objective and universal can be transmitted directly from those who have acquired the knowledge to those who have not. While designing a syllabus under a subject-centred curriculum, experts select the content which is most important or worth teaching in schools.
  - **Behaviourist Approach:** Behaviourist psychologists view learning as a change in behaviour and learning objectives are defined in terms of behavioural change. In behaviourist curriculum, teachers are instrumental to implement a curriculum developed by curriculum developers. The behaviourist curriculum does not take into consideration the learner's experiences, context and cognitive predispositions.
  - **Constructivist Approach: C**onstructivist curriculum focuses on learning environment and experiences, that are of crucial importance and can be generated by taking into consideration the context of the learner as well as the teaching-learning environment. The curriculum must engage learners with stimulating experiences by arranging a suitable learning environment.

- **Some of the important Approaches for curriculum Transaction and Organization**
  - **Integrated Approach:** Integrated curriculum is a way to teach students that attempts to break down barriers between subjects and make learning more meaningful to students. Through this integration, teachers expect students to understand the connections between the different sub-disciplines and their relationship to the real world.

- **Disciplinary Approach:**In this approach different branches of science are treated as separate disciplines namely Physics, Chemistry, Botany, Zoology, Microbiology and the content is treated for covering all aspects fully. It provides the pupil a sound knowledge of the fundamentals of various sciences and is more practical.
- **Interdisciplinary Approach:** Curriculum integration can be described as an approach to teaching and learning that is based on both philosophy and practicality. It can generally be defined as a curriculum approach that purposefully draws together knowledge, skills, attitudes and values from within or across subject areas to develop a more powerful understanding of key ideas.
- **Topical Approach:** In this method, a particular topic is started in a particular grade and finished over there only. Thus, a topic marked for a particular grade must not be touched in other grades. The selected topic becomes the centre of correlation
- **Concentric Approach:** This approach implies breaking up of topic into different subtopics and the portion is allotted to different grades. It implies the widening of knowledge just as concentric circles go on extending and widening.
- **Logical And Psychological Approach: These** are the two different views in the construction of the Physical Science curriculum. While the former advocates the organization of content the latter advocates the organization according to the development of the mind of the child. It demands that the content should be organized in a logical order depending upon the fundamental process and modes of thinking.
- **Unitary Approach:** The subject matter for the entire course is conveniently classified into different units and discussed fully once in some grade or other. So, in this approach, the entire curriculum is divided and organized into units, sub-units, topics or lessons. Lessons are related to each other from basic level to advanced level, subject to experimentation and revision.

3.2.5 Answers to 'Check Your Progress - 1 and 2'

Check Your Progress - 1
Refer Section 3.2.3.1.

Check Your Progress - 2
1. The different Approaches for construction of Physical Science Curriculum are
   a. Subject Centred Approach
   b. Behaviourist Approach
   c. Constructivist Approach

2. Characteristics of Integrated Approach
   - Encourages focus on basic skills, content, knowledge as a whole.
   - Higher-level thinking and reasoning and lifelong learning.
   - Structures learning around themes, big ideas and meaningful concepts.
   - Provides connections among various curricular disciplines
   - Provides learners opportunities to apply the skills they have learned.
   - Encourages active participation in relevant real-life experiences.
   - Captivates motivates and challenges learners.
   - Provides a deeper understanding of content
   - Offers opportunities for smaller group and individualized instruction

- Accommodates a variety of learning styles/theories i.e. social learning theory, cooperative learning, intrinsic motivation and self-efficacy
- The knowledge of subjects is given in the integrated form.
- It is activity-oriented and experience-centered.

3. Integrated Approach:

Integrated curriculum is a way to teach students that attempts to break down barriers between subjects and make learning more meaningful to students. Through this integration, teachers expect students to understand the connections between the different sub-disciplines and their relationship to the real world.

The subject matter for the entire course is conveniently classified into different units and discussed fully once in some grade or other. So in the Unitary approach, the entire curriculum is divided and organized into units, sub-units, topics or lessons. Lessons are related to each other from basic level to advanced level, subject to experimentation and revision.

3.2.6. Unit end Exercises

1. Explain the different Approaches for Curriculum construction in Physical Science.
2. Elaborate the following
    a) Subject Centred Approach
    b) Behaviourist Approach
    c) Constructivist Approach
3. Explain the Integrated Approach for Curriculum Construction.
4. Explain the Disciplinary Approach for Curriculum Construction.
5. Explain the Interdisciplinary Approach for Curriculum Construction.
6. Explain the Topical Approach for Curriculum Construction.
7. Explain the Concentric Approach for Curriculum Construction.

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Block 3 : Curriculum and Learning Resources in Physical Science

Unit 3 : Recommendations of NCF on Science Curriculum

Unit Structure

3.3.1 Learning Objectives

After learning through this Unit, the student teachers will be able to

- Explain the perception of Science according to NCF 2005;
- Explain the Criteria of Validity of Science Curriculum according to NCF 2005;
- Explain the Science Curriculum at different Stages as recommended by NCF 2005; and
- Explain the Outlook towards Science Education according to NCF 2005.

3.3.2. Introduction

The National Curriculum Framework is the dreamchild of the National Policy of Education as The National Policy on Education (NPE, 1986) proposed the National Curriculum Framework as a means of evolving a national system of education, recommending a core component derived from the vision of national development enshrined in the Constitution. The revised National Curriculum Framework (NCF) opens with a quotation from Rabindranath Tagore's essay, Civilization and Progress, in which the poet reminds us that a 'creative spirit' and 'generous joy' are key in childhood, both of which can be distorted by an unthinking adult world.The fact that learning has become a source of burden and stress on children and their parents is evidence of a deep distortion in educational aims and quality. To correct this distortion, the present NCF proposes five guiding principles for curriculum development: (i) connecting knowledge to life outside the school; (ii) ensuring that learning shifts away from rote methods; (iii) enriching the curriculum so that it goes beyond textbooks; (iv) making examinations more flexible and integrating them with classroom life; and (v) nurturing an overriding identity informed by caring concerns within the democratic polity of the country. In this Unit, we shall see the recommendations made by the National Curriculum Framework in relation to Science Curriculum.

3.3.3. Learning Points and Learning Activities

3.3.3.1. Recommendations of NCF on Science Curriculum

Exercise - 1
Write in the space provided below your vision of an effective Science Education.

Stage	Approaches/ Methods / Strategies
Primary School	
Higher Primary School	
Secondary School	

As you answered this question several thoughts would have crossed your mind in making science teaching and learning effective. National Curriculum Framework has meticulously worked in framing the recommendations for science education. Let us have a look at them.

A. Perception of Science as given by the National Curriculum Framework 2005

One important human response to the wonder and awe of nature from the earliest times has been to observe the physical and biological environment, look for any meaningful patterns and relations, make and use new tools to interact with nature, and build conceptual models to understand the world. This human endeavor has led to modern science. Broadly speaking, the scientific method involves several interconnected steps: observation, looking for regularities and patterns, making hypotheses, devising qualitative or mathematical models, deducing their consequences, verification or falsification of theories through observations and controlled experiments, and thus arriving at the principles, theories and laws governing the natural world. The laws of science are never viewed as fixed eternal truths. Even the most established and universal laws of science are always regarded as provisional, subject to modification in the light of new observations, experiments and analyses. Science is a dynamic, expanding body of knowledge, covering ever-new domains of experience. In a progressive forward-looking society, science can play a truly liberating role, helping people escape from the vicious cycle of poverty, ignorance and superstition. The advances in science and technology have transformed traditional fields of work such as agriculture and industry and led to the emergence of wholly new fields of work. People today are faced with an increasingly fast-changing world where the most important skills are flexibility, innovation and creativity. These different imperatives have to be kept in mind in shaping science education. Good science education is true to the child, true to life and true to science.

B. Criteria of Validity of a Science Curriculum according to National Curriculum Framework 2005

1. Cognitive Validity: Cognitive validity requires that the content, process, language and pedagogical practices of the curriculum are age-appropriate, and within the cognitive reach of the child.

2. Content Validity: Content validity requires that the curriculum must convey significant and correct scientific information. Simplification of content, which is necessary for adapting the curriculum to the cognitive level of the learner, must not be so trivialized as to convey something basically flawed and/or meaningless.

3. Process Validity: Process validity requires that the curriculum should engage the learner 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 child in science. Process validity is an important criterion since it helps the student in 'learning to learn' science.

4. Historical Validity: 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.

5. Environmental Validity: Environmental validity requires that science beplaced in the wider context of the learner's 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.

6. Ethical Validity: 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.

Check Your Progress - 1
Explain the Criteria of Validity of a Science Curriculum according to National Curriculum Framework 2005

3.3.3.2. Science Curriculum at different Stages as recommended by National Curriculum Framework 2005

The Curriculum at different Stages Consistent with the criteria given above, the objectives, content, pedagogy and assessment for different stages of the curriculum are summarised below:

Primary Stage

At the primary stage, the child should be engaged in joyfully exploring the world around and harmonizing with it. The objectives at this stage are to nurture the curiosity of the child about the world (natural environment, artifacts and people), to have the child engage in exploratory and hands-on activities for acquiring the basic cognitive and psychomotor skills through observation, classification, inference, etc.; to emphasize design and fabrication, estimation and measurement as a prelude to the development of technological and quantitative skills at later stages; and to develop basic language skills: speaking, reading and writing not only for science but also through science. Science and social science should be integrated as 'environmental studies' as at present, with health as an important component. Throughout the primary stage, there should be no formal periodic tests, no awarding of grades or marks, and no detention. At the upper primary stage, the child should be engaged in learning the principles of science through familiar experiences, working with hands to design simple technological units and modules (e.g. designing and making a working model of a windmill to lift weights) and continuing to learn more about the environment and health, including reproductive and sexual health, through activities and surveys. Scientific concepts

are to be arrived at mainly from activities and experiments. Science content at this stage is not to be regarded as a diluted version of secondary school science. Group activities, discussions with peers and teachers, surveys, organization of data and their display through exhibitions, etc. in schools and the neighbourhood should be important components of pedagogy. There should be continuous as well as periodic assessment (unit tests, term-end tests). The system of 'direct' grades should be adopted. There should be no detention. Every child who attends eight years of school should be eligible to enter Class IX.

Secondary Stage

At the secondary stage, students should be engaged in learning science as a composite discipline, in working with hands and tools to design more advanced technological modules than at the upper primary stage, and in activities and analyses on issues concerning the environment and health, including reproductive and sexual health. Systematic experimentation as a tool to discover/verify theoretical principles, and working on locally significant projects involving science and technology, are to be important parts of the curriculum at this stage.

Higher Secondary Stage

At the higher secondary stage, science should be introduced as separate disciplines, with emphasis on experiments/technology and problem-solving. The current two streams, academic and vocational, being pursued as per NPE-1986, may require a fresh look in the present scenario. Students may be given the option of choosing the subjects of their interest freely, though it may not be feasible to offer all the different subjects in every school. The curriculum load should be rationalized to avoid the steep gradient between secondary and higher secondary syllabi. At this stage, the core topics of a discipline, taking into account recent advances in the field, should be identified carefully and treated with appropriate rigour and depth. The tendency to cover a large number of topics of the discipline superficially should be avoided.

D. Outlook towards Science Education

Looking at the complex scenario of science education in India, three issues stand out clearly.

1. Science education is still far from achieving the goal of equity enshrined in our Constitution.
2. Science education in India, even at its best, develops competence but does not encourage inventiveness and creativity.
3. The overpowering examination system is basic to most, if not all, the fundamental problems of science education in India.

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 project work, learners' science congress, co-curricular activities etc. to promote curiosity, inquisitiveness and creativity.
- Organize science and technology fairs at local, district, state and national levels with the coordinated effort of national and state-level agencies, non-governmental organizations and teacher associations.
- Develop experimental and technological modules along with textbooks 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 the 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 practiced 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 requires a complete overhaul in the 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 the exchange of teachers within and outside schools may be promoted.
- Discourage the practice of entrusting teachers with extracurricular duties, reward and honour best practicing teachers with incentives and promotional schemes.

Equity: The disparity among poor and rich, caste inequalities, regional indifferences, etc. hinders 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 the social-economic divide and brings in social transformation among people.
- Even though the curriculum is contextfocused, it should provide scope to respect individual and diverse lifestyles.
- Implement suitable measures to sensitize teachers for 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 the social divide of deprivation of education.

Check Your Progress - 2

1. Which are the different areas considered by the NCF 2005 in their outlook towards Science Education.

3.3.4. Let us Summarise

- **Perception of Science given by National Curriculum Framework 2005**
  - The scientific method involves several interconnected steps: observation, looking for regularities and patterns, making hypotheses, devising qualitative or mathematical models, deducing their consequences, verification or falsification of theories through observations and controlled experiments, and thus arriving at the principles, theories and laws governing the natural world.
  - The laws of science are never viewed as fixed eternal truths.
  - Science is a dynamic, expanding body of knowledge, covering ever-new domains of experience.

- **Criteria of Validity of a Science Curriculum according to National Curriculum Framework 2005**
  - Cognitive Validity
  - Content Validity
  - Process Validity
  - Historical Validity
  - Environmental Validity
  - Ethical Validity

- **Science Curriculum at different Stages as recommended by National Curriculum Framework 2005**
  - **Primary Stage:**At the primary stage, the child should be engaged in joyfully exploring the world around and harmonizing with it.
  - **Secondary Stage:** At the secondary stage, students should be engaged in learning science as a composite discipline
  - **Higher Secondary Stage:**At the higher secondary stage, science should be introduced as separate disciplines, with emphasis on experiments/technology and problem-solving.

- **Outlook towards Science Education**
  - **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.
  - **Textbooks:** Textbooks are the core medium of transacting the curriculum
  - **Examination System:** Learners are to be assessed at various stages of learning to ensure the attainment of educational objectives.
  - **Teacher Empowerment:** The future teachers are trained and shaped at the teacher education institutions.
  - **Equity:** The disparity among poor and rich, caste inequalities, regional indifferences, etc. hinders economic and cultural development. Each school subject should prepare learners fight against such anomalies.

3.3.5.Answers to 'Check Your Progress - 1 and 2'

Check Your Progress - 1

1. Criteria of Validity of a Science Curriculum according to National Curriculum Framework 2005.

- Cognitive Validity
- Content Validity
- Process Validity
- Historical Validity
- Environmental Validity
- Ethical Validity

Check Your Progress - 2

Outlook towards Science Education

- Development of Inventiveness and Creativity
- Textbooks
- Examination System
- Teacher Empowerment
- Equity

1.3.6. Unit end Exercises

1. Explain the perception of Science according to NCF 2005.
2. Explain the Criteria of Validity of Science Curriculum according to NCF 2005.
3. Explain the Science Curriculum at different Stages as recommended by NCF 2005.
4. Explain the Outlook towards Science Education according to NCF 2005.

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Block 3 : Curriculum and Learning Resources in Physical Science

Unit 4 : Learning Resources in Physical Science

Unit Structure

3.4.1. Learning Objectives

After learning through this Unit, the student teachers will be able to

- Identify the different types of Learning Resources of Physical Science;
- Explain the meaning and types of Audio-Visual Aids;
- Explain the meaning and types of Self Learning Material;
- Explain the different types of Programmed Instruction; and
- Explain the different types of Field Resources.

3.4.2. Introduction

Science is nothing but our lives itself. While teaching Science as a subject, it is challenging to give our students an experience of all the processes of science. Science cannot be taught as just an idea without giving the students a first-hand experience of the concepts and processes it holds. But the complexity and the wideness of its processes make it difficult for a teacher to do justice to his/her teaching as he/she may not be able to bring the real world into the classroom.Hence one needs an alternate mode where students get to learn the concepts and ideas in science in the best possible way. This gives rise to the idea of Teaching and Learning Resources from where the students can get the best learning experience that can be provided for Science Teaching. In the present unit, we shall discuss the different Teaching and Learning Resources of Science and Physical Science in particular.

3.4.3. Learning Points and Learning Activities

Exercise - 1

Think of the different activities, objects, materials, or processes that your teacher used while teaching Science during your school days and make a list below.

As you answered the above question, I am sure there must have been several activities like an experiment, skit or field visits, objects and materials like test tubes, beakers, charts,

etc that have come to your mind which I am sure every teacher teaching science would have used in his/her classroom. These materials and activities must have made it easy for you to understand something which looked complicated and abstract otherwise. Teaching and Learning Resources make it easy for a learner to understand a concept which otherwise would look complicated. It helps the learner in his learning process and aids his effective learning. In this unit, we shall discuss some of the teaching-learning resources under the following classification.

Learning Resources in Physical Science can be classified as follows:

A. Audio-Visual Aids
B. Self-Learning Material
C. Programmed Instruction
D. Field Resources

3.4.3.1. Learning Resources in Physical Science: Audio -Visual Aids

Audio-Visual Aids are also called instructional material. Audio means “hearing” and “visual” means that which is found by seeing. So all such aids, which endeavor to make the knowledge clear to us through our senses are called “Audio-Visual Aids” or Instructional Material. All these learning materials make learning situations as real as possible and give us first-hand knowledge through the organs of hearing and seeing. Therefore, any device which can be used to make the learning experience more concrete and effective, more realistic and dynamic can be considered audiovisual material.

According to the Webster dictionary, audio-visual aids is defined as "training or educational materials directed at both the senses of hearing and the sense of sight, films, recordings, photographs, etc. used in classroom instructions, library collections or the likes".

Burton, “Audio-visual Aids are those sensory objects or images which initiate or stimulate and reinforce learning”

Audio-Visual Aids can be classified into the following types

It can be classified simply based on sensory experience. Because human beings derive their experiences mainly through direct sensory contact. Keeping this in view, it can be classified into three main groups:

1. Audio Aids: Training or educational materials directed at the sense of hearing **are** called Audio Aids.Example, Radio, Tape-recorder.

a) **Radio:**By definition, radio is the transmission and reception of signals through electromagnetic waves. Radio listening contributes immensely to the student’s fund of information. It exerts an influence on his attitudes and appreciations, social behaviour and power to develop critical thinking.
b) **Tape Recorder:**This is an extremely versatile aid that can be used effectively for introducing a lesson. For instance, the talk by a renowned scientist can be recorded and used when needed. Teachers can use this auditory aid for teaching several topics in physical science e.g. sound as well as commentary for slide shows.

2. Visual Aids Training or educational materials directed at the sense of vision arecalled Visual Aids. Examples are Chart, Black and while board, Maps, Pictures, Models, Text-books, Slide projector, Transparency, Flash-cards, Print materials etc.

a) **Chalk Board:** The chalkboard is a basic, most widely used and versatile tool of instruction. It helps in visually displaying ideas and concepts in the form of diagrams, figures and also in words. Calculations can be presented using a chalkboard. It helps students to visualize and understand ideas using the sense of vision.

b) **Bulletin Board:** The bulletin board is one of the oldest methods of visualizing organized instruction. It is the place for displaying bulletins, news items, announcements, multifarious items, and visual displays that are absorbing interest to the students. The chalkboard and the bulletin board are the two of the minimum visual needs in every classroom.

c) **Flannel Board:** The flannel board consists of a piece of flannel or felt made from wool, stretched tightly over a strong backing of plywood. Pictures, cards, and similar material can be made to stick on the flannel board if small pieces of the sandpaper, blotting paper, felt or flannel are glued on their back. Flannel board is an extremely versatile instructional device. Processes and procedures can be developed step by step while materials are added, taken off, or moved while the presentation unfolds.

d) **Charts:** Charts are one of the important media of teaching. Formerly, a chart usually referred to a type of map used for navigation, an outline map exhibiting temperature variations or perhaps a sheet giving tabular information. The present usage of the term includes a wide variety of graphic and pictorial material. A chart is a systematic arrangement of key facts or ideas in a graphic or pictorial form. It is a representation that depicts logical visualization of relationships by summarizing, comparing and contrasting in explaining the subject matter.

e) **Pictures:** Pictures can be used as teaching aids depending on the topics. Picture as a teaching aid is easy to be used and carried. It does not require electricity and is inexpensive to produce or purchase. It can be reused and is adaptable to many purposes. Pictures can be mounted on a hardboard or laminate.

f) **Flash Cards:** A flashcard is part of a set of cards on which are written items to be studied. They are "flashed" (shown quickly) one by one to a learner to elicit a quick response. The steps and processes in physical science can be effectively taught using flashcards.

g) **Models:** Of all the visual materials, models are nearest to living experiences. Models are replicas of the original thing. They are contrived experiences where reality is altered or simplified for teaching purposes. In many cases, working scale models of the original are used where the specific action of the original is duplicated and could be explained easily. Thus, models simplify reality and enable us to reduce or enlarge objects to any desirable size.

h) **Overhead Projector:** This device comes in models of various sizes and projects large size transparent images onto a screen under normal daylight conditions. Transparencies may be conveniently produced by drawing or writing directly onto transparent acetate sheets with felt tip pens or special O.H.P pens. They may also

be prepared using a photocopy process in which case the illustration is prepared on an ordinary sheet of white paper.

i) **Slides:** Slides may be mounted in glass, plastic or cardboard and the mount is always 2 inches square. Slides constitute one of the easiest means of bringing real-life situations into the classroom. They are less expensive and simpler to operate than film, easier to edit and arrange for training purposes and have great potential for adaptation to training needs. They may be organized into a complete lesson, accompanied by written notes or a recorded commentary.

j) **Filmstrips:** Instead of cutting up 35mm film into individual frames and mounting them separately, they are often preserved in strip form. Film strips have many advantages viz, portable, quick and easy to produce, less bulker, unbreakable, cannot get out of order, easy to make extra copies.

2. Audio-visual Aids examples are LCD projector, Film projector, TV, Computer, VCD player, Virtual Classroom, Multimedia etc.

a) **LCD Projector:** LCD projectors allow images to be projected in a crystal-clear format. teachers can make use of PowerPoint presentations, images and even films and videos as teaching tools through the use of these projectors. This makes the teaching of science more effective as many of the concepts which could not be brought to class can be shown through this media.

b) **Television:** Television has an immediacy that spans time and space and brings to the viewing audience thousands of miles away, interesting and informative events in the making. Television gives the student access to excellence. One can see and hear gifted artists, great scientists etc. The science programmes on television provide rich content to students and excellent instructional practices to the classroom teachers.

c) **Computer:** A classroom computer can be an incredibly effective tool for teaching and learning. Many benefits come along with having computers in the classroom such as the ability to provide more engaging activities for students, as well as allowing for the creation of more individualized lessons.A classroom computer can be defined as any electronic device that allows teachers and students to access the Internet to research, create, and complete work. Hence it has a huge implication in Physical Science teaching and learning.

d) **Virtual Classroom:** A virtual classroom is an online learning environment that allows for live interaction between the tutor and the learners as they are participating in learning activities. In other words, the virtual classroom is a shared online space where the learners and the tutor work together simultaneously. Usually, these interactions take place through videoconferencing. The participants have tools to present learning content in different formats, as well as to implement collaborative and individual activities. In this type of interaction, the teacher has a particularly important role as the moderator who guides the learning process and supports group activities and discussions.

e) **Multimedia:** Multimedia combines five basic types of media into the learning environment: text, video, sound, graphics and animation, thus providing a powerful new tool for education. It is exceptionally useful in explaining concepts in physical science since abstract concepts can be shown visually using multimedia devices.

Check Your Progress - 1

Enumerate the audio-visual learning materials that could be used while learning Physical Science.

3.4.3.2. Learning Resources in Physical Science: Self-Learning Material

Self-learning materials (SLM) is known as "any learning resource that can be used by a learner without the physical presence of a teacher".

Characteristics of Self Learning Material:

- **Self-Explanatory:** The self-learning materials are written in a way that does not require any intermediary (teacher) to explain the content. This means the content is written in simple language and in small chunks to help learners assimilate the Content by reading and working through the instructions. Thus, a teacher is built-in, into the text.

- **Self-Contained:** The self-learning materials are prepared in such a way that the learners normally do not require additional materials to learn the concepts/ subject matter. This is highly important for the learners since they are isolated and dispersed; they may not have access to good libraries and learning resources. Therefore, the learning materials supplied to them must be detailed and self-contained.

- **Self-Directed:** As learners study in isolation, the self-learning materials must be designed in a way that provides necessary directions to the learners to study and progress. This is done in the self-learning materials by using a variety of techniques including the use of hints, notes, graphics (icons) and explicit directions on how to do, what to do and what is expected of the learner. The use of learning objectives, guidance in the introduction, and a conversational style of writing text, instructions to do and how to answer the self-assessment questions are elements of self-direction that are used in self-learning materials to facilitate learning.

- **Self-Motivating:** One of the major roles of a teacher in the face-to-face education system is to motivate and encourage the learners to study and research. Teachers are role models and students generally try to emulate their teachers. They create interest and curiosity towards a subject. In self-learning materials, all these features should be included, and good self-learning material should arouse curiosity, and interest, encourage the learners towards the in-depth study and critical thinking, motivate them to question and reflect on their own experiences and practices, and also provide reinforcement on learning progress.

- **Self-Evaluating:** The self-learners need to know how they are progressing in their studies, particularly because they are quasi-permanently separated from the teachers and others in their peer group. The separation of teachers and learners inhibits two-way communication, and the learners may not get timely feedback or can't even compare their performance with other peer group members self-learning materials

should provide self-assessment questions and personalized feedback to allow the students to evaluate themselves and learn from their action.

Check Your Progress - 2

Explain the points to be kept in mind while preparing self-learning materials for students of Physics.

3.4.3.3. Learning Resources in Physical Science: Programmed Instruction

Programmed instruction is a method of presenting the new subject matter to students through a graded sequence of controlled steps with corresponding activities. Students work through the programmed material at their speed independently and assess their comprehension after each step through exam questions or filling in a diagram. This method consists of a network of tests and statements which direct the student accordingly depending on their pattern of errors.

Styles / Types of Programming

There are three types of programming

1. Linear Programming
2. Branching Programming
3. Mathetics Programming

a. Linear Programming:

The founder of this programming is B.F. Skinner. It is based on the theory of operant conditioning. It tells that "A Certain direction can be given to human behavior", for this purpose activities are needed to divide into small parts and make their analysis.

Linear programming is based on five fundamental principles-

1. Principles of a small step.
2. Principle of Active responding.
3. Principle of immediate confirmation.
4. Principle of self-pacing.
5. Principle of student testing.

The assumption behind the linear programming is that student learns better if the content is presented in small units, student response if immediately confirmed, results in better learning, student's error create hindrance in learning. The student learns better in Laissez fairy environment.

Frame size in small steps; include only one element of the topic at a time. Each step is complete in itself. It can be taught independently and can be measured independently. The frame structure is based on stimulus-response-reinforcement. There are four types of frames. Introductory frames, Teaching frames, practice frames and testing frames.

Responses in linear programming are structured responses and are controlled by the programmer and not by learners. Immediate confirmation of correct responses provide reinforcement, wrong responses are ignored.

It is used for secondary level students, used for achieving lower objectives of learning especially for recall and recognition, useful for the student of average and below-average intelligence can be used in the distance education programme.

Limitations of Linear Programming:

1. No freedom for the student to respond.
2. Based on learning theories which were formulated by experience conducted on animals. A human being is more intelligent, than animals, he has got an intelligent brain.
3. Every learner has to follow the same path; therefore, the student may cheat from one another.
4. Wrong responses are avoided in the programme. No remedy is provided for them.

b. Branching Programming

The founder of Branching programming is Norman A Crowder. It is based on the configuration theory of learning. It is a problem-solving approach. It is stimulus centered approach to learning.

It is based on three basic principles:

1. Principle of Exposition,
2. Principle of Diagnosis,
3. Principle of remediation.

The frame size is large. There may be a Para or page in the frame. The frame structure is Exposition- Diagnosis- Remediation types. There are two types of frames- Home page (for teaching and diagnosis) & Wrong pages (for remediation). Responses not rigidly structured and responses are selected by the learner and not by the programmer. Confirmation of correct responses provides reinforcement. Wrong responses also help in the diagnosis of weaknesses of the learner. The remedy is provided based onthe diagnosed weaknesses of the learner. The error helps in the diagnosis of the weaknesses of the learner. More than a 20% error rate can be accepted. The purpose of Branching programming is to draw out weak points of the learner and provide a remedy for recovering those weaknesses.

Branching programming is used for secondary as well as higher classes. Higher objectives can be achieved such as multiple discrimination etc. It is useful for students of above average and high intelligence. It can also be used in Distance education programmes.

Limitations of Branching Programming

1. It does not consider the learning process whether learning is taking place or not. The main emphasis is on diagnosing the weakness of learners and providing a remedy to them.
2. There is no sequencing of pages. Student finds it difficult to follow the steps. He does not find it exciting or motivating, therefore he does not want to go through these pages.
3. More emphasis on remediation rather than teaching. Hence, it is only a tutorial approach.

c. Mathetics Programming

The founder of Mathetics is Thomas F. Gilbert. “Mathetics is defined as a systematic application of reinforcement theory to the analysis and construction of complex repertoires which represent the mastery in the subject matter.” It is based on the connectivist theory of learning. It is a reverse chaining approach. It is based on the Principle of chaining, Discrimination and Generalization.

Frames size is organized in small steps but in a reverse chain i.e. from complex content to its small, simple units to attain mastery level; Frame structure is based on Demonstration-prompts-release. There are two types of frames- 1. Demonstration frames 2. Prescription frames.

Responses are structured responses and responses determined by the programmer. Completion of the task provides reinforcement. Wrong responses are ignored. The error helps in discrimination but not in learning. Its main purpose is to develop mastery of the content. The main focus is on Mathematics and grammar.

It is used for higher classes useful for the complex and difficult task. It is useful for developing concepts of mathematics and grammar. It can be used in Distance Education.

Limitations of Mathetics programming:

1. The main emphasis is on mastery of the content rather than changes in behavior of the learner.
2. Retrogressive chaining of stimuli is not effective for terminal behavior.
3. It is very difficult to develop a retrogressive learning package.

Check Your Progress - 3

Explain the different styles of programming and enumerate the merits and limitations of each one of them.

3.4.3.4. Learning Resources in Physical Science: Field Resources

c) ***Science Laboratories***:Laboratory teaching assumes that first-hand experience in observation and manipulation of the materials of science is superior to other methods of developing understanding and appreciation. Laboratory training also develops skills necessary for more advanced study or research.

d) ***Science Center:***Science centers are an important part of the informal education sector. Science centers provide an opportunity to enhance children's learning by helping them to see that science is not "simply about learning a fixed body of known facts but that it is also about the processes and skills necessary to discover these facts." Science centers also nurture a wealth of science communication expertise that can be of use to the formal education system in other ways.

e) ***Science Museum:*** A museum is defined as a building where historical arts, artifacts, works, sculptures, objects of culture or scientific interests are stored, preserved, studied and shown to the students and the general public. Interesting and valuable objects that have historical stories and values are collected and kept in the museum. They are educational and at the same time centers of amusements thereby being of relevant importance to education.

f) ***Industries:***Industrial visit is considered as one of the tactical methods of teaching. The main reason behind this, it lets the student know things practically through interaction, working methods and employment practices. Several scientific concepts and principles can be seen put to practice in such places.

Check Your Progress - 4

Explain the different field resources available for learning physical science

3.4.4. Let us Summarise

Learning Resources in Physical Science can be classified as follows

- **Audio-Visual Aids:**It can be classified simply on the bases of sensory experience as follows
  - ✓ **Audio Aids:** Training or educational materials directed at the sense of hearing **are** called Audio Aids.Example, Radio, Tape-recorder.
  - ✓ **Visual Aids:** Training or educational materials directed at the sense of vision arecalled Visual Aids. Examples are Chart, Black and while board, Maps, Pictures, Models, Text-books, Slide projector, Transparency, Flash-cards, Print materials etc.
  - ✓ **Audio-visual Aids:** Training or educational materials directed at a combination of a sense of hearingand sense of vision arecalled Audio-Visual Aids. Examples are LCD projector, Film projector, TV, Computer, VCD player, Virtual Classroom, Multimedia etc.

- **Self-Learning Material:** Self-learning material (SLM) is known as "any learning resource that can be used by a learner without the physical presence of a teacher".

- **Programmed Instruction:** Programmed instruction is a method of presenting the new subject matter to students through a graded sequence of controlled steps with corresponding activities.

There are three types of programming.

a. Linear Programming.
b. Branching Programming.
c. Mathetics.

- **Field Resources:** Some of the common field resources in Science are: Science Laboratories, Science Centre, Museums, Industries

3.4.5. Answers to 'Check Your Progress – 1, 2, 3 & 4'

Check Your Progress - 1
Refer Section 3.4.3.1.

Check Your Progress - 2
Refer Section Refer Section 3.4.3.2.

Check Your Progress - 3
Refer Section Refer Section 3.4.3.3.

Check Your Progress - 4
Refer Section Refer Section 3.4.3.4.

3.4.6. Unit end Exercises

1. Identify the different types of Learning Resources in Physical Science.
2. Explain the meaning and types of Audio-Visual Aids
3. Elucidate the different types of Audio-Visual Aids with examples.
4. Explain the meaning and types of Self Learning Material
5. What are the Characteristics of Self Learning Material? Explain
6. Explain the different types of Programmed Instruction.

7. How is Programmed Instruction useful in the effective learning of Physical Science, Explain.
8. Explain the different types of Field Resources.

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Block 3 : Curriculum and Learning Resources in Physical Science

Unit 5 : Print and Electronic Material in the area of Physical Science

Unit Structure

3.5.1. Learning Objectives

After learning through this Unit, the student teachers will be able to

- List the different types of Print material in the area of Physical Science;
- Explain the different types of Print material in the area of Physical Science;
- List the different types of Electronic material in the area of Physical Science; and
- Explain the different types of Electronic material in the area of Physical Science.

3.5.2. Introduction

For any kind of learning to be valid and optimum, one needs assistance. This assistance can be in the form of human guidance or the form of effective resources. If we observe the learning that takes place in a formal set-up, it makes use of a combination of both. Learning Resources can be of many types some of which we have discussed in the previous Unit. Print and Electronic media play a very important role in disseminating knowledge and information to people. Hence this can be considered a very useful resource in teaching and learning Physical Science. By print media we mean books, journals, magazines etc while the electronic material could be in the form of online information, CDs or any other electronically saved information. In this Unit, we shall discuss the different print and electronic materials that can be used in the area of Physical Science.

3.5.3. Learning Points and Learning Activities

3.5.3.1. Print Material in the area of Physical Science

Exercise - 1

Recall your student life and write in the space provided below the different print material you referred to, or your teachers suggested to you for learning Physical Science topics under the following classification.

Books	Journals	Magazines	Any other type of Print Material

As you answered the above question, I am sure you must have remembered several books, magazines etc that you have read to understand certain topics and gather more information about those topics. This must have made your learning more effective and long-lasting. Let us see what are the different types of learning materials that are in the print format can be used in optimizing Physical Science Learning.

A. Text Books

Text Book is "any manual of instruction, a book dealing with a specific subject of study, systematically arranged, intended to use at a specific level of instruction, and used as a principle source of study material for a given course" – J.B. Thomas

Text Books are useful guides for teachers and stable orientation for the students. Any book used as the basis or partial basis of concern of study can be called a textbook. It is a specially written book that contains selective and systematic knowledge. Every care is taken for coherence and sequence. It is made simple to the degree that suits the intended learner. Textbook serves as a guide for a teacher and s student as well. Its content decides the destination of both.

Characteristics of A Textbook

- **Conformity with the objectives of curriculum:** A standard textbook conforms to the pre-determined objectives of the curriculum. There must be coordination between the content of the textbook and the objectives of the curriculum.

- **Harmony with national ideology:** Every nation leads life according to its philosophy of life which is reflected in the system of education. This very philosophy of life is presented in the textbook contents so that the new generation may get acquainted with it.

- **Logical organization:** A logical organization can be observed in the content, skills and other activities selected for the textbook. The flow of information and skills should be from simple to complicated, know to the unknown, easy to difficult and from abstract to concrete. The content of the textbook should be integrated, balanced, sequenced and harmonized. It should not be disintegrated and parted. All concepts presented in the textbook must be interlinked and logically connected so that they may assist in understanding one another.

- **Conformity with the capabilities of the learners:** A standard textbook must be harmonized with the interests, needs, psychological demands and mental level of the student. In this situation, the students will take a keen interest in the educative and instructional process. Otherwise, the educative process will end in nothing. If the textbook content is not following the psychological needs and cognitive level of the students, the students will exhibit fatigue and disinterest which will lead, to wastage of academic and educational sources. A good textbook attracts the students in many ways if it is developed according to the established principles.

- **Unbiased content:** The content and other learning experiences of a good textbook are unbiased and objective. There should be no_ amalgamation of the personal aspirations and attachments of the writers in the contents of the textbook. The textbook should be free from all those academic contents which hurt a particular class of individuals or a school of thought. The content of the textbook must address the whole of mankind.

- **Comprehensiveness and simplicity:** Comprehensiveness and simplicity are the two primary traits of a textbook. The content of the textbook should be simple in nature and presentation but should be comprehensive in impression and effect. The content should cover all aspects of human life. In this way, the comprehensive aims of developing the personality of the individual shall be obtained. The developer of the textbook must avoid from irrelevant material but they must keep in mind the principle of comprehensiveness and simplicity during the development of the textbook.

- **Real-life experiences:** A good textbook makes individuals aware of the experiences of real life. The curriculum is concerned with life and life is a reality. The experiences of life are the precious heritage of mankind. A textbook must consist of human heritage. This heritage is transmitted to the students in terms of a textbook. Education is life and this life is presented in the textbook. In this regard, it seems necessary that the students should be acquainted with the truths of life so they may solve the problems of life.

- **Presentation of the content:** A psychological and logical order is observed in the presentation of a textbook. First of all, the topics are described and thereafter, such topics are mentioned in the textbook. The division of the content into topics and sub-topics facilitate the instruction and learning process. This division enables the teacher to teach a topic under various headings. On the other hand, it brings about facilitation in learning of a topic for the students.

- **External impression:** The external impression of a good textbook is always impressive and absorbing. The external impression includes printing on good quality paper, attractive title, appropriate volume, reasonable price and easy availability in the market. The external impression of a textbook matters much for a layman. A student may begin to dislike a subject because of the unimpressive title of a textbook. It is also possible that a student cannot get the benefit of a textbook because of its high price. The textbook should be free from all grammatical and typographical mistakes. Such mistakes may corrupt the meaning of the content and leave negative effects on the learning process.

- **Objectivity:** Objectivity refers to a tendency of viewing things based on external truths and unbiased findings. It denies personal desires and wills. A good textbook is marked with the feature of objectivity. The content of a textbook should be the spokesman of the external realities. All the content of a textbook should be verifiable. A textbook, lacking the quality of objectivity, cannot produce the students which the education system expects.

- **Explanation of the content:** The difficult points of a textbook are explained in terms of pictures, sketches, tables, concrete examples and diagrams. The use of these explanatory tools can bring about better instructional results. The students become able to understand the immaterial concepts presented in the textbook. The writers must be careful in the development of explanatory tools. They should keep the social values and curricular objectives during the development of these explanatory tools.

B. Reference Books

Reference books is a book intended to be consulted for information on specific matters. It is a resource book that gives wide scope for a particular field of information. The information is intended to be found quickly when needed. Reference works are usually referred to for particular pieces of information, rather than read beginning to end.

Characteristic of a Reference Book

1. It has a wide scope
2. The subject matter is grouped into units in a reference book.
3. It is open to all people
4. The subject matter is systematically organized.
5. A specific topic is elaborated with examples and illustrations.
6. Applicable to all levels of education.

C. Resource Books

Resource Book is an accumulated and non-prescriptive package of curriculum materials and information that can enhance a given teaching-learning situation. A resource book is a set of lessons on a topic with a unified purpose, organizational plans to translate the purposes into practice and evaluation to determine the success of the plans to meet or revise the designated purpose.

Characteristics of a Resource Book

1. It is a reservoir of information on a topic.
2. It is prepared by a teacher keeping in mind the exhaustive nature of the topic.
3. It covers content, activities, Teaching Learning Material and Evaluation Procedures
4. Has means, methods and techniques of teaching
5. It covers everything that is needed to attain the instructional objectives.

D. Teachers Hand Book

A handbook is a compact compilation of important facts, principles, theories and data in each of the various concise reference books providing specific information about a subject or topic. A book to which you can refer for authoritative facts; contributed articles to the basic reference work on that topic. The reference book listing brief facts on a subject or place or directions for maintenance of the work to be done is called a handbook. The teacher handbook is the record of the sequence of necessary points for classroom teaching.

Characteristics of a Teachers Hand Book

1. It is maintained by a teacher.
2. Has all the necessary knowledge and information required for a particular topic or class.
3. It can be used both by the teacher and a student to seek information.
4. It consists of knowledge, illustrations and examples on the topic covered.
5. Topics are covered comprehensively along with learning experiences

E. Laboratory Manual

A laboratory manual is an essential guide to laboratory work. It gives good practical guidance regarding the procedure, observation and precaution. The lab manual is a guideline book that demonstrates how inquiry-based labs allow students to plan, direct and integrate a range of science practices, such as designing experiments, collecting data and applying quantitative skills, emphasizes scientific inquiry, reasoning and critical thinking.

Characteristics of a Lab Manual

1. It should contain complete directions about the experiment.
2. It should give the procedure to be followed and the precautions to be observed.
3. It should give the method of recording of observation and tables if needed for recording the observation.
4. It should contain clear directions about writing and completingthe practical notebook.
5. It should consist of the equations, block and circuit diagrams.

F. Scientific Journals

In academic publishing, a scientific journal is a periodical publication intended to further the progress of science, usually by reporting new research.Articles in scientific journals are mostly written by active scientists such as students, researchers and professors instead of professional journalists. Scientific journals contain peer-reviewed articles, in an attempt to ensure that articles meet the journal's standards of quality and scientific validity. Although scientific journals are superficially similar to professional magazines, they are quite different. Issues of a scientific journal are rarely read casually, as one would read a magazine. The publication of the results of research is an essential part of the scientific method. If they are describing experiments or calculations, they must supply enough details that an independent researcher could repeat the experiment or calculation to verify the results. Each such journal article becomes part of the permanent scientific record.

Characteristics of a Scientific Journal

1. Often have a formal appearance with tables, graphs, and diagrams.
2. Always have an abstract or summary paragraph above the text; may have sections describing the methodology.
3. Articles are written by an authority or expert in the field.
4. The language includes specialized terms and the jargon of the discipline.
5. Titles of scholarly journals often contain the word "Journal", "Review", "Bulletin", or "Research".
6. Usually have a narrow or specific subject focus.
7. Contains original research, experimentation, or in-depth studies in the field.
8. Written for researchers, professors, or students in the field.
9. Often reviewed by the author's peers before publication (peer-reviewed or refereed).

G. Science Magazines

A science magazine is a periodical publication with news, opinions and reports about science, generally written for a non-expert audience. In contrast, a periodical publication, usually including primary research and/or reviews, that is written by scientific experts is called a "scientific journal".Science magazines are read by non-scientists and scientists who want accessible information on fields outside their specialization.Articles in science magazines are sometimes republished or summarized by the general press.

Characteristics of Science Magazines

- Has Attractive appearance and an Eye-catching cover
- Pictures and illustrations are in colour
- Usually use Glossy paper
- Audiences are usually Non-professionals i.e General audience
- Written in non-technical language
- The content consists of Personalities, news, and general interest articles
- Covers a wide variety of subjects

- Reviewed by editors
- Few or no bibliographic references

Check Your Progress - 1

1. Name the different types of print material that is available for teaching and learning Physical Science.
2. What is the difference between a Science Magazine and a Scientific Journal?

3.5.3.2. Electronic Material in the area of Physical Science

Exercise - 2

Have you ever used Electronic assistance to find information for any topic related to Physical Science? Write in the space below the different electronic material that you have used so far, to gather information related to Physical Science.

As you answered the above question, I am sure one common answer would have been the use of the internet which is aided by electronic devices. In today's world, electronic devices play a very important role in knowledge dissemination as the use of computers has become an inevitable part of our lives. Now let us what are the different electronic materials that we can make use of in teaching and learning Physical Science.

A. Educational CD's

CD's play an important role in the educational field. Compact Disc Read-Only Memory (CD-ROM) refers to a technology in which a range of data types, such as text, graphics, audio, photographs, and video can all be stored in digital form and accessed by conventional Personal Computers. In the past, learning and simply meant face to face lectures, reading books or printed handouts, taking notes and completing assignments generally in the form of answering questions or writing essays. Computers are an essential part of every classroom and teachers are using DVDs, CD-ROMs and videos to show students how things work and operate. Students can interact with the subject matters through the use of such web-based tools and CD-ROMs.

Importance of educational CD's

- Students can become active participants as opposed to passive ones where they simply receive instructions or information.
- The role of educational CD's in the field of education is fourfold:
    a. it is included as a part of the curriculum,
    b. as an instructional delivery system,
    c. as a means of aiding instructions
    d. as a tool to enhance the entire learning process.
- CD allows distant learning which means that it delivers a 'classroom' in the homes.
- The teacher can establish credibility in what they are teaching.
- It provides distance learners with online communities, live chat rooms and bulletin boards.
- It allows students to collaborate and communicate even though they are isolated in their own space.
- CD-ROM based training has helped eliminate the need for an instructor-based lesson plan.

- Students can grasp concepts faster,proceed and move along, without being held back by ones who need more time and help for learning.
- Educational CDs can include demos, feedbacks that can help the students to reflect on what they have learned.

B. Websites

A website is a collection of web pages. In other words, documents that are accessed through the Internet. A web page can contain any type of information and can include text, color, graphics, animation and sound. In the present day, most businesses, educational establishments and just ordinary people create a website to showcase and manage their activities over the web. The enormous popularity of the internet as a social networking, business and education tool paved its way for the rise of web pages.

Types of Education Websites

a) **Educational Video Websites:** An educational video website is one where study materials and other educational stuff is put up in a video format. Notable educational video websites include Teacher Tube, Discovery Education, Ted Videos, etc.
b) **Digital Libraries:** Digital libraries are a type of educational website where all educational stuff or research and study material is saved and displayed in digital formats such as text, images, audio, videos etc. They are also known as online libraries.
c) **How-to Websites:** How-to websites focus on the content on how to do certain stuff or how they work in detailed steps. These websites generously use photos and videos to help visitors absorb information more easily. Notable How-to websites include – WikiHow, Howcast, EHow, etc.

C. Learning Modules

A Learning Module is a logically structured collection of course content. Conceptually, it is similar to a chapter in a textbook. A Learning Module consists of several sections and activities. Faculty members can add folders and sub-folders to a Learning Module and impose a hierarchical structure over the content. The Table of Contents displays the hierarchy in an outline view and enables students to easily comprehend the scope and structure of a lesson.

Importance of Learning Module

- It's a packet of teaching materials consisting of behavioural objectives, a sequence of learning activities, and provisions for evaluation,
- The objectives are written in behavioural terms are specific.
- The sequence of learning activities is designed to:
  a. Provide instant feedback to the learner on his achievement.
  b. Proceed from lower to higher cognitive levels.
  c. Contain materials with intrinsic interest for the learner.
  d. Provide optional and recycling paths to achieve the objectives.
  e. Be self-continuative to the conclusion of the module.
  f. Equip the learner to achieve the stated behavioural objective.
- The evaluation procedures focus on the standard behavioural objectives. It enables the instructors to determine whether the learner has achieved the objective.

D. e-Books

An electronic book, also known as an e-book or eBook, is a book publication made available in digital form, consisting of text, images, or both, readable on the flat-panel

display of computers or other electronic devices. Although sometimes defined as "an electronic version of a printed book",some e-books exist without a printed equivalent. e-books can be read on dedicated e-reader devices, but also on any computer device that featuresa controllable viewing screen, including desktopcomputers, laptops, tablets and smartphones.

Check Your Progress - 2

1. Which are the different electronic materials that you can use in Physical Science Learning?
2. Which are the different types of Educational Websites?

3.5.4. Let us Summarise

- **Electronic Material in the area of Physical Science**
  - **Text Books:** Text Book is "any manual of instruction, a book dealing with a specific subject of study, systematically arranged, intended to use at a specific level of instruction, and used as a principle source of study material for a given course
  - **Reference Books:** Reference books is a book intended to be consulted for information on specific matters. It is a resource book that gives wide scope for a particular field of information.
  - **Resource Books:** Resource Book is an accumulated and non-prescriptive package of curriculum materials and information that can enhance a given teaching-learning situation.
  - **Teacher's Hand Book:**A handbook is a compact compilation of important facts, principles, theories and data in each of the various concise reference books providing specific information about a subject or topic.
  - **Laboratory Manual:**
  - A laboratory manual is an essential guide to laboratory work. It gives good practical guidance regarding the procedure, observation and precaution.
  - **Scientific Journals:**In academic publishing, a scientific journal is a periodical publication intended to further the progress of science, usually by reporting new research.
  - **Science Magazines:** A science magazine is a periodical publication with news, opinions and reports about science, generally written for a non-expert audience.

- **Electronic Material in the area of Physical Science**
  - **Educational CD's:** Compact Disc Read-Only Memory (CD-ROM) refers to a technology in which a range of data types, such as text, graphics, audio, photographs, and video can all be stored in digital form and accessed by conventional Personal Computers.
  - **Websites:** A website is a collection of web pages. In other words, documents that are accessed through the Internet. A web page can contain any type of information and can include text, color, graphics, animation and sound.
  - **Learning Modules:** A Learning Module is a logically structured collection of course content. Conceptually, it is similar to a chapter in a textbook. A Learning Module consists of several sections and activities.
  - **e-Books:**An electronic book, also known as an e-book or eBook, is a book publication made available in digital form, consisting of text, images, or both, readable on the flat-panel display of computers or other electronic devices.

3.5.5. Answers to 'Check Your Progress - 1 and 2'

Check Your Progress -1

1. Print material in the area of Physical Science
   a. Text Books
   b. Reference Books
   c. Resource Books
   d. Teacher Hand Book
   e. Laboratory Manual
   f. Science Magazines
   g. Scientific Journals

2. Difference between Science Magazine and Scientific Journal.

	Science Magazines	Scientific Journal
Appearance	Attractive appearance, Eye-catching cover Pictures and illustrations in colour Glossy paper	Plain cover May contain graphs, charts or case studies Plain paper
Audience	Non-professionals, General audience Written in non-technical language	Professors, scholars, researchers, or students Written in the technical language of the field
Content	Personalities, news, and general interest articles A wide variety of subjects Articles written by staff may be unsigned	Report original research, discoveries, or experimentation Publish research projects, their methodology, and significance Articles written by contributing authors, with institution indicated
Advertisements	Heavy	Few or none
Reviewers	Reviewed by editors	Reviewed by editors, peers, and referees
Documentation	Few or no bibliographic references	Bibliographic references (footnotes, endnotes, etc.)
Examples	National Geographic National Wildlife People Time	*Biology of the Cell* *Social Forces* *School Science Review* *Journal of Health Care Management*

Check Your Progress - 2

1. The different types of Electronic material that can be used in Physical Science Learning are
   a. Educational CD's
   b. Websites
   c. Learning Modules
   d. e-Books

2. Different types of Educational Websites are
    a. Educational Video Websites
    b. Digital Libraries
    c. How-to Websites

3.5.6. Unit-end Exercises

1. List the different types of Print material in the area of Physical Science. Elaborate.
2. Explain the different types of Print material in the area of Physical Science.
3. List the different types of Electronic material in the area of Physical Science. Elaborate.
4. Explain the different types of Electronic material in the area of Physical Science.
5. Write short notes on the following
    a. Text Books
    b. Reference Books
    c. Resource Books
    d. Teacher Hand Book
    e. Laboratory Manual
    f. Science Magazines
    g. Scientific Journals
6. What are the characteristics of a Text Book? Explain
7. What is an Educational Website? What are its types?
8. How are educational CD's useful in Physical Science Learning?
9. What is an e-book? Elucidate
10. Differentiate between Science Journal and Science Magazines

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Block 3 : Curriculum and Learning Resources in Physical Science

Unit 6 : Use of ICT tools and Online resources at various stages of Physical Science Teaching

Unit Structure

3.6.1. Learning Objectives

After learning through this Unit, the student teachers will be able to

- Explain the meaning of Information and Communication Technology;
- Explain the types of Information and Communication Technology Tools;
- Explain the benefits of ICT;
- Explain the meaning of Online Resources;
- Explain the types of Online Resources;
- Explain the different Online Tools for Teaching Physical Science; and
- Explain the meaning of Open Educational Resources.

3.6.2. Introduction

We are in the mid of the technological era. Technology has made our lives easy and our educational system has become broader and easily reachable. The technology has been assisting in a wide range of educational activities enabling the educationists to expand the possibilities of effective teaching and learning. The use of a wide variety of technological tools is collectively termed as Information and Communication Technology. As teachers have to be acquainted with the use of Information and Communication Technology to increase the quality and effectiveness of learning among the students. In this unit, we shall discuss the meaning of Information and Communication Technology and its tool that can be used in education.

3.6.3. Learning Points and Learning Activities

3.6.3.1. Information and Communication Technology Tools

Exercise - 1

Answer the following questions

1. Which are the different Mobile and Computer applications that you are familiar with which can be used in the classroom for teaching?

2. For what different purposes have you used a computer or a mobile in your classroom teaching?

Today use of mobile and computers is the basic need of a teacher. And hence I am sure you are already aware of several mobile and computer applications that are very useful in classroom teaching. In this unit, we shall discussInformation and Communication Technology as a whole which is useful in Education.

A. Meaning of Information and Communication Technology (ICT)

Information and communications technology (ICT) is an extensional term for information technology (IT) that stresses the role of unified communicationsand the integration of telecommunications (telephone lines and wireless signals) and computers, as well as necessary enterprise software, middleware, storage and audio-visual systems, that enable users to access, store, transmit, and manipulate information.

The term ICT is also used to refer to the convergence of audio-visual and telephone networks with computer networks through a single cabling or link system. There are large economic incentives to merge the telephone network with the computer network system using a single unified system of cabling, signal distribution, and management. ICT is an umbrella term that includes any communication device, encompassing radio, television, cell phones, computer and network hardware, satellite systems and so on, as well as the various services and appliances with them such as video conferencing and distance learning.

ICT is a broad subject and the concepts are evolving. It covers any product that will store, retrieve, manipulate, transmit, or receive information electronically in a digital form (e.g., personal computers, digital television, email, or robots).

B. Types of ICT Tools in Education

Information and Communication Technology consists of various tools and systems that can be exploited by capable and creative teachers to improve teaching and learning situations. ICT tools can be classified as follows:

a) **Informative Tools:**Informative tools are applications that provide large amounts of information in various formats such as text, graphics, sound, or video. Informative tools can be regarded as a passive repository of information (Chen & Hsu, 1999). Examples include tools and information resources of the existing multimedia encyclopedia of the Internet. The Internet is a huge electronic database, and researchers consider the Internet as the most significant ICT tools in e-learning environments. In short, students consider the Internet as a virtual textbook, reference library, virtual tutor, learn to study shortcuts and virtual study groups. E.g. Internet, Network Virtual Drive, Intranet systems, Homepage, etc.

b) **Situating Tools:** Situating tools are a system that lay the students in an environment where it involves a context and the occurrence of a situation. Examples of such systems include simulation, virtual reality and multi-user domain. Situating tools software tools such as CD-ROM. CD-ROM offers a hypermedia application that gives better opportunities for teachers to enhance the learning environment. Hypermedia application covers more than one of the following media such as text, audio, graphic images (still images), animation and video clips. Hypermedia applications are well integrated into the learning environment to enhance student autonomy and thinking. A multimedia presentation topic will help students to conceptualize the ideas of the real world by integrating the theories in the practical application of real-world situations. It is to

increase students' ability to use the conceptual tools of the discipline in authentic practice. Multimedia able to put the amazing array of resources on student and lecturer resources on teaching and student control. E.g. - CD-ROM, etc.

c) **Constructive Tools:** A constructive tool is a general-purpose tool that can be used to manipulate information, construct their knowledge or visualize student's understanding. Construction tools such as Microsoft Word or PowerPoint has a strong impact in the educational environment and is widely used in most organizations in the form of memos, reports, letters, presentations, record routine information, giving businesses the most. PowerPoint is a presentation graphics program packaged as part of Microsoft Office for Windows or Macintosh. Although generally used for developing business presentations, it is also very advantageous in the context of increase creativity among students. While word processing program is the most common computer applications used, as a spreadsheet-like Excel is just as important in teaching and learning of English. Students will be exposed to learning design and statistical data using the Excel program that can be automated through the formula. E.g. MS Word, PowerPoint, FrontPage, Adobe Photoshop, Lego Mindstorm, etc.

d) **Communicative Tools:** Communicative tools are systems that allow easy communication between teachers and students or between students outside the physical barrier classroom. It is including e-mail, electronic bulletin boards, chat, teleconference and electronic whiteboard. Synchronous communicative tools such as chat or video conference enable real-time communication while using the tools of communicative asynchronous (e.g. e-mail and electronic whiteboard) is a system in which exchange of messages between people are not 'live' but somehow delayed. The communicative tool is most appropriate for activities requiring more time to think before responding. The utilization of electronic mail is increasing day by day. E-mail is the most commonly used on the Internet. It is easy to use as it is a primarily text-based system and simple communication tool for teachers and students that allows students to dominate class beyond the physical barrier. E.g. e-mail, SMS, etc.

e) **Collaborative Tools:** Collaboration tools of ICT is currently the focus of much interest and emerging as the development of new tools that make online collaborative projects draw a realistic option for a distributed group work. The Internet can be used for many collaborative activities such as meetings, discussions are taking place, working on the document, information dissemination, and other tasks. Interactive electronic whiteboard is not just used as tools for meeting and development, but recently became the most popular tool among teachers. Whiteboard is an electronic device that interfaces with the computer where the computer image is displayed on the board that can be manipulated interactively. This tool is increasingly popular with teachers when used in conjunction with a computer and a video projector that produces an interactive learning community. Instead of having to crowd around one or two computers, interactive whiteboard not only displays the materials but also to respond to human interaction with computer commands and orders on a touch screen. Besides, these technologies provide impulsive information sharing, constructing knowledge and stimulate personal growth. Other collaborative tools, such as E-mail messaging, Wireless Application Protocol (WAP) and General Packet Radio Services (GPRS) embedded in micro-browser equipped mobile phones or GPRS-enabled handheld computers are other ICT tools that can link students in different geographic locations exceeding the boundaries of class. Besides, the development of mobile phones and PDA allows learners to exchange information in a short time

simultaneously and asynchronously, and provides flexibility for one-one, one-to-many and many-to-many communication, especially for the online discussion forum. E.g.discussion boards, etc.

C. Benefits of Utilizing ICT In Education

- Increase in pupils' motivation, enthusiasm and confidence
- Positive association with the attainment
- Learning possibilities expanded via collaboration, interaction and communication in the target language
- Potential for differentiation according to individual pupil need
- It facilitates the latest information for the user with a click of a mouse.
- The speed and automatic functions of ICT allow a teacher to demonstrate, explore and clarify aspects of the teaching method which enable the students to learn more effectively;
- The capacity and coverage of ICT to assist the teachers and pupils easy access to for historical event or current formation
- The temporary nature of the information stored, processed and presented using ICT enables simpler methods as documents could be changed and corrected by editing software provided in the programs.
- the interactive way in which information is stored, processed and presented can enable teachers and students to explore the model, communicate effectively with others and present information to different audiences.
- ICT in an appropriate manner enables new methods of teaching and learning, especially for students in exploring exciting ways of problem-solving in the context of education. New ways of teaching and learning are supported by constructivist learning theory and a paradigm shift from teacher-centered pedagogy of memorization and rote-learning to focus on student-centered.

Check Your Progress - 1

1. What is ICT?
2. Which are the different types of ICT Tools.

3.6.3.2. Online Resources

Exercise - 2

Have you ever used the internet to search for information related to your lessons? List the different websites or the types of resources you have visited online for your learning.

The Internet has become a part of our life with the advent of smartphones. Internet search has become a basic necessity of our lives. It has also made our learning easy as information is available at our fingertips. Let us in this unit see the different types of resources that can be used in Education.

A. Meaning of Online Resources

In general, web pages and documents on the internet that provide useful information are known as online resources. These resources are accessible via the Internet and the World Wide Web. While an online resource is archetypal data and educational, any support software available online can also be considered a resource. It consists of Materials, notes, timetables, notices, etc., available online for reading.

B. Types of Online Resources

a) **Databases:** Databases are indexes that enable you to search for articles within journals. Many also provide abstracts of the articles.

b) **Electronic Books:** The Library buys books in electronic format whenever possible. All of them can be read on any computer which is connected to the Internet and many can also be downloaded to laptops, tablets, and other devices for reading offline. You can find e-books through Library Search and on the publishers' websites.

c) **Electronic Dictionaries and Encyclopedias:** Some key reference works are also available online.

d) **Journals and e-Journals:** Journals (or periodicals) are held in all of the University Libraries and an increasing number are available electronically both on-and-offcampus.

e) **Official Publications:** Government publications from the Central Government and the State government are available online.

f) **Online Newspapers**: Different online newspapers can be a good resource for learning in Physical Science.

g) **Referencing Resources:** Cite Them Right Online is a digital resource designed to help students with referencing. EndNote is a personal bibliographical database, which you can use to store your collection of references. Our guide shows how you can search the major databases and import records to your EndNote library.

h) **Video, Image & Sound Resources:** This is the biggest online resource for Physical Science learning since most of the topics require visualization and videos, image and sound make it possible for effective learning.

C. Online Tools for Effective Physical Science Teaching

1. **Google Classroom:** Google Classroom is the ultimate online hub for your classroom. It can be used to publish assignments, create classes, make announcements, and organize digital files for your classroom. Google Classroom allows you to communicate with your students via email, without even leaving the app. You can also start a conversation with one, several, or all students within the same interface.

2. **Google Docs:** Google Docs is often confused with Google Drive, but the two are different. While Google Drive is online storage for your digital files, Google Docs is a word processing tool that can be used to create word documents. It is strikingly similar to Microsoft Word with two exceptions: Google Docs is free and it's cloud-based. When it comes to the classroom, it can be used to go paperless. Google Docs can also be used in a collaborative assignment where a group of students works on a writing project together. Google Docs comes with a built-in chat module for real-time teamwork.

3. **Google Forms:** Google Forms can be used to create pop quizzes and other assessments. The beauty of Google Forms is that these tests are self-grading. With Flubaroo, you can assign tests to specific students, record responses, and then send

email results to both students and their parents. Plus, Flubaroo is a free add-on for Google Forms.

4. **Google CS First:** The CS stands for Computer Science. There's little doubt that computer science is the face of the future. If you teach children from ages 9 to 14, the Google CS First program is worth considering. Through this program, Google provides all training and materials for starting and instructing a computer science club in your school– no experience needed.

5. **Google Science Fair**: Google also runs its own science fair. This online competition is open to students around the globe, aged 13 to 18. Winners are awarded scholarship funding, mentorship, and an educational trip.

6. **Hangouts on Air:** Hangouts on Air is a tool that allows you to host live broadcasts with just a webcam, a computer, and an Internet connection. There are a lot of great uses for Hangouts on Air in the classroom. A favourite option is to host guest speakers for your classroom with this tool. If you want to interview or interact with a special guest, but you can't coordinate a visit, use Google Hangouts on Air to do so. With this tool, your entire class can interact with the person on the other side of the screen by taking turns to ask questions. Another option for Hangouts on Air is to teach a class remotely, which makes sense if you're collaborating with another teacher.

7. **Google Earth:** This app explores the earth in 3D. you can use Google Earth in every major discipline, from computing math equations to understanding marine biology and the universe. While it's named Google Earth, you're not bound to just this celestial body when using this immersive tool. Explore the moon, see the face of Mars, or even zoom up close to distant galaxies far, far away.

8. **YouTube:** YouTube happens to be the Internet's second-largest search engine, and you can indeed find just about any answer on this popular video site. However, YouTube is also an educational resource that you should definitely consider for free, high-quality videos on every topic imaginable. From Einstein's Theory of Relativity to the migratory pattern of wildebeests, you'll find a wealth of information to support your lesson plan.

9. **Google+:** It's Google's answer to social media, and it's sort of like a mashup between Facebook and Twitter. While there are many applications for Google's social network, one of the best reasons why a teacher should be on Google+ is to network with other educators. On Google+, you can keep up with the latest trends in education, get needed support, and participate in lively discussions with fellow educators.

C. Open Educational Resources (OER)

Open educational resources (OER) are freely accessible, openly licensed text, media, and other digital assets that are useful for teaching, learning, and assessing as well as for research purposes. The term OER describes publicly accessible materials and resources for any user to use, re-mix, improve and redistribute under some licenses. The development and promotion of open educational resources are often motivated by a desire to provide an alternate or enhanced educational paradigm.

1. Definition and scope

The idea of open educational resources (OER) has numerous working definitions. The term was first coined at ***UNESCO's 2002 Forum on Open Coursewareand*** designates "teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions. Open licensing is built within the existing framework of intellectual property rights as defined by relevant international conventions and respects the authorship of the work".

Often cited is the ***William and Flora Hewlett Foundation*** term which used to define OER as:

OER are teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use and re-purposing by others. Open educational resources include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge

The ***Hewlett Foundation*** updated its definition to:

"Open Educational Resources are teaching, learning and research materials in any medium – digital or otherwise – that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions". The new definition explicitly states that OER can include both digital and non-digital resources. Also, it lists several types of use that OER permits, inspired by 5R activities of OER.

5R activities/permissions were proposed by David Wiley, which include:

- **Retain** - the right to make, own, and control copies of the content (e.g., download, duplicate, store, and manage)
- **Reuse** - the right to use the content in a wide range of ways (e.g., in a class, in a study group, on a website, in a video)
- **Revise** - the right to adapt, adjust, modify, or alter the content itself (e.g., translate the content into another language)
- **Remix** - the right to combine the original or revised content with other material to create something new (e.g., incorporate the content into a mashup)
- **Redistribute** - the right to share copies of the original content, your revisions, or your remixes with others (e.g., give a copy of the content to a friend)

Users of OER are allowed to engage in any of these 5R activities, permitted by the use of an open license.

The Organization for Economic **Co-operation and Development (OECD) defines OER as**: "digitized materials offered freely and openly for educators, students, and self-learners to use and reuse for teaching, learning, and research. OER includes learning content, software tools to develop, use, and distribute content, and implementation resources such as open licences".(This is the definition cited by Wikipedia's sister project, Wikiversity.) By way of comparison, the Commonwealth of Learning "has adopted the widest definition of Open Educational Resources (OER) as 'materials offered freely and openly to use and adapt for teaching, learning, development and research'".

The Wiki-Educator project suggests that OER refers "to educational resources (lesson plans, quizzes, syllabi, instructional modules, simulations, etc.) that are freely available for use, reuse, adaptation, and sharing'.

2. Advantages of using OER

- Expanded access to learning – can be accessed anywhere at any time
- Ability to modify course materials – can be narrowed down to topics that are relevant to course
- Enhancement of course material – texts, images and videos can be used to support different learning styles
- Rapid dissemination of information – textbooks can be put forward quicker online than publishing a textbook
- Cost-saving for students – all readings are available online, which saves students hundreds of dollars.

3. Disadvantages of using OER

- Quality/reliability concerns – some online material can be edited by anyone at anytime, which results in irrelevant or inaccurate information
- Limitation of copyright property protection – OER licenses change "All rights reserved." into "Some rights reserved." so that content creators must be careful about what materials they make available
- Technology issues – some students may have difficulty accessing online resources because of slow internet connection, or may not have access to the software required to use the materials

Check Your Progress - 2

1. What are Online Resources?
2. Elaborate OER.

3.6.4. Let us Summarise

- **Information and Communication Technology(ICT):** Information and communications technology (ICT) is an extensional term for information technology (IT) that stresses the role of unified communicationsand the integration of telecommunications (telephone lines and wireless signals) and computers, as well as necessary enterprise software, middleware, storage and audio-visual systems, that enable users to access, store, transmit, and manipulate information.

- **Types of ICT Tools in Education**
  a. Informative Tools: E.g. Internet, Network Virtual Drive, Intranet systems, Homepage, etc.
  b. Situating Tools: E.g. - CD-ROM, etc.
  c. Constructive Tools: E.g. MS Word, PowerPoint, FrontPage, Adobe Photoshop, Lego Mindstorm, etc.
  d. Communicative Tools: E.g. e-mail, SMS, etc.
  e. Collaborative Tools: E.g.discussion boards, etc.

- **Online Resources:** In general, web pages and documents on the internet that provide useful information are known as online resources.

- **Types of Online Resources**
  a. Databases
  b. Electronic Books
  c. Electronic Dictionaries and Encyclopedias
  d. Journals and e-Journals
  e. Official Publications
  f. Online Newspapers
  g. Referencing Resources
  h. Video, Image & Sound Resources

- **Online Tools for Effective Physical Science Teaching**
  - **Google Classroom:** It can be used to publish assignments, create classes, make announcements, and organize digital files for your classroom.
  - **Google Docs:** Google Docs is a word processing tool that can be used to create word documents.
  - **Google Forms:** Google Forms can be used to create pop quizzes and other assessments.
  - **Google CS First:** Through this program, Google provides all training and materials for starting and instructing a computer science club in your school
  - **Google Science Fair**: Google also runs its own science fair. Winners are awarded scholarship funding, mentorship, and an educational trip.
  - **Hangouts on Air:** Hangouts on Air is a tool that allows you to host live broadcasts with just a webcam, a computer, and an Internet connection.
  - **Google Earth:** While it's named Google Earth, you're not bound to just this celestial body when using this immersive tool. Explore the moon, see the face of Mars, or even zoom up close to distant galaxies far, far away.
  - **YouTube:** YouTube happens to be the Internet's second-largest search engine, and you can indeed find just about any answer on this popular video site.
  - **Google+:** On Google+, you can keep up with the latest trends in education, get much-needed support, and participate in lively discussions with fellow educators.

- **Open Educational Resources (OER):**Open educational resources (OER) are freely accessible, openly licensed text, media, and other digital assets that are useful for teaching, learning, and assessing as well as for research purposes.

3.6.5 Answers to 'Check Your Progress - 1 and 2'

Check Your Progress - 1

1. Information and communications technology (ICT) is an extensional term for information technology (IT) that stresses the role of unified communicationsand the integration of telecommunications (telephone lines and wireless signals) and computers, as well as necessary enterprise software, middleware, storage and audio-visual systems, that enable users to access, store, transmit, and manipulate information.

2. Types of ICT Tools in Education
   a. Informative Tools: E.g. Internet, Network Virtual Drive, Intranet systems, Homepage, etc.

b. Situating Tools: E.g. - CD-ROM, etc.
c. Constructive Tools: E.g. MS Word, PowerPoint, FrontPage, Adobe Photoshop, Lego Mind storm, etc.
d. Communicative Tools: E.g. e-mail, SMS, etc.
e. Collaborative Tools: E.g.discussion boards, etc.

Check Your Progress - 2

1. In general, web pages and documents on the internet that provide useful information are known as online resources.
2. Open educational resources (OER) are freely accessible, openly licensed text, media, and other digital assets that are useful for teaching, learning, and assessing as well as for research purposes.

3.6.6. Unit end Exercises

1. Explain the meaning of ICT.
2. Which are the different tools of ICT? Explain
3. What is the use of ICT? Elucidate with examples
4. Which are different Online tools that can be used to make Physical Science Teaching Effective?
5. Illustrate the use of Online tools in Physical Science Teaching.
6. What are Open Educational Resources? Explain
7. Which are the different types of Open Educational Resources. Explain
8. Elucidate the advantages and disadvantages of Open Educational Resources.

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Block 4 : Planning of Teaching Learning and Assessment of Physical Science

Unit 1 : Planning of Teaching in Physical Science: Importance

Unit Structure

4.1.1. Learning Objectives

After learning through this Unit, the student teachers will be able to

- Explain the importance of Planning of Teaching in Physical Science;
- Explain the planning of a Lesson Design;
- Explain how to identify and organize the concepts in Physical Science Teaching;
- Explain the Basic Principles for Planning a Lesson in Physical Science; and
- Explain the Elements of a Physical Science Lesson.

4.1.2. Introduction

As a Physical Science teacher, several questions may come up to you before entering a classroom, such as how are you going to facilitate your students to learn science, how can you generate thinking and curiosity among your students,how are you going to encourage them to ask questions,what if the activities do not work, what if you do not answer all the questions of students, how will you assess students' learning or will your students be satisfied by your way of assessment? An answer to all these questions would be good planning of your lesson. A plan is nothing but a guide that can sail you smoothly through the teaching process. It is a tool that equips you to confidently enter the classroom and successfully achieve all that you intend to achieve. In this Unit, we shall discuss the importance and basics of planning a Lesson in Physical Science.

4.1.3. Learning Points and Learning Activities

4.1.3.1. Planning of Teaching in Physical Science

Exercise - 1

What according to you do think are the necessary things you need to keep ready before entering the classroom to teach a Physical Science Lesson?

As you answered the above question, all those things which you thought were necessary to teach Physical Science would have crossed your mind. Now we shall discuss these things in a more systematic and orderly way.

A. Importance of Planning of Teaching in Physical Science

- It boosts your self-confidence and reduces your strain and anxiety about your teaching.
- Gives time to think about how to engage learners actively, and be creative in designing teaching-learning experiences. Planning for teaching-learning may also be termed as designing for learning.
- It saves your time, energy, efforts and resources.
- Activities and experiments may become more effective if you perform and check the functionality of the apparatus and activities beforehand. You can anticipate students' questions and inquiry for which you can plan your teaching-learning strategies.
- You can assess whether your learning objectives have been realized or not. If not, what alternative strategies you need to plan? What modifications in the teaching-learning situation are needed?
- What question will you ask students? What steps will you take to help them observe, record, discuss, draw conclusions, critically think and communicate during the teaching-learning process and carrying out activities?
- How can you organize the class as well as the activities effectively?
- How can you switch over from one concept to another concept without leaving a gap in between?
- What assignment can you give to your students to reinforce the concepts learnt in the class?
- It gives you a sense of ownership of the curriculum.

B. Planning a Lesson Design

Teachers need to understand how to plan lesson design, so that learners are challenged to think. Teachers also need to know how learners are constructing their knowledge and what they are learning. Meaningful learning takes place when the teacher can involve the students in the process of learning, by taking them beyond the process of listening to that of thinking, reasoning and doing.

For planning meaningful learning design in physical science through a learner-centered approach you may start asking yourself questions like:

- What concepts are relevant to learners' interests?
- What can I expect them to know?
- How will learners interact with the learning materials in particular learning situations? What questions they might ask?
- What misconceptions and naive concepts learners might have? How can I elicit those concepts from them?
- What misconceptions and naive concepts might emerge out of the teaching-learning process and how can I deal with them?
- What diverse needs of the learners I need to consider in grouping them and selecting teaching-learning materials?
- What can be the learning indicators? How can I get evidences of their learning of ideas, concepts and process of science?

Frank answers to such questions will help you meet the purpose of teaching-learning, i.e. learners' learning.

C. Identification and organization of Concepts

Identification and organization of concepts are two basic components and an initial activity for teaching-learning. An efficient science teacher should know how best one can identify, organize, design and assist in the progress of learning experiences under specific conditions and situations to help diverse groups of students.

i. Factors that need to be considered for the organization of the concepts

1.Student's consideration: Students are constructors of knowledge and the teacher is a facilitator of learning. Students are at the focus of your teaching-learning. Each student is an individual with her interests, abilities and experiences. Each student has special strengths and limitations. Students are constantly in a state of change, i.e. their ways of thinking and their personality change. They come to class with their concepts and previous experiences. Your role as a teacher is to identify and remove their misconceptions and naive concepts, inculcate a habit of argumentation, articulation and make them critical and reflective thinkers. Therefore, before identifying and organizing concepts for teaching-learning, you should keep the following points in your mind: What do you know about your students, individually and as a heterogeneous group? Are they easy or difficult to motivate? What do they already know about the concept you are planning to transact? How might they best learn? What accommodations will be needed for students with special educational needs?

2. Content and process consideration: What main ideas and concepts are involved? What teaching-learning materials will you need to transact the concepts? In what order should the teaching-learning activities be arranged? How can you devise a variety of learning activities and experiences to transact the concepts?

3. Time consideration: How much time is available for it? Do you need more than one day or one period for a particular topic?

4. Resource consideration: What resources are available in the school and community such as laboratory, library, ICT resources, science centre and museum and with people within the community who might contribute to the teaching-learning process in the school?

5. Teacher consideration: The teacher needs to identify the pre-existing understandings that students bring with them. Inquiring into students' thinking orally or in written form and creating classroom tasks and the environment under which students' thinking can be revealed are important to: λ transact the same concept in various ways and, thus providing different learning experiences to learners for a firm foundation of factual knowledge; λrecognize preconceptions of students that make the understanding of particular subject matter challenging; λ work with those preconceptions, so that students build their knowledge on them and challenge them when appropriate, and replace them; and λ integrate teaching-learning of metacognitive skills into the curriculum. 6. Technical consideration: What appropriate equipment, hardware and software are available for effective transactions?

ii. Need for identifying and organizing concepts for teaching-learning science

Identification and organization of concepts help a teacher to know:

- What are the most relevant concepts to the topic?
- What do students need to know about a particular topic?
- What are the misconceptions and naive concepts students might have and their way of removal?

- What misconceptions and naive concepts might arise during the teaching-learning and how will these be tackled?
- What will you do to ensure that your students understand the concepts?
- What are the learning indicators that can show that students have meaningfully understood the relevant concepts and processes?

E. Basic Principles for Planning a Lesson in Physical Science

1. **Every learner constructs his/her knowledge:** The teacher's responsibility is to enable this process through appropriate means and process and with adequate help and support. There can be several ways of constructing knowledge and there could be several ways of generalizing as well as validating the knowledge constructed.

2. **Importance of experience in learning:** Experience is perhaps the most important step in the construction of knowledge. All possible opportunities to observe, feel, work with hands, reflect and arrive at ideas should be provided to learners.

3. **Active engagement of the learner in the construction of knowledge:** It refers to the engagement of the body as well as mind. Learners can be actively engaged when they feel motivated to learn. They can be involved in the inquiry, debate, discussion and reflection. An element of challenge in the context of capabilities of the learner is critical for the process of her active engagement and learning various concepts, skills, and attitudes.

4. **Every learner is unique:** Every learner constructs her knowledge in her way. Some learners might find a particular kind of learning process challenging and enjoyable while others might not enjoy it as much. The level of learners' engagement could vary. Although it is difficult to respond to each learner's preference in everything a teacher does, it would help to have a broad understanding of the patterns of their thinking and response process. If the teacher involves learners and remains flexible while planning her work, the individual unique abilities of learners will bring tremendous richness to the classroom process.

5. **Variety of situations and multiplicity of strategies are important for creating diverse experiences:** Different kinds of situations provide different kinds of learning experiences to students. Exposure to a variety of learning situations such as self-work, small group work, and whole class (or a large group) work helps in widening the experiential base. It also helps in developing diverse perspectives of learning. Therefore, it becomes important to have opportunities for self-learning, peer learning, and learning through interaction with teachers. The experience of working in diverse situations also helps in realizing the necessity and developing the skills of interdependence and cooperation. The experience of self-learning could help in developing the capability for independent action. Similarly, there could be several ways of inquiry and exploration. If classroom questioning and dialogue could be suitable for the transaction of some concepts; collecting information through observation followed by its processing, analysis, and theory building would be more appropriate for some other concept. A place for work with hands would also be important in many cases. Similarly, it is also important for teachers to be familiar with different forms of expressions, verbal and non-verbal, as well as ideas, so that they can create space and opportunities to allow all these to happen.

6. **The implication of aims for classroom practices:** The entire organization of the classroom and learning experiences needs to be such that they promote the same ethos, values, and principles. For instance, the aim of promoting equity, democracy, freedom and plurality through education has to be reflected in all aspects of the pedagogy including the strategies, the teacher-student relationship, and the kind and nature of learning experiences. It would be difficult to promote equity and democracy through a classroom where the teacher does not allow children to ask questions, where the teacher does not make an extra effort to make a relatively silent child speak and participate, and where varying opinions are not encouraged to be voiced and debated. In other words, democracy or equity is not taught only by covering these as knowledge areas but has to be made part of the regular classroom process.

7. **An enabling teacher-learner relationship:** The process of learning requires uninhibited participation and engagement of learners that can be largely facilitated by teachers. Teachers' expectations from learners have proved to be one of the important factors in determining their motivation to learn, and consequently the pace and level of their learning. The teachers need to develop an affectionate and equal kind of relationship with learners, irrespective of their background and specificities. They should be responsible for making the learners feel comfortable and acceptable in the class, which is one of the first requirements for learning to happen.

8. **Providing space for parents and community:** While school is a structured space for guided learning, the process of constructing knowledge is a continuous one, which goes on even outside the school. Providing some space to the community in the classroom processes as part of the curricular plan could help in developing a mutual appreciation and greater coordination among them. Parents or community members could be seen as resource persons for exposure to certain ideas and concepts and could be requested to share some of their experiences with students.

Check Your Progress - 1

List the Basic Principles for Planning a Lesson in Physical Science

4.1.3.2. Elements of a Physical Science Lesson

A standardized format of a lesson or unit plan cannot capture the interest of all learners. A well-organized teaching-learning situation can have an appeal to students yet follow the curricular guidelines of the school. Therefore, you need to design various learning situations creatively and innovatively to cater to the learning needs of different learners. There are certain basic elements of a lesson plan. Knowledge of these basic elements of a lesson plan will be a great help to you in planning for lesson design.

1. Title of the lesson/unit
2. Learning objectives and key concepts of the time frame
3. Pre-existing knowledge
4. Materials, equipments, resources
5. Introduction
6. Presentation
7. Assessment
8. Extended learning, assignment

It is important to understand that this is not a rigid picture of a lesson plan. There are many ways to design a lesson and you may think of many innovative designs of it depending on the learning needs of the learners, the nature and context of the concepts, learning situations and your resourcefulness. You may need to change, add, omit or delete some elements as you move from one lesson to another and even when the classroom interactions are going on to meet different needs of the learners.

a. **Learning objectives and key concepts:**Objectives are the first step in the process of planning and thus form the basis of the subsequent steps of the plan. Objectives of the lesson need to be planned by keeping in view
   - the Nature of Science
   - Aims of Learning Physical Science
   - context of the learner and his/her needs.

b. **Pre-existing knowledge**: By pre-existing knowledge, we mean the knowledge and experiences, which you consider essential for students to possess for learning the lesson being planned. Those earlier experiences and concepts learnt by the students, which are crucial for the comprehension of the lesson, should be considered in previous knowledge for their better understanding. Paying attention to previous and existing knowledge helps a teacher to identify misconceptions and naive concepts of students and reconstruct their ideas that are scientifically accepted.

c. **Teaching-learning materials and involving learners in arranging them**: Teaching-learning materials aid in learning. These can be equipment, apparatus, model, chart, real objects, video, audio-video aids, etc. Learning can be reinforced with teaching-learning materials of different varieties, because they stimulate, motivate as well as capture learners' attention for a while during the teaching-learning process. While selecting appropriate teaching-learning materials for our classroom, we need to make sure that they should cater to the needs of learners learning with various learning styles.

d. **Introduction:** A good beginning is crucial for the success of any endeavour. Relating learning with everyday life experiences of the learner generates interest in learning new concepts. The main purpose of the introduction is to motivate and prepare the students to learn the topic by relating their existing knowledge with the new knowledge. Besides motivation, other purposes of introduction may be to:
   - establish continuity of the lesson;
   - highlight the importance of the lesson;
   - clarify the objectives of the lesson;
   - raise curiosity among the students;
   - present a brief outline of the lesson;
   - create interest among the students; and
   - test their previous knowledge, etc.

e. **Presentation/Development:** Presentation/development of the lesson should be per the objectives of the lesson. You should also take into account the following:
   - nature of the subject matter
   - learning context of your students
   - classroom environment and infrastructure available and
   - your context.

As presentation will vary, depending on the factors mentioned above, several illustrative plans are being given in upcoming sections of this unit. It involves splitting the lesson/unit into smaller ones for a given period and including many activities to help learners to observe, feel, reflect and arrive at ideas through their own experiences. The learning experience of students can be enriched by:

- discussion and argumentation.
- activities and experiments.
- pre-lab, and post-lab discussion to engage learners in thinking, planning and relating knowledge with their existing ideas.
- computer simulation and other interactive software, reviewed webpages
- quiz, project, field visit, etc.
- review and feedback.
- assessment that is intertwined with all stages of the lesson.

f. Assessment: The purpose of this element of a lesson plan is to get feedback from learners. Assessment should be an integral part of the design of a lesson. Learning is a kind of understanding that emerges from a well-developed and supported theory, an explanation of phenomena, data, feelings, or ideas. Learners' understanding is uncovered through their performances and products that clearly and thoroughly explain how things work, and how do they connect those performances and products with the relevant concepts. Learning evidences acquaint the teachers with students' understanding of concepts and how they show the meaning of facts, concepts and application of knowledge. Evidences of learning come from the assessment of students' work such as experiments, presentation, homework, assignment, explanations, worksheet, test, project, etc.

g. Determining learning evidences: We can infer that learning evidences are concerned with the assessment. One of the main objectives of science education is the development of students' understanding of science concepts. Students reveal their understanding most effectively when they are provided with proper opportunities and an environment to express themselves. How can we determine the evidence of students' understanding? Learning evidence help us to evaluate their progress. Let us now see how to determine learning evidence.

1. ***Set objective:*** This is a learning objective we have discussed earlier.
2. ***Identify ends:*** Learning ends should be a part of your vision for the learner, or what you envision about the learner – to know, understand or perform. These may provide a framework for culling content and sifting it into various areas and strands of learning.
3. ***Expand or recombine:*** Can specified ends be broken down into smaller pieces (such as knowledge, specific skills and performances, or learning objectives), or compressed and integrated with other subject areas, or combined into a comprehensive problem, simulations, or self-directed investigation?

h. Determine acceptable evidence for collecting indicators of learning:

- What evidence will prove that students have achieved the objectives or completed the problem
- What will they, or should they, be able to do to give evidence of learning?
- Can these evidences be placed in graded tasks specific to learning indicators with clearly stated parameters for each level of gradation (i.e. unacceptable, acceptable and exemplary; or at introductory, practiced, and advanced levels).

Before collecting evidences for understanding, the teacher must be clear about the following points:

- What kind of evidence does a teacher need to find learners' understanding? What would be the nature of the task to provide such evidences? For example, would it be the performance of an experiment or activity or writing an answer to an open-ended question or oral presentation.
- The teacher should know the learners' thought process along with their answers or solutions.
- What specific characteristics in the learners' responses should be examined to determine the extent to which the learning objectives are achieved?
- Their explanations of why they did what they did; their reasoning and justification for the approach or response.
- Can the proposed evidence enable a teacher to infer learners' knowledge, skill and/or understanding?
- Reflection on the result, as it gives further insight into the extent of understanding of the concepts.

i. **Planning of the acceptable evidences of learning for assessment:** Planning on the acceptable evidences of learning helps the teacher to remain focused on the task at hand and integrate assessment with the teaching-learning of physical science. A summary containing salient features of the lesson can be prepared side-by-side (for the blackboard work) with the presentation. It can help you revisit and reflect on the feedback obtained during the teaching-learning process.

j. **Extended learning/assignment:** The most valuable assignment is the one that a student finds interesting and important, and understands why it is important. The assignment may vary from student to student due to their different interests and needs. Providing constructive and positive feedback to them encourages them to work on their assignments. will also get enhanced.

Check Your Progress - 2

What are the elements of the Physical Science Lesson?

4.1.4. Let us Summarise

- **Importance of Planning of Teaching in Physical Science**
  - It boosts your self-confidence
  - Gives time to think about how to engage learners actively,
  - It saves your time, energy, efforts and resources.
  - Assess your learning objectives
  - Plan question to be asked

- **Planning a Lesson Design:** Teachers need to understand how to plan lesson design, so that learners are challenged to think. Teachers also need to know how learners are constructing their knowledge and what they are learning. Meaningful learning takes place when a teacher can involve the students in the process of learning, by taking them beyond the process of listening to that of thinking, reasoning and doing.

- **Factors that need to be considered for the organization of the concepts**
  - Student's consideration
  - Content and process consideration
  - Time consideration
  - Resource consideration
  - Teacher consideration

- **Need for identifying and organizing concepts for teaching-learning science**: Identification and organization of concepts help a teacher to know the relevant concept, what students need to know, misconceptions and naive concepts, ensuring students understand the concepts, learning indicators.

- **Basic Principlesfor Planning a Lesson in Physical Science**
  - Every learner constructs his/her knowledge
  - Importance of experience in learning
  - Active engagement of the learner in the construction of knowledge
  - Every learner is unique
  - Variety of situations and multiplicity of strategies are important for creating diverse experiences
  - The implication of aims for classroom practices
  - An enabling teacher-learner relationship
  - Providing space for parents and community

- **Elements of a Physical Science Lesson**
  - Title of the lesson/unit
  - Learning objectives and key concepts of the time frame
  - Pre-existing knowledge
  - Materials, equipments, resources
  - Introduction
  - Presentation
  - Assessment
  - Extended learning, assignment

4.1.5. Answers to 'Check Your Progress - 1 and 2'

Check Your Progress - 1

1. **Basic Principlesfor Planning a Lesson in Physical Science**
   - Every learner constructs his/her knowledge
   - Importance of experience in learning
   - Active engagement of the learner in the construction of knowledge
   - Every learner is unique
   - Variety of situations and multiplicity of strategies are important for creating diverse experiences
   - The implication of aims for classroom practices
   - An enabling teacher-learner relationship
   - Providing space for parents and community

2. Elements of a Physical Science Lesson

- Title of the lesson/unit
- Learning objectives and key concepts of the time frame
- Pre-existing knowledge
- Materials, equipments, resources
- Introduction
- Presentation
- Assessment
- Extended learning, assignment

4.1.6. Unit end Exercises

1. Explain the importance of Planning of Teaching in Physical Science.
2. Explain the planning of a Lesson Design in Physical Science.
3. Explain how to identify and organize the concepts in Physical Science Teaching.
4. Explain the factors that need to be considered for the organization of the concepts.
5. What is the need for identifying and organizing concepts for teaching-learning physical science?
6. What is the purpose of an Introduction in a Physical Science Lesson? Explain.
7. How can we collect learning evidences for assessment in Physical Science? Elucidate with examples.
8. Explain the Basic Principles for Planning a Lesson in Physical Science.
9. Explain the Elements of a Physical Science Lesson.

4.1.7. References

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Block 4 : Planning of Teaching Learning and Assessment of Physical Science

Unit 2 : Planning for exposure to various learning resources through projects (both in schools and outside)

Unit Structure

4.2.1. Learning Objectives

After learning through this Unit, the student teachers will be able to

- Explain the meaning of the Project;
- Explain the principles and types of Projects;
- Explain the stages involved in a Project;
- Explain the role of a teacher in a Project; and
- Explain the different learning resources inside and outside the school.

4.2.2. Introduction

One of the important aims of education is to help students to become responsible democratic citizens of the country. The responsibility of science teachers is not only to teach facts, principles and processes of science, but also to facilitate students to discharge their social responsibilities and preserve democracy as well. They should appreciate how science and technology have developed and are affected by many diverse individuals, cultures and societies. They need to be encouraged to appreciate and participate in the responsible use of science and technology for the benefit of society, to visualize the future of our nation and to become sensitive and responsible citizens. It is important to develop critical thinking in them about the interconnectivity of science, technology and society to maintain a healthy and sustainable society. Students should be encouraged to develop a scientific vision about different issues, acquiring and processing information, about scientific and technological developments and their relevance to everyday life and long-term implications to society. Therefore, science teachers should view their obligations from a broader perspective. One of the best ways in which all this can be developed is through the inculcation of the Project method of teaching. This helps the pupils to venture into their surroundings and society and in turn, develop social and scientific values. In this unit, we shall discuss how to use the learning resources inside and outside the school through the Project method of learning.

4.2.3. Learning Points and Learning Activities

4.2.3.1. Project Method

Exercise -1
Select an object in your school campus (E.g. the flag post) and perform the following activity.

- Daily mark the tip of its shadow.
- Note down the changes and answer the following questions.
  1. What changes did you observe in the shadow on daily basis?
  2. What could be the reason and in which direction is the shadow shifting?

You were given an activity where you encountered a problem. To find the answers to the problem given I am sure you went about a process of collecting information relating to the problem. I am sure you made records on daily basis and came to a conclusion. This process of learning by completing a problematic act in its natural set up is known as the Project method. Let us now see how the project method can be used usefully in learning Physical Science.

A. Meaning of Project Method

Project Method was propounded by W.H. Kilpatrick. It is based on the Philosophy of pragmatism. This method was perfected by J.A. Stevenson and was one of the predominant methods of teaching science in schools in the U.S.S.R. This method consists of chiefly of building a comprehensive unit around an activity that may be carried on in the school or outside. The essence of the method is to carry out a useful task in a group in which all students work co-operatively. The curriculum, content and technique of teaching are considered from a child's point of view and demand that the students should think and select their studies for themselves. 'Learning by doing' and 'Learning by Living' are the two cardinal principles of this method. Children learn through association, co-operation and activity.

The term project has been defined by many people. It usually implies the separate following of individual problems by students or a small group of students over a few days or a few weeks and such problems may include several sub-problems. It may involve a variety of activities and generally, it results in some physical outcome -product, written report or a display.

B. Definitions of Project

Stevenson**,** "A project is a problematic act carried to completion in its natural setting"
Kilpatrick, "A project is a whole-hearted purposeful activity proceeding in a social environment"

Ballard,"A project is a bit of real-life that has been imparted into school."

Parker,"A project is a unit of activity in which pupils are made responsible for planning and purposing"

Thomas and Long, "A voluntary undertaking which involves constructive efforts or thought and eventuates into subjective results"

By analyzing these definitions, we see that a project has some purpose and there is planning to achieve that purpose which is achieved in social, real and natural situations created in the school.

C. Principles of the Project Method

1. **Principle of Purpose:** The activity performed by the students must be significant and of interest to them. It must be purposeful and combining life with learning.
2. **Principle of Activity:** The pupils are naturally active. Opportunities should be provided for them to be active and do things for themselves. They must be kept active mentally as well as physically and must bear maximum responsibility.
3. **Principle of Reality:** This method aims at reproducing real-life situations into school. Pupils are given opportunities to exercise their own in real-life situations.
4. **Principle of Freedom:** The desire for any activity should be spontaneous and not forced by the teacher. It should grow out of the pupil's own purpose and need. They should be free to do and express themselves.
5. **Principle of Utility:** Knowledge should be useful and practical.

D. Types of Projects

According to Kilpatrick Projects are of the following types

1. **Producer Projects:** In such projects, the emphasis is directed towards the actual construction of a material object or article.
2. **Consumer Projects:** Here the objective is to obtain either direct or vicarious experience, such as reading and learning stories, listening to a musical delectation etc
3. **Problem Projects:** In problem projects, the chief purpose is to solve a problem involving intellectual processes, such as determining the density of a certain liquid.
4. **Drill Projects:** The objective of drill projects is to attain a certain degree of skill in a reaction as learning a vocabulary.

E. Steps Involved in a Project

1. **Providing a Situation (Creating a Situation):** Provide such a situation wherein pupils feel the spontaneous urge to carry out a particular project according to their needs and interest. The teacher has to discover their needs, interests, tastes and aptitudes of children. He may draw the pupil's attention to the projects in mind through informal conversation or discussion by taking out children outside school. The pupils are brought face to face with the problem.
2. **Choosing and Purposing (Selection of the Project):** The children should be tempted to choose the project. The teacher should stimulate discussions by suggestion. While choosing the project the teacher should bear in mind that it should be of a real need for pupils. The purpose of the project should be clearly defined and well understood by the pupils. The project should be common and acceptable to all. In case of wrong choices, the teacher should tactfully guide them to see that their project is not good and should allow them to choose another project. They should be asked to write down the reasons for selection.
3. **Planning:** Planning in a project is very important for the success of a project depends upon a good planning. The students should plan out the whole scheme under the guidance of the teacher. The teacher should prepare two to three plans in mind and guide the students in the light of those throughout plans. Every child should be encouraged to participate in the discussion and to make his suggestions. All the pupils are taught to write down the plan properly.

4. **Executing:** The teacher should assign duties and distribute work among the pupils of the group according to their interests and abilities. Every child should contribute actively to the execution of the project. It is no use assigning work to a wrong student, say to give the work of painting and drawing to a student who cannot draw a straight line even, will be a folly. Students interested in reading should be given an assignment on referring books and collecting data, one interested in Physical work may be assigned a similar work and so on. It is the longest step in the project and requires patience. A single project promotes a great many activities of knowledge. The teacher should guide, encourage and watch the progress of students and give instructions wherever need be.
5. **Evaluating:** The students review the project and find out the mistakes if there are any. Self-criticism is an important training and should not be neglected. The teacher will see to it that the objectives of the project have been achieved.
6. **Recording:** The students keep a complete record of work – how they planned, what discussions were held, how duties were assigned etc. and finally criticism of their work and some important point for future reference.

F. Role of a Teacher in a Project

1. A teacher is a friend, philosopher and guide. He moves with the students and does not hesitate to give guidance wherever necessary.
2. The teacher develops a close, intimate and healthy relationship with the students.
3. A teacher should learn with the students and should claim to know everything.
4. A teacher should allow students to develop their character and personality by allowing them to accept responsibilities and discharge them efficiently.
5. A teacher should provide a democratic environment in the class so that the students express themselves freely without fear.
6. A teacher should be alert and active all the time to see that the project is moving in the right direction.
7. A teacher should have thorough knowledge about the children to allot them work accordingly.

Check Your Progress I

1. What is a Project?
2. Which are the different types of Projects?

4.2.3.2. Learning Resources Inside and Outside the School

Exercise - 2

List the things which you find inside and outside your school campus, which you think can be used as Learning Resources in teaching Physical Science. Specify which topic of Physical Science can be learnt using those things.

Things inside School Campus		Things outside side School Campus	
Things	**Concept to be taught**	**Things**	**Concept to be taught**

You will find a lot many things inside and outside your school campus which can be used as a learning resource in Physical Science. Let us now discussit in detail.

A. Learning resources from the immediate environment

The immediate environment of the learner is a natural learning resource that can be used in making curricular choices. The immediate environment includes the physical, natural and socio-cultural world. Learners find acquired knowledge significant if learning of science takes place from the primary context of their immediate environment. The process of constructing knowledge is a continuous one, which goes even outside the school. It implies that learning is also a continuous process and it has a broader meaning than what takes place in school.

Teachers of physical science should appreciate that the environment around the student is full of learning opportunities. They might utilize every conceivable situation for the learning process. For example, on the school ground, certain things are almost always available such as soil, plants, trees, insects, birds, sunshine and shadows, bicycles and automobiles. A range of problems for the projects can be identified from these things, situations and materials.

For Example:

a) Students can measure the difference in the temperature in the Sun and the shade using a laboratory thermometer to observe that the Sun is a source of energy. They may repeat this activity at the same time and at the same place for a week(s) to analyze the data and learn to plot a graph from their data.
b) The effect of projection angles on the range of a projectile can be shown with a stream of water from a garden hose.

A corner of the room may be used to organize learning materials, to keep some appropriate reference and other self-learning materials collected by the students (sample of soils, fabric, magnetic toys, etc.). When some students finish their assigned lesson before the pre-arranged time, they may work on the projects allotted to them. Many learning opportunities are available in the school ground/classroom/kitchen/bathroom/markets/on the roads itself. Outside the classroom, experiences of the learners can be used in teaching-learning of science to provide them first-hand experience for enhanced learning and a sense of appreciation to the environment. It may consist of a wide range of materials.

Some examples from the immediate environment and the concepts that can be explained using these examples are given below:

- Bicycle tires: Friction, gears, levers.
- Cemented surface/paved surface/grass: Friction, heat absorption.
    - Slide: Gravity, friction.
    - Swing: Oscillatory motion.
    - Merry go round: Centripetal and centrifugal force.
    - Flagpole: Change in size and position of shadow.
    - Football/cricket/hockey: Projectile motion, rate of change of momentum.
    - Electric fan: Conversion of electric energy into mechanical energy, rotatory motion.
    - Pool/pond/river: Buoyancy, Archimedes Principle, Ecosystem.
    - Watching the stars: Constellation.
    - Rainbow: Refraction, total internal reflection of light.
    - Clouds: Water cycle, light travels faster than sound, lightning, thunder.
    - Seasons: Tilt of earth.
    - Garden flower: Colours (electromagnetic spectrum).

- Common Salt: Solubility, concentration, etc.
- Sunlight: Heat, temperature..
- Phases of moon: Luminous and non-luminous bodies, the revolution of the moon around the earth.
- Day and Night: Rotation of earth.

Good projects can be planned using these resources.

Now let us look at concepts and the examples of materials or events from the immediate environment to illustrate those concepts.

- Pulleys: Washing machines, generators, etc.
- Projectiles: Long jump of athletes, water fountain, fireworks, the trajectory of a football, basketball, golf ball, etc.
- Lenses and mirrors: Camera, sunglasses, contact lens, barber's mirrors, driver's side mirror, bathroom mirror, etc.
- Fibers: Jute, wool, cotton.
- Conversion of one form of energy into another: Almost all machines around us.
- Propagation of waves in solids, liquids and gases: Propagation of longitudinal and transverse waves in slinky (a type of big spring), ripples in the water reservoir, echo in a big hall/well, etc.

Some natural pH indicators that can be used in teaching-learning situations are given below.

- Beets: The basic solution will change the colour of beet juice from red to purple.
- Onion: It can be used as a factory indicator. We cannot smell onions strongly in basic solutions. Also, red onion changes from pale red in an acidic solution to green in a basic solution.
- Turmeric: It contains a yellow pigment, curcumin, which changes from yellow at pH 7.4 to red at pH 8.6.
- Colour change lipstick: Test the colour change lipstick to determine its pH range. Most cosmetics change colour due to changes in pH.
- Red cabbage pH indicator colours: Take filter paper (or coffee filter) and soak it in a concentrated red cabbage juice solution.

After a few hours, remove the paper and allow it to dry. Cut the filter into strips and use them to test the pH of various solutions.

Learners should be encouraged to construct and reconstruct their knowledge from observing, classifying, categorizing, questioning, reasoning, arguing, and interacting with the natural world and people around them. A science teacher should think on the line of flexibility, contextuality and plurality in designing curricular experiences.

B. Using community resources

Community resources can be used in teaching-learning of science either by bringing the community to the class or by taking a class to the community.

a) Bringing the community to the class

The teacher must explore opportunities for the active engagement of the parents and the community in the teaching-learning process of physical science. Different members of the community also hold a large variety of valuable knowledge. Many of these members may be willing to share their knowledge and experience with the students. These members can be

invited to school and learners can interact with them. The teacher should remain aware of the range of community, individuals and organizations that can be accessed to provide significant learning experiences to learners. Learners can visit their places of work also. The expertise of members varies from community to community.

Some examples are:

- Electrician: Domestic wiring, short circuit, fuse, switches, elements of iron, toaster, etc.
- Carpenter: Lever, inclined plane, wedge, torque, etc.
- Musicians: Depending on the kind of instrument they play (string, membrane, air column) they can talk about how sound changes by changing various parameters (length, thickness). If possible, they can bring a few types of instruments and demonstrate them to the class.
- Veterinary doctors: How to measure body temperatures of different animals, features of various living beings which help them to adopt to their specific surroundings.
- Potters: Rotational motion, centripetal force, etc.

b) Taking a class to the community

In many cases, learners can be taken to the community resources of learning. When organized from the point of view of enrichment of teaching-learning experiences, it is a field visit. This makes learning realistic, concrete and interesting. Learners get an opportunity to discover the concept and their connection with their environment. They can use this opportunity to learn various skills in interacting with the physical world, materials, technology and other people. It helps students to create knowledge by figuring out the components of objects, events, people, and concept

The resources maintained by the community can provide great learning experiences for students. These resources if tapped properly can help us in moving from science as an interpretation of visual and auditory symbols (words) to science as an experience. These community resources vary from place to place.

Some such resources are listed below:

- Hydroelectric/thermal power plants.
- Science Museums: Actual objects, working models, mirrors, lenses, etc.
- Planetariums: Solar systems, telescopes, night sky watching.
- Jantar Mantar: Sun dials.
- National Physical Laboratory: Standard of the time
- Movie theatre: Acoustics.
- Hospital: Mirrors used for examining ear, nose, throat, teeth, ultrasound.
- Optician: Lenses used in reading glasses, grinding and coating of lenses.
- Market:
    - ✓ Shoe shop – soles of sport shoes, friction.
    - ✓ Fabric Shop– Fibre obtained from plants (cotton, jute), fibre obtained from animals (wool), fibre obtained from insects (silk).
    - ✓ Things like paints (solution), gemstones (solid solutions), jellies (gel), foam rubber (solid solution) as examples of colloidal solution.
- Electroplating unit– How objects are electroplated, How waste material is discarded considering environmental issues?
- Construction site– How lightning conductor is fixed in a building?
- Barber shop– Images in parallel mirrors.

- Fire brigade
- Railway station
- Post office
- Police interceptor vehicles– measuring the speed of moving vehicles.
- Bakery
- Chemical industry
- Hillside– erosion effects.
- Beaches– wave actions.
- Junkyard – electromagnetic crane.

C. The pooling of learning resources

In the school, the classroom is the first physical space that a child associates herself with and feels closest to. Thus, the first pooling of resources can start right from the classroom itself. This pooling of resources can be developed in the form of a science corner. The development of a science corner becomes even more important in schools situated in areas of resource crunch where setting up of full science laboratories is difficult. For this, one or two tables can be arranged in the classroom. Children should be encouraged to bring materials they think are relevant for discussions and display. These materials can be used to provide them hands-on experience and can be used in their project works. Also, these materials should be continuously updated and changed as per the learning needs, interests and curiosity of children.

Systematic experimentation as a tool to discover or verify theoretical principles is an important part of the curriculum at the secondary and higher secondary stage. Thus, schools require well-equipped laboratories for students at this stage. Yet these are still not available on a scale required for effective teaching-learning of science. As a part of an effort to provide all children with the necessary hands-on experience of equipment and experiments given in their science curriculum, at least at the cluster level, a resource centre may serve as a cluster laboratory. Schools of the cluster could plan their timetable so that for half a day, once a week, their science laboratory class is held at the cluster level laboratory. Specific equipments such as a telescope could be shared among schools if they are placed at the cluster centre, which can then serve as a resource centre. For the period of teaching-learning on the concerned concept, the teacher can borrow materials from the centre and thereafter, return them to enable other teachers to borrow them. Teaching aids and other learning materials or models selected in the science exhibition can also be placed at the cluster centre. In this way, the resources gathered by one teacher can also be utilized by others, and it would become possible to have multiple sets necessary for the whole class to use.

Neighbouring schools, colleges or training colleges, institutions may allow students to work in their laboratories. Teachers need to be resourceful to utilize such opportunities. There is a growing emphasis on Information and Communication Technology (ICT) for effective learning. Many schools are now equipped with computers, and in some areas radio and TV-based learning and interaction are being introduced. Some selected schools may also have teleconferencing facilities. These Information and Communication Technology (ICT) facilities can also be shared between schools. In many parts of the country, community libraries are functioning in rural areas, and government libraries exist in many district headquarters. A network of school libraries with cluster-level/block level library can be established for its enrichment.

Check Your Progress - 2

1. List some learning resources you find in your immediate environment
2. Suggest any two ways of pooling learning resources.

4.2.4. Let us Summarise

- **Project Method:** A project is a problematic act carried to completion in its natural setting. A project is a whole-hearted purposeful activity proceeding in a social environment.

- **Principles of the Project Method**
  1. Principle of Purpose
  2. Principle of Activity
  3. Principle of Reality
  4. Principle of Freedom
  5. Principle of Utility

- **Types of Projects**
  1. Producer Projects
  2. Consumer Projects
  3. Problem Projects
  4. Drill Projects

- **Steps Involved in a Project**
  1. Providing a Situation
  2. Choosing and Purposing
  3. Planning
  4. Executing
  5. Evaluating
  6. Recording

- **Role of a Teacher in a Project**
  - A teacher is a friend, philosopher and guide.
  - A teacher should be alert and active all the time to see that the project is moving in the right direction.
  - A teacher should have thorough knowledge about the children to allot them work accordingly.

- **Learning resources from the immediate environment**: The immediate environment includes the physical, natural and socio-cultural world. E.g. Bicycle tyres: Friction, gears, levers, Watching the stars: Constellation.

- **Community resources**
  - ***Bringing the community to the class*:** Different members of the community also hold a large variety of valuable knowledge. These members can be invited to school and learners can interact with them. Some examples are: Electrician, Musicians etc.
  - ***Taking class to the community:*** When organized from the point of view of enrichment of teaching-learning experiences, it is a field visit. The resources maintained by the community can provide great learning experiences for students. For example, Science Museums, Planetariums.

- **The pooling of learning resources:**
  - The pooling of resources can be developed in the form of a science corner.
  - As a part of an effort to provide all children with the necessary hands-on experience of equipment and experiments given in their science curriculum, at least at the cluster level, a resource centre may serve as a cluster laboratory.
  - Neighbouring schools, colleges or training colleges, institutions may allow students to work in their laboratories.

4.2.5.Answers to 'Check Your Progress - 1 and 2'

Check Your Progress - 1

1. A project is a whole-hearted purposeful activity proceeding in a social environment"
2. Types of Projects
   a) Producer Projects
   b) Consumer Projects
   c) Problem Projects
   d) Drill Projects

Check Your Progress - 2

1. Some learning resources in our immediate environment.
   - Merry go round: Centripetal and centrifugal force.
   - Flagpole: Change in size and position of shadow.
   - Rainbow: Refraction, total internal reflection of light.
   - Clouds: Water cycle, light travels faster than sound, lightning, thunder.
   -
2. Pooling learning Resources
   1. Forming a science corner in the classroom.
   2. Form a science laboratory at the cluster level and share the resources.

4.2.6. Unit end Exercises

1. What is a Project? Explain stating definitions.
2. Elucidate the different types of Projects.
3. Explain the principles of Project methods.
4. Explain the steps involved in a Project.
5. What is the role of a teacher in the Project Method of teaching? Explain.
6. Which are the different learning resources we can find inside and outside the school for teaching Physical Science? Explain
7. Explain what learning resources from our immediate environment can be used in Physical Science teaching?
8. Which are the different community resources? Explain
9. Explain how will you pool the learning resources of Physical Science.

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Block 4 : Planning of Teaching Learning and Assessment of Physical Science

Unit 3 : Facilitating the formation of groups; Planning and organizing activities in Physical Science, planning laboratory work and ICT application in learning Science/Physics/ Chemistry

Unit Structure

4.3.1. Learning Objectives

After learning through this Unit, the student teachers will be able to

- Explain the facilitation of group work in Physical Science;
- Explain the planning and organization Activities in Physical Science;
- Explain the planning and organization of Laboratory Work in Physical Science; and
- Explain the application of ICT in Physical Science.

4.3.2. Introduction

Science teaching and learning cannot happen without hands-on experience. The laws and principles of science are best learnt by observing, testing and experimenting. A Physical Science teacher has a great responsibility to give his/her students the experience that can help the students to understand the subject correctly. Hence science laboratory and use of ICT play an important role in a Physical Science classroom. The activities that a teacher plans using the Laboratory and ICT need to be meticulously planned so that the student gets the right knowledge to an optimum level. Group work also plays an important role while planning these activities. A Physical Science teacher needs to be equipped with the knowledge and skills of all of these. In this Unit, we shall discuss how a Physical Science teacher should facilitate group work and also plan activities, laboratory work and application of ICT.

4.3.3. Learning Points and Learning Activities

4.3.3.1. Planning and Organizing Group Work and Activities in Physical Science

Exercise - 1

Have you ever taken part in group work? What has been your experience? Explain how you benefitted from group work of any type.

We would one or the other time worked in groups for our projects, assignments, activities etc. Group work surely has built in us a team spirit where our tolerance, adjustment and co-operation has been put to test. Group work builds some great social values that one may not

be able to learn in isolation. In this unit, we shall discuss how group work and activities can be organized in a Physical Science class.

A. Group Work

a) Importance of Group Learning in Physical Science

Group Learning is very important in the teaching-learning of physical science.

- Group learning is a vehicle for nurturing various interpersonal skills in students.
- Students working in the group display their growth in tolerance, their ability to listen to others and respect each other's views.
- It brings improvement in self-reliability, independence in dealing with others and their ability in making decisions; and in becoming considerate and helpful towards others.
- They also develop logical and critical thinking, communication skills, and presentational skills.
- Group work creates situations for students to develop skills of argumentation and tolerance.
- It can also promote opportunities for confronting different ideas, learning ways to express one's point of view, the ability to make oneself understandable by others; the capacity of being involved actively in discussions and accepting criticism.
- In a group, students jointly negotiate understanding, plan tasks, explain things to each other, share ideas and coordinate actions.

b) Facilitating the formation of groups

The following points can be kept in mind for facilitating the formation of groups in the class.

- The particular task is performed by a group approach.
- Learning objectives for the concepts to be transacted.
- Abilities are required for performing the task
- Helping students to select the work of their interest and choice and prepare an outline of the work
- Forming different heterogeneous groups of students to cater to their varied needs and abilities
- Supporting students to find resources, people, books, library, videos, to collect information and data?
- Discussing regularly with students of different groups regarding their progress.
- Helping students in writing reports and giving presentations.
- Assessing students and providing them feedback.
- Self-assessment while planning group works to make certain that meaningful learning of all students is taking place.

c) Collaborative Learning Approach (CLA)

In CLA, learners take responsibility for their learning. It promotes self-learning skills in them. They have to discuss their ideas with their group members, relating them to their previous experiences. The teacher facilitates situations for active participation in the teaching-learning process by encouraging collaboration among the learners. She communicates the goal to be achieved within a limited time frame realizing and respecting the diverse needs of the learners and their different styles of learning. The collaborative learning approach develops both academic and social skills in the learner in an integrated manner.

i. Steps of a collaborative approach

- The problem, issue or concept is identified to be dealt with in a group situation.
- The formation of groups (say 3 to 6 students) is facilitated by the teacher.
- There is the exchange of ideas, discussion on the issue at hand or performance of activities or experiments to clarify the concept in a group situation.
- The teacher facilitates their interactions directed towards the set goal within the stipulated time frame.
- Learning evidences are assessed throughout the teaching-learning process and feedback is provided to all groups of learners.

ii. Ensuring meaningful learning through CLA

- Ensure that the group is heterogeneous. There should be learners learning with different paces and styles in a group. However, keep grouping patterns flexible and consider the choice of learners also.
- Every time keep on changing the members of the group.
- Facilitate them to form group rules. If there is a disagreement, consensus should emerge.
- Make it a point that the group leader will facilitate the work of the group and keep them organized. The leader should not dominate over other members.
- Tell one student of the class to pass on the name of group members and group leaders on a piece of paper for your record.
- While assessing, you may give the same grade to all members of the group as far as possible. This will prompt the learner to learn with greater pace to motivate other learners to perform.
- It will be convenient for you if you start this approach 2–3 months after the session starts. It will give you enough time to identify the academic and social skills of all the students and help you to facilitate them in the group formation.
- Ensure that members of all groups should be made responsible for their work. All members should remain open to each other's idea and get equal opportunities to share their ideas and work
- All members should be given the liberty to express their ideas freely and work cohesively towards achieving the goal.

iii. Ways of applying collaborative learning approach

There are various ways in which the collaborative learning approach may be applied such as given below.

1. Brainstorming

- A problem is identified.
- Small groups are formed.
- All members are encouraged to find a solution and express their ideas.
- No idea is criticized. However, ideas can be modified.

2. Task group

- A task is identified.
- Small groups are formed.
- Each group of the class is assigned a specific task to be completed within a time frame.
- The task of each group is evaluated by the other group.
- Completion of the task is the responsibility of all.

3. Inquiry group

- The teacher creates a situation of some discrepant event during the teaching-learning process.
- Different groups work on the same problem and may come up with a different hypothesis, solutions and conclusion.
- To get involved in the inquiry, learners may discuss, share their ideas, derive.

B. Planning and Organizing Activities in Physical Science

Teaching-learning of science is a process and its three essential components are—to acquire knowledge, to understand the concepts or principles and to apply those in a novel situation to solve a problem. As learning by doing is a cardinal principle of science teaching-learning should be interwoven by activities to facilitate understanding. Therefore, planning the activity is the core of the planning teaching-learning experiences of physical science. For example, it is quite difficult to explain, Archimedes' principle only by theoretical description. A student's mind may not readily accept the result. If this principle is explained by doing an actual experiment to show that when an object is partially or wholly immersed in water, there is an apparent loss of its weight and this loss is equal to the weight of the displaced liquid, it will leave a permanent impression on the mind of the learners.

a) Activities in Physical Science

i. **Experiments:** The basis of science is proof through practical experiments. There are several topics in Physical Science that can be demonstrated through experiments in the classroom. Students should be involved in such experiments so that they learn by doing.

ii. **Fun Experiments:**Fun experiments are experiments that may not be directly related to the topic of the class but develop a scientific attitude among students. Fun experiments can be a relaxing activity for students along with being introduced to scientific principles.

iii. **Debate:** Debate is a process that involves formal discussion on a particular topic. In a debate, opposing arguments are put forward to argue for opposing viewpoints. In Physical Science several topics can be put for discussion which can bring out fruitful outcomes.

iv. **Quiz**: Quiz is a form of game or mind sport, an attempt to answer questions correctly. It is a game to test knowledge about a certain subject. Quiz could be a great activity in Physical Science, for evaluation of the topics taught. It can develop an interest in the subject among students.

v. **Group Discussion:** Group discussions can be organized in Physical Science to ascertain the results and applications of certain principles of science. It can bring out several insights about the topic of discussions and help students to think widely.

Check Your Progress - 1

1. How is group work important in a Physical Science Class?
2. Which are the different activities that you can organize in a Physical Science classroom?

4.3.3.2. Planning and Organizing Laboratory Work and ICT application in learning Physical Science

Exercise - 2

I am sure all of you all have used a Science Laboratory and performed experiments during your school and college days. What different things do think should be kept in mind while planning Laboratory work?

Your answer would surely have covered the different aspects which make a laboratory, like the organization of apparatus, planning of lab schedule and most importantly the safety measures. Let us now discuss the various aspects related to Laboratory work in Physical Science.

A. Laboratory Work in Physical Science

a) Laboratory as a learning resource

1. Laboratory work can be used as a powerful learning resource for science.
2. Laboratory work is based on the principle of learning by doing and it is an integral part of science education.
3. It helps in a better understanding of various concepts of science and the construction of knowledge.
4. The first-hand experience obtained through experimental work imprints a permanent impression on the mind of the learners.
5. It provides an opportunity for the teacher to inculcate various process skills of science, viz. observation, classification, analysis of data, recording, inferring, generalizing and communicating.

b) Planning and Organizing laboratory work

Science teachers must plan laboratory work well in advance for making the best use of available materials and time. A teacher should plan on thinking along the following lines:

- Make the objective of activity/experiment/project work clear to the students.
- Check for the materials/apparatus available in the laboratory.
- Involve the learners in setting up the experiments.
- Experiment beforehand to check the functionality of all apparatus.
- Check if the procedure is simple and can be performed within the allotted time.
- See how the applications of the findings enhance the learning of pupils.
- See if the laboratory experiments can be integrated with the classroom teaching-learning experiences.
- It should be ensured that students have the sound theoretical knowledge required for handling the apparatus and performing the experimental work. For this, theory and practical teaching-learning situations should be properly integrated and coordinated.
- During the laboratory work, extensive and critical discussion on the theoretical aspects of the experiments with the students and continuous assessment of their performance are of utmost importance.
- A notice board to display safety rules of the laboratory, time- table, list of experiments, group patterns, etc. can be maintained and kept up to date.
- Good discipline is necessary for the smooth functioning of the laboratory work.
- Maintaining all possible standards of safety in the laboratory and inculcating a safety-conscious attitude in students is important.

- Safety kits such as fire extinguishers, sand buckets, rubber gloves, separate dustbins for dry and wet waste materials, etc. should be kept handy.
- The first-aid box must be kept ready and timely replenishment of medicines must be ensured.

c) Safety in laboratories

One of the important duties of a science teacher is to develop safety-conscious attitudes and safe personal habits in students. They should be explained the laboratory safety rules with reasoning. The layout of the laboratory should be such that the teacher can oversee the activities of all the students in the class. The location of water, gas, electricity main control and fire fighting equipment should be at the proper and convenient place. Some common potential hazards in physics and chemistry laboratories are discussed below:

(i) Mechanical and glassware hazards All equipments with moving parts constitute a hazard if they are misused or fail to operate properly. Wherever possible, the moving part of the apparatus should be guarded properly. Some precautionary measures

- Students should be instructed to stay away from the heavy slotted weights hanging from the apparatus, such as the sonometer.
- Large glass containers must be handled by the neck. Proper care should be taken in storing the apparatus.
- Reagents likely to react vigorously with each other should be kept as far apart as possible. Liquids placed in spherical containers act as a lens, focusing enough sunlight to cause a fire. They should be kept in dark.
- Broken glass pieces can be cleaned with the aid of some plasticine.
- Glass tubing should be cut with a file or glass knife, the hands being protected by a cloth. It should be carried vertically.
- Wherever possible, glass materials may be replaced by a less hazardous alternative, e.g. plastic bowls and measuring cylinders.
- Glass stoppers that have become jammed should be loosened by tapping gently with a wooden block wrapped in a soft cloth or if the bottle contents are appropriate, by running warm water over the neck of the bottle.
- Experiments involving the heating of solutions should be done in pyrex glassware, not in ordinary glassware.

(ii) Electrical hazards

The obvious danger in using electrical equipment is that of electric shock and fire hazards. The electrical resistance of the body varies enormously from one individual to another and within the same person under different conditions. The resistance is very low if the skin is moist. A current of 100 mA through the body can be fatal. A higher current can also produce burning. Some precautionary measures.

- The electric power supply or the electrical outlet in the physics laboratory should be sufficient in number, properly insulated, in excellent working order, properly grounded, and inspected routinely by qualified electricians.
- Wherever electrical outlets are not available, extension cords that are as short as possible and insulated properly for that particular voltage and current should be used.
- Equipment should carry a distinctive on/off light.
- The range of the measuring instruments should be properly marked and the students should understand the meaning of the range properly.

- Wearing metal rings, necklaces, using metallic prongs, pencils, rulers, etc. should be avoided while working with switched-on electrical equipment and apparatus.
- Service of electrical appliances, devices and apparatus should always be done by qualified experts.
- Hands and bench should be kept dried and long trailing leads and makeshift connections should be avoided in the experiments.

(iii) Toxical hazards

It would be better to treat all chemicals as though they were poisonous, as the range of toxic substances is greater than those declared officially. Some precautionary measures

- All the chemicals should be adequately labeled.
- Careful supervision is required in the use of caustic and corrosive substances.
- Ingestion of chemicals is most likely to arise from pipetting by mouth. Vigil should be kept on the students.
- Gases, vapours, fine spray and fumes of toxic materials may enter the body by inhalation. Therefore, it is of utmost importance to use the right techniques for performing the experiment and having the provision of cross ventilation in the laboratory.
- Special care must be taken in some of the experiments, such as benzene should be replaced by methylbenzene, wherever possible; chlorine gas should not be prepared in large quantities on an open bench.
- Children are inquisitive by nature. It should be ensured that they do not touch or smell toxic substances. They should be made aware of the harmful effect of those materials.

d) Handling Laboratory Accidents

Despite taking all the precautions and minimizing the risks, what to do if an accident occurs. The most important consideration is to act quickly, quietly and methodically without being panic-stricken. It will be too late to think about the procedure after an accident has happened. Keep the first aid box handy. A list of common accidents and their remedies approved by a good doctor should be hung on one side of the first aid cupboard so that the right medicine can be applied in case of a certain accident. However, the purpose of first aid is not to substitute the doctor's treatment, but to ensure that no further deterioration occurs. Following steps should be taken:

- Remove the injured person(s) from further hazards. This might be disconnecting the electrical supply, gas or water or removing it from fire, etc. Apply first aid immediately.
- If necessary, seek the help of your colleague to control the class.
- Inform the school office of the accident for arranging medical care.
- After the accident, submit a written report to the administration stating the facts.
- Some other actions may be necessary to take, such as calling a fire brigade, evacuating the class into the open air, etc.

B. Application of ICT in Physical Science Teaching

Since we have already seen what ICT is and what are the different tools of ICT, here we shall discuss how it can be applied in a Physical Science classroom. Following are the different ways of applying ICT in the classroom.

1. **Gamified Learning:** Computer games can help in developing typing skills and many other computer-related skills. Learning can and should be fun and using technology for gamified learning in your classroom can be advantageous to achieving that goal. And while learning software can be a great teaching tool, gamified learning can also be as simple as creating a virtual scavenger hunt by coming up with a list of questions for students to search and find the correct answers for and adding students to pairs or groups to encourage collaboration and teamwork.

2. **Digital Field Trips:** An increasingly popular, useful, and cost-effective tool for teachers searching for new ways to use technology in the classroom is taking digital field trips. Google Street view and other similar apps allow you to virtually explore parks, forests and even national and international landmarks from the comfort of your classroom.

3. **Integrate Social Media:** Because students already spend so much of their time on social media, integrating its use into your classroom is among the most innovative ways to use technology in the classroom by connecting students to curriculum, classroom resources, and one another. Create a Facebook group specifically for your class where you post discussion topics or develop unique classroom Twitter hashtags students can use to discuss lessons or ask questions!

4. **Gather Student Feedback:** The true test of any classroom structure and/or curriculum is how well it helps students learn, and getting feedback from students is vital to assessing this, determining what is and isn't working, and addressing problems and confusion as they arise. Use online surveys and polls to perform daily or weekly check-ins with students to get their opinions on lessons and address lingering questions or concerns.

5. **Creating Digital Content:** Creating digital content related to the things they are learning is a great way for students to display their creative talents as well as showcase learning. As with any other project, the process of creating content is most effective when students can express themselves in ways that highlight and accommodate their strengths and learning/communication styles. Provide options for students to express themselves through blogs, videos, podcasts, eBooks, flyers and other digital art, or any other means they feel most comfortable. Respecting each student's individuality and needs for creative expression helps them flourish as learners.

6. **Using a Classroom Calendar:** Develop a shared online calendar for your classroom through Google Calendar or a similar program for posting important updates. Post assignment due dates and classroom events (such as field trips and guest speakers) in one easily-accessible location for both teachers and students. Go a step further and share the calendar with parents to keep them connected and engaged with their child's learning.

7. **Review and Critique Webpages:** While we know you can find almost anything on the internet, we also know that much of what you may find is not reliable information from reliable sources. Empower your students with the digital literacy to analyze and discern reliable web pages and sources from unreliable ones by reviewing them together, developing and communicating standards for what makes a good source.

8. **Video/Multimedia Lessons and Presentations:** Bring presentations to life for students by incorporating visual effects, photos, videos, and music into them. Developing slideshows and digital presentations, playing music or a video for background and context

while presenting, or inviting virtual guest speakers to engage with your class via programs designed for conference calls (such as Skype, Google Hangouts, and Facetime) are all fun and creative ways to boost engagement with lessons while teaching the benefits of technology and multimedia use.

9. **Online Activities for Students Who Finish Work Early:** Set up learning stations to encourage and support students working at their own pace. If a student finishes an assignment early, rather than being stuck waiting for other students to catch up or class to end, students can extend and enhance their learning by visiting a learning station and watching videos, playing learning-based games, or exploring other online activities related to their learning.

Check Your Progress - 2

1. What are the important aspects you need to keep in mind while planning Laboratory work?

2. Which are the different ways in which you can apply ICT in the classroom?

4.3.4. Let us Summarise

- **Importance of Group Learning in Physical Science**
  - Students working in a group display their growth in tolerance, their ability to listen to others and respect each other's views.
  - It brings improvement in self-reliability, independence in dealing with others and their ability in making decisions; and in becoming considerate and helpful towards others.
  - They also develop logical and critical thinking, communication skills, and presentational skills.

- **Collaborative Learning Approach (CLA):** In CLA, learners take responsibility for their learning. They have to discuss their ideas with their group members, relating them to their previous experiences.

- **Ways of applying collaborative learning approach**
  - Brainstorming
  - Task group
  - Inquiry group

- **Planning and Organizing Activities in Physical Science:** Different activities that can be planned in Physical Science Teaching are Experiments, Fun Experiments, Debate, Quiz, Group Discussion.

- **Laboratory as a learning resource:** Laboratory work is based on the principle of learning by doing and it is an integral part of science education. The first-hand experience obtained through experimental work imprints a permanent impression on the mind of the learners.

- **Planning and Organizing laboratory work**
  - Make the objective of activity/experiment/project work clear to the students.
  - Check for the materials/apparatus available in the laboratory.

- Experiment beforehand to check the functionality of all apparatus.
- Check if the procedure is simple and can be performed within the allotted time.
- Safety kits such as fire extinguishers, sand buckets, rubber gloves, separate dustbins for dry and wet waste materials, etc. should be kept handy.
- The first-aid box must be kept ready and timely replenishment of medicines must be ensured.

- **Safety in laboratories**: One of the important duties of a science teacher is to develop safety-conscious attitudes and safe personal habits in students. They should be explained the laboratory safety rules with reasoning.

- **Mechanical and glassware hazards**: Broken glass pieces can be cleaned with the aid of some plasticine. Wherever possible, glass materials may be replaced by a less hazardous alternative, e.g. plastic bowls and measuring cylinders. Experiments involving the heating of solutions should be done in pyrex glassware, not in ordinary glassware.

- **Electrical hazards: The** obvious danger in using electrical equipment is that of electric shock and fire hazards. The electric power supply or the electrical outlet in the physics laboratory should be sufficient in number, properly insulated, in excellent working order, properly grounded, and inspected routinely by qualified electricians.

- **Toxical hazards:** It would be better to treat all chemicals as though they were poisonous, as a range of toxic substances is greater than those declared officially. Careful supervision is required in the use of caustic and corrosive substances.

- **Handling Laboratory Accidents:** The most important consideration is to act quickly, quietly and methodically without being panic-stricken during times of Accidents. Keep the first aid box handy. First aid is not to substitute doctor's treatment, but to ensure that no further deterioration occurs.

- **Applying ICT in Physical Science Classroom**
  - Gamified Learning
  - Digital Field Trips
  - Integrate Social Media
  - Gather Student Feedback
  - Creating Digital Content
  - Using a Classroom Calendar
  - Review and Critique Webpages
  - Video/Multimedia Lessons and Presentations
  - Online Activities for Students Who Finish Work Early

4.3.5.Answers to 'Check Your Progress - 1 and 2'

Check Your Progress - 1

1. Importance of Group Work in Physical Science classroom
   - Students working in a group display their growth in tolerance, their ability to listen to others and respect each other's views.
   - It brings improvement in self-reliability, independence in dealing with others and their ability in making decisions; and in becoming considerate and helpful towards others.

- They also develop logical and critical thinking, communication skills, and presentational skills.

2. Different activities that can be planned in Physical Science Teaching are Experiments, Fun Experiments, Debate, Quiz, Group Discussion

Check Your Progress - 2

1. Points to be kept in mind while planning Laboratory work isthe objective of activity/experiment/project, materials/apparatus, the functionality of all apparatus, time, Safety kits, First-aid box.
2. Different ways in which ICT can be applied in a classroom areGamified Learning, Digital Field Trips, Integrate Social Media, Gather Student Feedback, Creating Digital Content, using a Classroom Calendar, Review and Critique Webpages, Video/Multimedia Lessons and Presentations, Online Activities for Students Who Finish Work Early.

4.3.6. Unit end Exercises

1. Explain how group work can be facilitated in Physical Science Teaching?
2. What is the importance of Group Learning? Explain
3. What is a collaborative learning Approach? Explain the ways of applying CLA in the Physical Science classroom?
4. Explain the planning and organization of Activities in the Physical Science classroom?
5. Which are the different activities that can be conducted during Physical Science teaching?
6. Explain the planning and organization of Laboratory Work in Physical Science.
7. Elucidate the safety measures to be taken in a Physical Science Laboratory.
8. Explain different ways in which ICT can be applied in Physical Science Class.

4.3.7. References

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Block 4 : Planning of Teaching Learning and Assessment of Physical Science

Unit 4 : Reflective Planning; Unit Plan; Developing lesson designs on different topics and through various approaches

Unit Structure

4.4.1. Learning Objectives

After learning through this Unit, the student teachers will be able to

- Explain the meaning of Reflective Planning in Teaching;
- Explain the strategies of Reflective Planning in Teaching;
- Explain the meaning of Unit Plan;
- Explain the steps of Unit Plan;
- Explain the different Approaches of Lesson Planning; and
- Write a Lesson Plan using the 5E's Approach of Lesson Planning.

4.4.2. Introduction

Planning is a very essential part of any teaching process since teaching aims at a favorable behavioural change. And this change needs to be to the maximum possible level among each child. Each child is different and has different learning needs. A teacher addressing these students need to be ready to meet the needs of each of them, in a manner required by each of them. Such a planning process is tedious and energy consuming. If a teacher can reflect on his/her teaching along with the planning then he/she will have several insights that can be a guiding light in his/her further planning of units and Lessons. A teacher also needs to be familiar with the different approaches which he/she can use while planning her lesson to meet the needs of students. In this Unit, we shall discuss the different approaches of Lesson Planning and also discuss how to reflect on 1Physical Science teaching.

4.4.3. Learning Points and Learning Activities

Exercise - 1

Have you ever reflected on any of your life events? If so, write in brief in which different situations have you reflected over particular events of your life and why?

4.4.3.1. Reflective Planning and Unit Plan

Usually, we reflect on those situations of life where we have failed in something or those things which have not turned out the way we expected. We try to find out the reason for our failure and try to rectify it so that we get success the next time. But reflection would be a

useful practice irrespective of the result, to better the outcome of any situation through analysis and identification of best practices when we are in a successful situation or change our practices when things are not as we expected. This holds good in a teaching situation too. Let us now discuss Reflective Planning in Physical Science Teaching and also go through the steps of Planning a Unit.

A. Reflective Planning

Reflection on teaching-learning and planning needs to be done continuously. Let us see how frequently we need to plan and revise our planning.

- Daily to organize the learning materials for the next day and to review the day's teaching-learning experiences.
- Weekly to make unit plan and to work out details of activities, experiments and projects.
- Monthly to review the learning progress of the learners and examine critically curricular experiences and organization of their work. Subject committee meetings can be held at the school and cluster level to share ideas and plan for the forthcoming month.
- At the beginning and end of the year to evolve an annual plan for all curricular activities of physical science. It may include a plan for science club activities, field visits, laboratory work and organization of specific days like science day, environment day, etc.

a) Meaning of Reflective Planning in Teaching

Reflective planning means to plan by looking at what you do in the classroom, thinking about why you do it, and thinking about if it works - a process of self-observation and self-evaluation. Reflective teaching is a form of self-assessment. It is a method of improving teaching skills using metacognitive awareness. Through reflection and making conscious efforts to evaluate one's current abilities, continuous improvements can be made in honing one's teaching abilities.

b) Strategies of Reflective Teaching

- **Teaching journal:** This is the easiest way to begin a process of reflection since it is purely personal. After each teaching session, you head back to your office and write about what happened. You may describe your reactions and feelings and those you observed on the part of the students. Posing questions about what you observed can be helpful. Journal writing does require a bit of discipline in taking the time to do it regularly.
- **Peer observation:** Invite a colleague to come into your class to collect information about your lesson. This may involve a simple observation task or merely note-taking. A peer observation will ideally relate to the area you have identified to reflect upon. For example, you might ask your colleague to focus on which students contribute most in the session, what different patterns of interaction occur, or how you deal with errors.
- **Recording lessons:** Video or audio recordings of lessons can provide very useful information for reflection. You may do things in class you are not aware of or there may be things happening in the class that as the teacher you do not normally see. Audio recordings can be useful for considering aspects of teacher talk. Video recordings can be useful in showing aspects of your behaviour.

- **Student feedback: A**sk your students what they think about what goes on in the classroom. Their opinions and perceptions can add a different and valuable perspective. This can be done with simple questionnaires.

B. Unit Plan

A unit is a large subdivision of subject matter wherein a principle or a topic or a property is at the center of the well-organized matter. A unit is not just blocks of subject matter but is composed of both method and content. Thus, a unit organizes instruction and increases the probability that instruction will be presented in a cohesive, meaningful and logical way.

Before preparing detailed lesson plans for the day on a given topic, it is always advantageous and helpful to plan for the whole unit, to ensure continuity in the teaching-learning process and have a holistic view of the content. Individual lesson plans then can easily be planned based on this holistic plan. While selecting a unit, it should be kept in mind that a teaching-learning unit is not just a collection of unrelated topics or lessons, but such an integrated whole where each lesson is a part of the whole unit and leads to the development of a new lesson in the unit. A unit of science is concerned with its content and strategies of teaching-learning in an evolving manner. It is neither a block of the subject matter nor a series of independent lessons. In a unit plan, the subject matter is split into smaller sections to have a brief overview of various concepts and interconnectivity among them.

Steps in Unit Planning

A unit should always be viewed as an integrated whole. While planning a unit, the following factors should be kept in mind.

1. **Content Analysis:** In unit planning, the emphasis is placed on analyzing the content, terms, facts, concepts, situations, processes, generalizations, principles, laws etc. This analysis helps the teacher get a thorough in-depth understanding of the subject. This step will increase his self-confidence and help him to plan his lessons retaining the continually through the unit.
2. **Objectives with specifications:** The teacher should identify the general and specific objectives of the unit, after going through the content.
3. **Learning Activities:** The third step is largely a matter of deciding upon suitable experiences that may be provided for pupils. Learning is not a pouring-in process, but a gradual process that comes about as a result of experiences. The best topics for the units provide for a variety of field trips, experiments, demonstrations and projects. All these experiences can then be backed up with reference books, films and slides. Keeping in mind individual differences, the psychology of learning, the content and objectives, suitable learning activities can be planned to which the students will be exposed during the course of the unit. Instructional activities also include the specific teaching strategies that will be employed by the teacher during instruction.
4. **Testing Procedures:** The last step of unit planning involves the choice of suitable evaluation tools and techniques through which the teacher can evaluate the content coverage and the teaching method used.

Check Your Progress - 1

1. What is Reflective Planning in Teaching?
2. How does a unit plan influence the planning of a lesson?

4.4.3.2. Developing lesson designs on different topics and through various approaches

Exercise - 2
What different stages of a Lesson have you encountered in a classroom, as a student? How did these stages of Lesson help in your learning?

As you recalled, you would have surely remembered your teacher asking you questions or performing activities as she/he began her lesson. Your teacher would have performed experiments or given examples during the lesson to introduce to you the various new concepts. At the end of the lesson again your teacher would have asked you questions based on the day's topic. There is a systematic approach to the teaching of any lesson to make it effective and useful. Let us now see the different approaches that one can use while planning a Physical Science Lesson.

A. Approaches to Lesson Planning in Physical Science

a. Herbartian Approach
It is a product of the Herbartian school of Pedagogy propagated by J.F Herbart (1776-1841) and his followers. The formal steps involve in it are:

1. **Preparation or Introduction:** The teacher must prepare the students to receive new knowledge. This knowledge is to be linked with the previous knowledge of the students. Preparation means the exploration of the pupil's knowledge, which leads to the aim of the lesson. This can be done through testing the previous knowledge through questions, using teaching aids and through skillful conversations.

2. **Presentation:** Before the presentation of the subject matter the aim of the lesson should be clearly stated. By this, the teacher and the students are engaged in a common pursuit. In the presentation step, the students must get some new ideas and knowledge.Both the teacher and pupils should be active participants in the teaching-learning process.

3. **Comparison or Association:** Some examples are given to the students and they are asked to observe and compare them with another set of examples and facts. This step is important where some definition or some generalization is to be induced by the students.

4. **Generalization:** With this step, the aim of the lesson is achieved. This step involves reflective thinking because the whole knowledge learnt in the presentation is to be systematized which leads to generalization, formulae, rules etc. through comparison and association. This step completes the inquiry by providing the answer to the problems with which it began.

5. **Application:** At this stage, the students make use of the acquired knowledge in familiar and unfamiliar situations. At the same time, it tests the validity of the generalizations arrived at by the pupils. In this way, the new knowledge gained by the pupils will become permanent in the minds of the students and will not fade from consciousness soon.

6. **Recapitulation:** This is the last step. The understanding and comprehension of the subject matter taught by the teacher can be tested by putting some suitable questions on the topic to the students. This will also help the teacher to find out whether his method of teaching is effective and successful or not.

b. Evaluation Approach or Bloom's Approach to Lesson Planning

According to this approach, teaching activities must be objective centred. Bloom considers education as a tripolar process. Educational Objectives, Learning Experiences and Change of Behaviour. According to the Evaluation Approach, the lesson plan has the following six steps

1. **Content or teaching points:** In the first column of the lesson the content to be taught should be selected from the prescribed textbook.
2. **Objectives and their specifications:** In the second column the general aims of teaching, their classes and characteristics along with relevant and desirable behaviours should be written in short form.
3. **Teacher's activities:** In the third column the teacher should mention his activities. Under teachers' activities, all those activities are included which are concerned with the content, like asking questions, statements, use of material aids and to clarify the terms and concepts.
4. **Student activities:** In this column student's activities should be written, for example, to answer questions, to tell the meanings of the words, to prepare material and to study it.
5. **Teaching aids:** In the fifth column of the lesson plan, the material aid required for teaching is mentioned which makes the contents clear and understandable.
6. **Evaluation:** In the last column, the devices of evaluation should be mentioned with the help of which daily evaluation of teaching objectives of each lesson and the learning experiences may occur.

c. R.C.E.M. Approach

The approach has been developed at Regional College of Education, Mysore (R.C.E.M.) and leaves the name R.C.E.M approach. This approach makes use of the concept of the systems approach to education. The three main steps involved in this approach are Input, Process and Output. The three aspects are as under

1. Expected Behaviour Outcome
2. Communication Strategy
3. Real Learning Outcomes

Input steps are concerned with the identification and specification of the educational objectives. The objectives are written in behavioural terms. The input step resembles the introduction step, the process resembles the presentation step of the Herbartian Approach. It represents the interaction process of the classroom. It includes activities of the teachers as well as students and teaching strategies. The output is concerned with the evaluation phase of the lesson.

d. 5E Approach

The 5 E lesson supports inquiry-based instruction. It allows children to make discoveries and to process new skills engagingly. Teachers can also adequately plan power objectives more effectively by using the 5E process. Children are not just learning with this method; they are more knowledgeable about their metacognition because they are coached

along and not dictated by teachers merely lecturing. The role of the teacher is to facilitate and support students as they use prior knowledge to build new knowledge. The 5 Es are:

1. **Engage:** To engage means to excite and to draw your child or student's curiosity. It is not forcing children to learn but inviting them to do so. This is how lessons are introduced. It does not have to be difficult or overly-detailed just interesting enough to open student's minds for the learning process to begin. Using technology to engage student learning makes planning very easy for teachers in today's classrooms. Using Smartboard technology, videos, illustrations, asking questions, KWL charts, reading a great book, acting out a character, or even introducing a game are ways to engage students at the beginning of a lesson.

2. **Explore:** Once students are fully in grossed in the lesson, intrigued by a video or maybe a book, now it is time to allow them to explore the concept. The idea of exploring is to allow the learner to practice or work with their new knowledge in some way. The most effective explorations allow for mistakes or trial and error. It is looking at a concept before discussing all the details, with hopes that students will discover answers to possible questions through exploration.

3. **Explain:** Students now have an opportunity to hear from their educator. The teacher's role so far has been to mainly facilitate learning, now they can use their expertise to answer questions students may have about what they are learning. They also may pose questions to the student to see what they can explain about what they have learned. Checking for misunderstandings helps the teacher to observe what objectives need to be clarified or taught. The lesson is reinforced by what the students have seen from their exploring.

4. **Elaborate:** Here the students can participate in an extension or a different activity that either re-teaches an objective or teaches more details about the concept being taught. Here differentiation can be used. A student above level will need an elaboration that extends or enriches the lesson. A student below level will need perhaps a repeat of the same explore activity with more teacher input to guide students through again to correct misunderstandings.

5. **Evaluate:** Finally, after the objectives are taught, it is time to assess. What have students effectively learned? What do they not understand? What should be done to help them? Assessments do not have to be a traditional quiz or essay. It can be a reflection, a project, a book report, or a model.

Lesson Plan based on 5E Approach

Chapter: Chemical Reactions **Class:** VIII

Title of Lesson: Physical and Chemical Change **Time Required:** 45 minutes

Materials Required: Mg ribbon, spirit lamp, watch glass, litmus paper, lead nitrate solution, KI solution, Na2SO4 solution, BaCl2 solution, lead nitrate crystals, NH4Cl crystals, test tubes.

Key Concepts: The occurrence of a chemical reaction is accompanied by one or more of the following observations:

- Change in state
- Change in colour
- Evolution of a gas
- Change in temperature

Classroom Proceedings

1. Engage

Have you noticed that butter hardens when kept in cold conditions? What happens to its material? Does it change? Justify your claim. Does its taste remain the same? Can it be turned soft again?

The teacher facilitates the class in group formation and encourages them to enlist the changes that they have come across from their daily experiences, for example,

a. Melting of ice
b. Curdling of milk
c. Rusting of iron
d. Tearing of paper
e. Crumpling of paper
f. Burning of paper
g. Growth of a plant
h. Ripening of fruit
i. Melting of wax
j. Freezing of water

The teacher draws their attention to the following categories and assists them in putting enlisted changes in the relevant category.

Materials remain the same and change can be reverted easily	**Materials remain the same and change cannot be reverted easily**	**Materials changes and change cannot be reverted**

Learners' inquiry drives the teaching-learning process. The teacher facilitates the inquiry to move towards the concept of physical and chemical changes. The changes in which material remains the same are called physical changes and the changes in which the composition of elements of the material changes are called chemical changes. Students categorize the above changes as chemical changes and physical changes and write the results in tabular form.

Change	**Physical Change**	**Chemical Change**

Do you think it is easy to identify physical change and chemical change? Let us perform some activities to explore this problem.

2. Explore

Activity-1

- The teacher facilitates the group of students to put zinc granules in a test tube and add dilute HCl to it.
- The students observe and answer the following questions. They write the answers in the following Table.

Activity No. What did we do?	**What was the observation?**	**Is something new formed?**	**Why do you feel so?**
1. Add zinc granules to dilute HCl	Bubbles are formed and the test tube has become warm	Yes	Zinc granules have changed in colour. Gas is being evolved.
2.			
3.			

Subsequently,the following activities are to be performed and students complete the Table given above.

Activity-2: A Mg ribbon is burnt using a spirit lamp (demonstration by the teacher).

- Teacher: What do you observe?
- Student: Mg ribbon burns with a dazzling white flame.

Activity-3: Aqueous solution of Na2SO4 is taken in a test tube and a few drops of BaCl2 solution are added. Pedagogy of Science: Physical Science ⇒ 452

- Teacher: What Teacher: What do you observe?
- Student: A white solid is formed.

Activity-4: Aqueous solution of lead nitrate is taken in a test tube and a few drops of KI solution are added.

- Teacher: What do you observe?
- Student: A yellow solid is formed.

Activity-5: Crystals of Pb (NO3) 2 are taken in a test tube and heated gently over a flame. (demonstration by the teacher).

- Teacher: In each of the activities performed above, do you think a new substance is formed?

The teacher assists students in generating arguments about how can they define a chemical change.

3. Explain

Students explain in their own words, what they learnt from the activities. For example, the occurrence of a chemical change may be identified by any of the following observed changes:

- Change in state
- Change in colour

- Change in temperature
- Evolution of a gas

4. Elaborate (independent practice)

Physical and chemical changes are identified by more than one parameter. Students add some more parameters to identifying these changes in the activities performed.

5. Evaluate

Evaluation is done involving students in the identification of Learning Indicators (LI) in the class. The teacher helps students in identifying the tasks specific to the learning indicators such as:

- contribution in the form of inquiry in performing activities;
- argumentation;
- collaboratives work; and
- recording and reporting the observation, etc.

Check Your Progress - 2

1. What are the different Approaches to Lesson Planning?
2. What do you mean by 5E in Lesson Planning?

4.4.4. Let us Summarise

- **Reflective Planning:** Reflective planning means to plan by looking at what you do in the classroom, thinking about why you do it, and thinking about if it works - a process of self-observation and self-evaluation.

- **Strategies of Reflective Teaching**
  - Teaching journal
  - Peer observation
  - Recording lessons
  - Student feedback

- **Unit Plan:** A unit is a large subdivision of subject matter wherein a principle or a topic or a property is at the center of the well-organized matter. In a unit plan, the subject matter is split into smaller sections to have a brief overview of various concepts and interconnectivity among them.

- **Steps in Unit Planning**
  1. Content Analysis:
  2. Objectives with specifications
  3. Learning Activities
  4. Testing Procedures

- **Approaches to Lesson Planning**
  - Herbartian Approach
  - Evaluation Approach or Bloom's Approach to Lesson Planning
  - R.C.E.M Approach
  - 5E Approach

4.4.5. Answers to 'Check Your Progress - 1 and 2'

Check Your Progress -1

1. Reflective planning means to plan by looking at what you do in the classroom, thinking about why you do it, and thinking about if it works - a process of self-observation and self-evaluation.
2. Planning for the whole unit ensures continuity in the teaching-learning process and gives a holistic view of the content. Individual lesson plans then can easily be planned based on this holistic plan.

Check Your Progress - 2

1. Approaches to Lesson Planning
   - Herbartian Approach
   - Evaluation Approach or Bloom's Approach to Lesson Planning
   - R.C.E.M Approach
   - 5E Approach
2. 5E's: Engage, Explore, Explain, Elaborate, Evaluate.

4.5.6. Unit end Exercises

1. What is reflective Planning? Discuss the situations which require reflective planning in an educational setup?
2. Discuss the different strategies that can be used for Reflective Planning in Physical Science Teaching?
3. Elucidate the steps of a Unit Plan.
4. Which are the different approaches of Lesson Planning? Explain
5. Explain the steps of the Herbartian Approach of Lesson Plan.
6. Elaborate the steps of Evaluation Approach of Lesson Plan
7. Explain the 5E's Approach of Lesson Plan with an Example.
8. What are 5E's? Explain its importance in a Physical Science Lesson.

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Block 4 : Planning of Teaching Learning and Assessment of Physical Science

Unit 5 : Development of Test Items (open-ended and structured) in Physical Science, its administration, assessment and evaluation

Unit Structure

4.5.1. Learning Objectives

After learning through this Unit, the student teachers will be able to

- Explain the meaning of Evaluation;
- Explain the Steps of Evaluation;
- Explain the Types of Evaluation;
- Explain the meaning of Achievement Test;
- Explain the Types of Achievement Test; and
- Explain the steps involved in the Construction of Objective-Based Tests.

4.5.2. Introduction

One of the most important parts of the teaching-learning process is evaluation. However hard a teacher has worked on his/her instruction unless he/she evaluates the outcomes of his/her instruction the learning does not become complete. Several aspects influence a teaching-learning process, which includes the teacher's capacity, environment, pupil's capacity etc. These aspects by far affect the quality of the outcome of any learning process. To understand the effectiveness of the instruction and thereafter rectify its strength and weaknesses and take corrective measures a teacher will require the knowledge of the outcome. Evaluation gives this feedback to the teacher. Hence the effectiveness of a teaching-learning process lies in how well the process has been evaluated. In the following Unit, we shall discuss and understand what evaluation is and how one can construct a good evaluation process in Physical Science.

4.5.3. Learning Points and Learning Activities

4.5.3.1. Evaluation in Education

Exercise - 1

In your classroom, I am sure you have seen a variety of students who respond differently to your teaching. Describe briefly in the space below, how exactly you go about checking if your teaching has reached your pupils.

As you answered the above question, I am sure you have specified many evaluation techniques that you must have used in your classrooms. Now let us understand evaluation in a more organized manner.

A. Meaning of Evaluation

Evaluation is a process that includes measurement and possibly testing but it also contains the notion of a value judgment. If a teacher administers a test to the class and computes the percentages of correct responses, measurement and testing have taken place. The scores must be interpreted which may mean converting them to values like A's, B's, and C's and so on or judging them to be excellent, good, fair or poor. This process is evaluation because value judgments are made.

Evaluation is a comprehensive and continuous process that covers every aspect of an individual's achievement in the educative programme. It is an integral part of education in which students and teachers are partners. It signifies a wider process of judging student's progress in various aspects.

B. Steps involved in Evaluation

The process of Evaluation involves the following steps

- **Defining the Objectives to be Tested:** Determining and classifying what is to be evaluated always has priority in the evaluation process.
- **Stating the Objectives:** State objectives in terms of behavior modification i.e. learning outcomes
- **Selection of Evaluation Tools:** After the objectives are clarified, select the evaluation tools and techniques to appraise a group of them.
- **Efficacy of Tools:** Ensure that the selected tools satisfy the criteria of validity, reliability, objectivity and usability
- **Administering the Tools:** Administer the tool of evaluation selected or constructed to assess the selected objectives. This will yield raw scores of the students.
- **Interpretation of Data:** Interpret the scores obtained using various methods of interpretation.
- **Application of results:** Apply the results of the evaluation to the teaching methods, learning activities and experiences.

C. Types of Evaluation

P.W. Airasian and G.F. Madaus have classified classroom evaluation procedures as follows

1. Determine pupil performance at the beginning of instruction (Placement Evaluation)
2. Monitor learning progress during instruction Formative Evaluation
3. Evaluate achievement at the end of instruction (Summative Evaluation)
4. Diagnose learning difficulties during instruction (Diagnostic Evaluation)

1. Placement Evaluation: Placement Evaluation is concerned with the pupil's entry-level performance and focuses on the following. Placement evaluation aims to determine the position in the sequence of learning activities and the mode of instruction that is to benefit the pupil the most

This type of evaluation assesses

- Whether the students possess the knowledge and skills required to begin the planned instruction
- To what extent the student has already mastered the objectives of the planned course.

- Whether it is possible to place him in a more advanced course
- The mode of instruction best suited to the student's needs, abilities and skills.

2. Formative Evaluation: The term formative denotes the ongoing or systematic assessment of student achievement while the term course or instructional programme is in progress. Feedback to the students and not the assignment of a grade should be the purpose of making a formative evaluation. The gathering of data during the time of the programme to guide the developmental process is formative evaluation. A person who is continually being evaluated during the course will find many things that can be changed for the better during the operation of the programme. Thus, formative evaluation is most useful for the immediate decision making the student face. The daily interaction between the teachers and students provides the students with necessary feedback for immediate decision making. The feed-back depends upon

- Determining what a student needs to know to facilitate further improvement.
- Gathering accurate data using a variety of appropriate devices (tools)
- Presenting these data to the student in a fashion he will comprehend.

Thus,it's a continuous and integral part of instruction where one uses a variety of techniques such as attitude and aptitude inventories, checklists, rating scales etc other than the tests. It is an end in itself and its main function is the appraisement of the value of evidences collected by the data-gathering devices.

3. Summative Evaluation: The term summative refers to assigning a grade for a student's achievements at the end of a term, course or instructional programme. Therefore making an overall assessment or decision with the instructional programme is summative evaluation. It may focus only on a single aspect of subject matter achievement or skills. It is a means to an end and its main function is the collection of evidences to determine the present status or position of a pupil in a particular area. It may be done off and on and it need not be an essential part of instruction. The interaction between the teacher and the pupil is very limited and the feedback that the pupil gets is much less when compared with the formative evaluation.

4. Diagnostic Evaluation: Test results provide a basis for concluding learning and teaching. A useful test not only provides information about student's achievement but also reveals the instructional effectiveness as well. Where instruction is of group nature, test results must apply to judgments of group progress. The interpretable tests give the teacher information on the adequacy of instruction. If proficiency on a particular object has not been demonstrated by many students, it is probably because instruction in this area has been less successful. Probably the learning experiences were insufficient for the achievement of this objective. Changes in lesson plans or learning materials for attaining this objective should be seriously considered for subsequent instruction or replace those currently in use. Thus evaluation serves many important diagnostic purposes too.

D. Achievement Test

Achievement means one's learning attainments, accomplishments and proficiencies in a selected subject matter. According to Dennis Baron and Harold W. Bernard, the concept of achievement involves the interaction of three factors namely, aptitude for learning, readiness for learning and opportunity for learning. Achievement in education precisely speaking implies one's knowledge, understanding or skills in a specified subject or a group of subjects.

Achievement constitutes an important tool of evaluation. The teacher must know how far the pupils have attained in a particular subject area.

a. Functions of Achievement Tests

The major functions of achievement tests are that they

1. Provide a basis for promotion to the next grade.
2. Help in finding out at the beginning of the year where each student stands in the various academic areas.
3. Help in determining the relative position of a student in a particular subject or area of learning.
4. Motivate the students before a new assignment is taken up.
5. Help the teacher to see for himself how effectively he is doing, what is getting across to pupils and what is not.
6. Provide the teacher evidence relating to the realization of the objectives, effectiveness of the learning experiences provided and mode of instruction employed.
7. Help the teacher in identifying pupils' difficulties and arranging for remedial measures.

b. Types of Achievement Tests

1. Oral Tests: Oral Test is a formal test that is conducted face-to-face with the examiner and is characterized by an immediate verbal response. It is a practice in which the examiner poses questions to the pupil in spoken form. The pupil has to answer the question in such a way as to demonstrate sufficient knowledge of the subject to pass the exam.

Types of Oral Tests

a) **Monologue Speaking (Presentation):**Pupils are asked to perform some task or asked to talk or present something on a specified subject matter.
b) **Dialogue Speaking (Oral Interview):**The pupils are put into a discussion with the teacher or the examiner where the examiner can ask questions.
c) **Multilogue Speaking (Discussions & Debates):**The pupils are put into a discussion or debate and their proficiency in the subject matter is tested.

2. Written Tests: Written-testsare characterized by writing where a student needs to express his knowledge and understanding of a subject in the written form.

Types of Written Tests

a) Essay Type: Robert L. Abel and David A. Frisbel have defined an Essay test as "An essay test presents one or more questions or other tasks that require extended written responses from the person being tested". It is very difficult to give an exact and perfect definition of an essay test. Usually, an essay test refers to any written test that requires an examinee to write several paragraphs or passages. However,the answer may constitute even a sentence or paragraph or steps and cases.

b) Short Answer Type: In simple language, it may be stated that a short-answer type test is between an essay type test and an objective test.

Anthony J. Nitku "Short answer items require the examinee to respond to the item with a word, short phrase, word or symbol."

Robert L. Abel and David A. Frisbel"A short-answer test item aims to test knowledge by asking examinees to supply a word, phrase, or number that answers a question or complete a sentence."

c) **Objective Type: R.L. Ebel and D. A. Frisbie (1986)** define an objective test as "One that can be provided with a simple predetermined test of correct answers so that objective opinion or judgement in the scoring procedure is eliminated."
Lou M. Carey (1988) defines an objective test as "Objective test items are called objective because they can be scored more objectively than any other type of item used to measure student's performance. Selected response items include alternative response, matching, keyed and multiple-choice items."

Types of Objective Type Test

1. Alternate Response Type Test Item: In the alternate-response test, out of two responses only one is correct. A student selects one of the two responses and judges the truth otherwise of the statement. Some of the common variations of alternate-response test items are

a) True- False
b) Yes-No
c) Right- wrong
d) Correct –Incorrect

2. Matching Type Test Items: N.E. Gronlund (1985) " The matching exercise consists of two parallel columns with each word, number or symbol in one column being matched to a word, a sentence or phrase in the other column. The items in the column for which a match is sought are called premise and the items in the column from which the selection is made are called responses." There are several varieties of matching tests. In the traditional format, a matching test consists of two columns. The examinee is required to make some sort of association between each premise and each response in the two columns. He pairs the corresponding elements and records his answers.

3. Multiple Choice Type Test Items: According to N.E. Gronlund "A multiple-choice test item consists of a problem and a list of suggested solutions. The problem may be stated as a direct question or an incomplete statement and is called the stem of the item. The text of suggested solutions may include words, numbers, symbols, or phrases and are called alternatives (also called choices or options). The pupil is typically requested to read the stem and the list of alternatives and to select the one correct or best alternative."

A multiple item consists of two parts

1. The stem which contains the problem
2. Options or responses i.e. list of suggested answers.

Forms of Multiple Type Test

a) **The correct answer form**: It contains three or more choices but only one of them is correct.
b) **The best form:**One or more or all choices may be correct but one of them is the best answer.
c) **The multiple response form:**The correct answer may consist of more than one choice and the examinee is asked to identify all those which are correct.
d) **The incomplete statement form:** The step is incomplete and can be completed by the correct choice. The examinee is asked to select the correct one.
e) **The substitution form:**The word outlined in the stem is to be substituted by the correct response. Responses are given and the examinee is asked to select the one which can substitute the desired word.

f) **The combined response form:**The choices are different phrases or sentences of a paragraph. The examinee is required to correct the order of the phrases or sentences.

Check Your Progress - 1

1. What is Evaluation?
2. Which are the different types of Achievement Tests?

4.5.3.2. Construction of Objective-Based Tests

Exercise - 2

In space provided answer how you would test the pupil's learning after teaching a chapter in Physical Science?

There are many ways in which we can test a pupil's learning. To have a good test it should be valid, reliable, objective, usable, discriminating etc. The construction of an objective-based test is not a simple task and requires the complete understanding and practice of all the processes involved in it. Because the paper-pencil test is the most predominant procedure at present in assessing the achievements of pupils, it is worthwhile to discuss the objective-based and objective type tests which should take the place of the prevalent subjective essay type tests. W this view, let us discuss how to construct the objective-based test in Physical Science.

A. Steps in Construction of Objective Based Test

1. **Planning the Test:** The planning of the test includes the following aspects
   a) **The objectives:** The objectives of teaching science which should be achieved through the teaching of a particular portion of the content should be selected, classified and clarified in terms of behavioural patterns.
   b) **Content:** The position of the syllabus which is to be tested should also be specified.
   c) **Number of Test Items:** The total number of test items in the test should be finalized before starting to prepare the test. This number should be per
      i) the duration of the test
      ii) the form of test items
      iii) the age level of the students
      iv) the difficulty value of the subject matter
      v) the range of subject matter to be tested
   d) **The purpose of the Test:**The purpose for which the test is given should be very clear in the beginning whether it is diagnostic or for classifying pupils etc.
   e) **Other factors:** All the conditions under which the test is to be administered should be well thought of in advance e.g. facilities, cost of materials, the experience of the pupils etc.
   f) **Distribution of weightage:** After the objectives, content and the total number of test items have been decided it is important to give the different objectives and the units in the content due weightage to ensure proper coverage of each. Each objective is defined in terms of behaviour change and each behaviour change is in turn given the due weightage. To facilitate the distribution of test-items under particular behaviour and content, it is always advisable to prepare a Bi-dimensional Chart. This chart shows the distribution of items content-wise and behaviour wise. This becomes the blueprint which serves as the frame of reference for constructing the test.

2. **Preparing the Test:** When the total number of items and the weightage to the objectives and the content is finalized the actual preparation of the test starts. While preparing the test, the following things should be kept in view.
   i) Include more than one type of item.
   ii) All items of a particular type should be placed together
   iii) Most of the items should be of 50% difficulty.
   iv) Arrange items in ascending order of difficulty.
   v) Each item should be well-phrased and the number of words in the items should be minimized as far as possible to reduce the reading load. It should not be ambiguous or provide clues to have figurative language or heavy vocabulary. It should help in determining the whole answer than a part of it.
   vi) The directions should be clear, complete and concise.
   vii) Most of the items should be of the multiple-choice type to reduce the guessing.

3. **Administering the Test:** After the test is prepared it is administered to the students
   The following points should be kept in view while administering the test
   i) If the questions are of easy, short answer and objective type they should not be given simultaneously. The objective type should generally be given first and then the essay type.
   ii) The normal conditions should be ensured such as seating arrangement, lighting etc.
   iii) The time allowance should be generous.
   iv) The instructions should be very clear about a) recording answers, b) the credit given to each question c) the scoring procedure to be used etc.

4. **Scoring the Test**
   i) The scoring procedure should be simple. There should be one-point credit to each response. The scoring may be in the form of percentage marking, letter grading. Description or point award.
   ii) Answer keys should be prepared. It may be in the form of a punched out cardboard key or the right answer is marked R with a red pencil.
   iii) When the number of alternatives in a multiple-choice type of items is less than six, the correction for chance formula should be used as below:
      a) For two alternative questions, S=R-W
      b) For multiple-choice S=R - $\frac{W}{O-1}$

      Where S = Score Corrected
      R = No. of right answers
      W= No. of wrong answers
      O = No. of Options

5. **Evaluating the Test:** After scoring, the results should be interpreted and evaluated from the following points
   i) Quality of pupil's achievement
   ii) The achievement of a particular objective.
   iii) The quality of teaching.
   iv) The curriculum.
   v) The quantity of the test itself

6. **Item Analysis:**To know whether the test item has the difficulty value or not, the item should be analyzed. This can be found out by arranging the score of students highest to lowest. Then take the papers of $\frac{1}{3}^{rd}$ of students who got the highest scores and $\frac{1}{3}^{rd}$who got the lowest scores and find out whether the item discriminates the poor students from a good student or not.

Usually, the test item should have 50% difficulty i.e. it must be solved by 50% of students. To find out whether the item has a good discriminating value and is worth retaining, find out the number of students who attempted the item correctly in the 27% high group and 27% low group. The items in which the number of correct responses of the high group exceeds that of the low group are the best and should be retained. This can be found out bu the following formula:

W_L- W_H= +ve

Where W_L is no. of wrong responses in the low group.

W_H is the no. of wrong responses in the high group

If the difference between the $W_L$and W_H is positive, the item is the best and should be retained. The item which shows the zero or no discriminating value should be discarded.

The difficulty of each choice is simply the percentage of students responding to that choice. It is calculated by taking the total number of students responding to each choice (high group + low group)and dividing it by the total number of students responding to that item. In equation form, this would be

$$\text{Difficulty} = \frac{numbercorrectinHig\quad hGroup\ + numbercorrectinLowGroup}{TotalnumberofStudents}$$

Discriminating Index: The discriminating index refers to the degree to which the item discriminates between students in the high group and students in the low group. The discrimination index is calculated by subtracting the number of students in the low group responding to a given choice form the number of students in the high group responding to that choice and dividing by one half of the total number of students. In equation form, this would be

$$\text{Discrimination Index} = \frac{numbercorrectinHig\quad hGroup - numbercorrectinLowGroup}{\frac{1}{2}TotalnumberofStudents}$$

The positive discrimination index indicates that more students who scored high on the test are responding correctly to that item than students who scored low on the test. A negative index means just the opposite - more students who scored low on the test are responding to that test item than students who scored high on the test.

Check Your Progress - 2

Which are the different steps to be followed in the construction of Objective Based Tests in Physical Science Evaluation?

4.5.4. Let us Summarise

- **Meaning of Evaluation:** The concept of Evaluation in Education (1963) of the NCERT considers evaluation as the "process of determination"
  - ✓ The extent to which an objective is being attained
  - ✓ The effectiveness of the learning experiences provided in the classroom
  - ✓ How well the goals of education have been accomplished.

- **Steps involved in Evaluation**
  - ✓ Defining the Objectives to be Tested
  - ✓ Stating the Objectives
  - ✓ Selection of Evaluation Tools
  - ✓ Efficacy of Tools
  - ✓ Administering the Tools
  - ✓ Interpretation of Data
  - ✓ Application of results

- **Types of Evaluation**
  1. Determine pupil performance at the beginning of instruction (Placement Evaluation).
  2. Monitor learning progress during instruction Formative Evaluation.
  3. Evaluate achievement at the end of instruction (Summative Evaluation).
  4. Diagnose learning difficulties during instruction (Diagnostic Evaluation).

- **Meaning and Definition of Achievement Test: Gronlund (1977)** defines an achievement test as "a systematic procedure for determining the amount a student has learned through instruction".

- **Functions of Achievement Tests**
  1. Basis of promotion to the next grade.
  2. Finding out at where each student stands in the various academic areas.
  3. Determining the relative position of a student.
  4. Help the teacher to see how effectively he is doing
  5. Evidence relating to the realization of the objectives, effectiveness of the learning experiences provided and mode of instruction employed.
  6. Identifying the pupil's difficulties and arranging for remedial measures.

- **Types of Achievement Tests**
  - ❖ **Types of Oral Tests**
    a) Monologue Speaking (Presentation
    b) Dialogue Speaking (Oral Interview
    c) Multilogue Speaking (Discussions & Debates

  - ❖ **Types of Written Tests**
    a) Essay Type
    b) Short Answer Type
    c) Objective Type

  - ❖ **Types of Objective Type Test**
    a) Alternate Response Type Test Item
    b) Matching Type Test Items
    c) Multiple Choice Type Test Items

- ❖ ***Forms of Multiple Type Test***
  a) The correct answer form
  b) The best form
  c) The multiple response form
  d) The incomplete statement form
  e) The substitution form
  f) The combined response form

- Steps in Construction of Objective Based Test
  1. Planning the Test
  2. Preparing the Test
  3. Administering the Test
  4. Scoring the Test
  5. Evaluating the Test
  6. Item Analysis

4.5.5. Answers to 'Check Your Progress - 1 and 2'

Check Your Progress -1

1. The concept of Evaluation in Education (1963) of the NCERT considers evaluation as the "process of determination"
   - ✓ The extent to which an objective is being attained
   - ✓ The effectiveness of the learning experiences provided in the classroom
   - ✓ How well the goals of education have been accomplished.
2. Types of Achievement Tests
   - Oral Tests
   - Written Tests
   - Objective Type Test

Check Your Progress - 2

1. Steps in Construction of Objective Based Test
   - Planning the Test
   - Preparing the Test
   - Administering the Test
   - Scoring the Test
   - Evaluating the Test
   - Item Analysis

4.5.6. Unit-end Exercises

1. Explain the meaning of Evaluation quoting pertinent definitions.
2. Explain the types of Evaluation.
3. Explain the steps of Evaluation.
4. What is Achievement Test? Explain
5. What are the functions of Achievement Test?
6. Explain the types of Achievement Test.
7. Explain the types of Oral Test.
8. Elucidate the types of Written Test.
9. Explain the types of Objective Type Tests.
10. Explain the stages involved in the Construction of the Objective Based Test.

4.5.7 References

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Block 4 : Planning of Teaching Learning and Assessment of Physical Science

Unit 6 : Professional Development of Physical Science Teachers

Unit Structure

4.6.1. Learning Objectives

After learning through this Unit, the student teachers will be able to

- Explain teaching as a profession;
- Enumerate the need and importance of Physical Science Teachers;
- List the functions of Physical Science Teachers;
- Explain the Pre-service professional development Programmes for Physical Science Teachers; and
- Explain the In-service professional development Programmes for Physical Science Teachers.

4.6.2. Introduction

Learning is a lifelong process and knowledge is ever-evolving.The teachers of physical science need to remain engaged in their professional development throughout their careers as teachers. Their learning and professional development do not end with the completion of the pre-service education programme. They need to continue their growth for enhancing their effectiveness as a science teacher. One of the main reasons behind it is that knowledge in science and its applications are ever-expanding. Approaches to teaching-learning of science are being continually improved and made innovative as a result of researches in science education and educational psychology.New and better apparatus and kits are being developed and used in the teaching-learning process of science. Information and Communication Technology (ICT) has opened up new opportunities in the field of education. A continual system of new teaching-learning materials in the form of new textbooks, teachers' handbooks, laboratory manual, assessment sourcebook, science kits are being produced to facilitate teachers to enhance the effectiveness of the teaching-learning process. Hence a teacher needs to be abreast with the latest knowledge and happening and this is possible only through a deliberate professional development by them. In this Unit, we shall discussthe various means for the professional development of Physical Science teachers.

4.6.3. Learning Points and Learning Activities

4.6.3.1. Teaching as a Profession

Exercise - 1
Recall your student life and list those qualities and attributes that you liked in your Physical Science Teacher. What are the most memorable activities you remember of your Physical Science Class?

As you answered the above question, I am sure you remembered that Physical Science teacher of yours who was able to reach out the subject to you through experiments and first-hand experiences and also that teacher who was considerate enough to reach out to your learning needs. A teacher needs to be equipped with not just the knowledge and information about the subject but also the right means and techniques for delivering it to the students. And this learning is a lifelong process. In the following paragraphs let us see what are the functions of a Physical Science Teacher to make him/her an effective one.

A. Teaching as a profession

Some characteristics of the profession can be enumerated that are found to be relevant towards determining its existence as a profession.

1. A profession requires specialized knowledge with extensive training and an advanced level of intellectual skills in carrying out its service to society.
2. A profession provides an essential service that is both unique and definite to society and only the people within that profession should provide the service.
3. Members of a profession enjoy a considerable degree of autonomy and decision-making power.
4. Members of a profession are required to accept personal responsibility for their actions and decisions.
5. A profession is responsible for monitoring its members and self-governing.
6. A code of ethics exists within a profession that sets out acceptable conduct for its members. The existence of this code is necessary to enforce a level of high standards.
7. A profession emphasizes the services it provides over the financial rewards.
8. It is generally agreed that members of a profession not only get paid for their work but receive a high salary commensurate with the time and effort required to obtain their specialized knowledge and skills.
9. Society must recognize an occupation as a profession.
10. A profession is considered a lifework or terminal occupation. Those involved usually stay in the field for the rest of their careers.
11. Professional development of a person in a profession is a continuous process.

You can reflect on the nature and dynamics of the action of a teacher as a professional. A teacher needs to recognize herself as a professional endowed with the necessary knowledge, attitude, competence, commitment, enthusiasm, the spirit of seeking new ways and means of dealing with teaching-learning situations and the capability of reflection on her practices. She should be sensitive and perceptive not only to the learners and the institution but also to the emerging concerns in a larger social perspective within which one functions. With proper planning, the teacher acquires confidence and presents the content with flexibility.

While planning teaching-learning experiences of physical science, a teacher has to consider many factors required for effective teaching-learning experiences such as:

- individual differences;
- cognition level of learners;
- importance of learners' experiences and their existing ideas;
- process of learning - assimilation, accommodation and construction and reconstruction of concepts;
- learning styles of learners;
- approaches and strategies of teaching-learning, tools and techniques of assessment;
- management of discipline in class, etc.

A teacher can acquire this knowledge from her B.Ed. course. Teachers need to be prepared to care for children and should love to be with them;

- understand children within social, cultural and political contexts.
- be receptive and be constantly learning;
- view learning as a search for meaning out of the personal experience, and knowledge generation as a continuously evolving process of reflective learning;
- view knowledge not as an external reality embedded in textbooks, but as constructed in the shared context of teaching-learning and personal experience;
- own responsibility towards society, and work to build a better world;
- appreciate the potential of productive work and hands-on experience as a pedagogic medium both inside and outside the classroom; and
- analyze the curricular framework, policy implications and texts.

NCF-2005 Responsibility of a science teacher is not just the teaching-learning of a particular subject to learners in the school but also helping them in their all-round development of personality. As a teacher, one has to understand and explore the learners to provide a conducive environment for learning and suitable learning experiences.

Thus, pre-service training is needed to empower student-teachers in facilitating learners for their intellectual development; emotional development; behavioural development; physical development; social development.

It is observed that there is a difference in the skills and attitude of the teachers who have received proper training as compared to those who have not received it. If a teacher is trained, she can design effective teaching-learning experiences considering individual differences.

B. Need and Importance of Physical Science Teacher

1. Science is an indispensable part of education. A teacher plays an important role in the system of education. Hence Science Teacher is a must in the process of imparting scientific knowledge in the field of education.
2. In this era of science and technology, the future of mankind depends upon science teaching and science teacher.
3. Science is one of the subjects of the curriculum and it contributes towards the realization of the aims and objectives of teaching. Hence a Science teacher is very necessary to realize the aim of all-round development of students.
4. The educative values derived from the study of science are not inherent in the subject matter, they are potentialities realized by skillful teaching. The quality of science

education depends on the quality of the science teacher and not only on the material facilities.

C. Functions of a Physical Science Teacher

a) Teaching Functions: With regards to teaching, a science teacher has to perform the following duties and responsibilities

- Make efforts for successful, meaningful and effective teaching
- Build understanding and motivation among pupils
- Create interest among pupils for science through effective presentation of the topic using audio-visual aids.
- Create a positive attitude towards science through a proper appreciation of the achievement of pupils
- Have proper planning and preparation of subject matter to be taught
- Select a suitable method for effective teaching of the Physical Science Subject
- Give adequate consideration due consideration to individual differences while evaluating teaching and learning and while assigning homework.

b) Departmental Functions: In schools, there may be a single science teacher or more than one teacher. In both situations, a teacher has to perform various types of departmental duties such as

- Organizing and looking after the department of science.
- Organize and maintain the Science Club, Science Laboratory and Science Library
- Organize and participate in departmental meetings and discussions.
- Select and prepare an order for purchasing and maintaining the equipments, books and periodicals on science
- Accept and carry out successfully any related work assigned by the Head of the Department or institution

c) Social Functions: A science teacher shoulda good relation and link with the community. He can perform his social responsibilities in the following way

- Act as the educational counselor of the society
- Connect with the parents of the pupils in improving the relationship between school and community.
- Should help the community in overcoming superstitions and developing scientific attitude.
- Should involve the community and organize Science Fairs/Exhibitions, Science Museum, Science Club, Guest Lectures etc. which should be open to all.

Check Your Progress - 1

1. What is the need for a Physical Science Teacher?
2. List some functions of a Physical Science Teacher.

4.6.3.2. Professional Development of Physical Science Teachers

Exercise - 2
Which are the different modes and methods you have used to gain knowledge, experience and skills in various aspects of your life?

As you recalled all those modes and methods which helped you gain knowledge, experience and skill related to different aspects of your life, you must have observed that some of them were formal training while others were through informal ways. As a teacher, there are several means and methods through which you can gain knowledge, skill and experience related to your profession. This in turn can help the teacher in his/her professional growth. Let us discuss different programmes for the Professional Development of Physical Science Teachers.

A. Pre-service professional development Programmes for Physical Science Teachers
I. At Elementary Level (Up to Class VIII)
(i) Diploma in Elementary Teacher Education
a) Duration of course: 2 years
b) Eligibility: 12th class
c) Admission criteria: Entrance test

(ii) Bachelor of Elementary Education
a) Duration of course: 4 years
b) Eligibility: 12th class
c) Admission criteria: Entrance test B.

II. At Secondary and Higher Secondary Level
(i) Bachelor in Education
a) Duration of course: 2 years [2 years at Regional Institute of Education, (RIEs), NCERT];
b) Eligibility: Graduate for Trained Graduate Teacher (TGT); Post Graduate for Post Graduate Teacher (PGT);
c) Admission criteria: Entrance test and interview or only Entrance Test

(ii) Bachelor in Education through Distance Mode
(a) Eligibility and admission criteria are the same for regular B.Ed. programme.
(b) Additional requirement: 2 years of full-time teaching experience in a school
(c) Duration: 2 years

(iii) Bachelor in Education for TGTs and PGTs for students with Special Educational Needs. (SEN) All criteria for admission are the same for regular B.Ed. Programme.

(iv) Four-year integrated B.Sc.-B.Ed. courses
(a) Duration of course: 4 years
(b) Eligibility: 12th class
(c) Admission criteria: Class 12th marks and interview

B. In-Service Professional Development Programme

I. Need for In-Service Professional Development Programmes

- Though the pre-service professional training is very important, the professional training received by a teacher during a pre-service teacher training programme is not always sufficient for her entire career.
- When a teacher starts her teaching career, the situation faced by each teacher is unique. She has to think creatively for context-specific examples and to come up with innovative ideas for using local resources to provide meaningful teaching-learning experiences in physical science to the learners.
- New developments in science and pedagogy of physical sciences are occurring continuously. Unless teachers are facilitated to keep themselves abreast of these developments, they are bound to show resistance to new ideas no matter how sound they look to educationists.
- Teachers can identify the areas related to learning of physical science where they feel the need for training, and go to such organizations for consideration of their participation.
- Science teachers also need to keep track of developments in other curricular areas so that they can adopt an integrated approach and provide holistic learning experiences to the learners.
- Society is also changing with time and this has a great impact on education. The teacher has to adapt her teaching-learning strategies to these changes.
- The teacher should continuously improve her skills in the development of teaching aids, science kits, improvised apparatus; laboratory work; writing better test items; continuous and comprehensive assessment of learners and how to:
  - create and organize constructivist learning situations such as observation, collaboration, multiple interpretations, etc.
  - move beyond textbook and classroom;
  - engage learners to reflect, analyze and interpret in the process of knowledge construction, etc.
- The teacher has to continuously hone her abilities to integrate a variety of learning experiences such as debate, discussion, drama, poster making, celebrating specific days and field trips with classroom experiences.
- In-service training provides an opportunity for the participating teachers to work collaboratively; share ideas, thoughts and experiences on learning resources, activities, experiments and strategies of the transaction of different concepts.
  - ✓ Science teachers also need to understand the problems of students having special needs such as Dyslexia, Dyscalculia,etc.

II. Opportunities for In-service professional development

Some of the opportunities through which a science teacher can achieve continuous professional development.

a) **Interacting with peer teachers**: Science teachers could come together and form their forum to discuss academic matters. For a teacher desiring to bring an improvement in her professional work, the best way is to share and seek help from other experienced teachers of the school who are themselves keen to grow as effective teachers. Issues like planning for learning experiences, designing improvised apparatus, context-specific examples, etc. can be discussed for mutual enrichment. Observing classroom teaching-learning and laboratory work conducted by colleagues may also help get many ideas. They should also

interact with teachers of neighbouring schools through informal/formal meetings, e-mails and various social networking sites. Contributing to the magazines for science teachers, organizing seminars, symposia, science exhibitions, interacting with scientists and educationists of eminence can all contribute to the development of quality in teachers.

b) **Reading for professional growth**: Science teachers should devote time to reading for their professional growth. They should regularly read various books, journals and periodicals related to science and science education. Reading of these on regular basis can keep science teachers up-to-date on contemporary developments in the content and pedagogy of science. For this, they can spend some time in the school library. They can subscribe to a few journals also. Teachers should become members of a professional library to get access to science books, educational journals and various curriculum materials prepared by state education departments.

c) **Attending in-service teacher training programmes and workshops:** In-service training programmes and workshops are conducted by experts to take care of the particular needs of teachers. Some of the areas in which teacher training programmes and workshops are conducted regularly in Physical sciences are Designing improvised apparatus, Developing Low-cost teaching-learning materials, writing test items, improving laboratory skills, Content enrichment in science/physics/chemistry, activity-based teaching-learning and Use of Science kits. Whenever teachers feel a need for training in a particular area, they may request the authorities to provide them the opportunity to attend such training or workshop.

d) **Membership of professional organizations**: Many national and international professional organizations provide an excellent forum to teachers for exchanging their ideas. These are dedicated to the promotion of science education and the professional growth of science teachers.

e) **Sharing through seminars, conferences, journals and magazines**: In seminars and conferences, one gets an opportunity to meet a large number of teachers and exchange teaching-learning experiences and innovative ideas with them. By attending relevant science seminars and conferences, a science teacher can learn about the innovations that other teachers are doing. The notifications for seminars and conferences come out in newspapers and journals. This information is also available on the relevant websites. The teachers can send their request for participation after seeking permission from their school authorities. The teachers can also send their articles to any national or international journal or magazine for publication and wider dissemination.

f) **Online sharing and collaboration:** Internet penetration is increasing in the country day-by-day and hence, the internet facility is becoming available to an increasingly large number of teachers. There are many online blogs, discussion forums, e-journals and e-magazines which provide teachers immense possibilities to share experiences and learn from each other. Through the internet, teachers across the regions and nations can connect with each other, discuss and exchange views. Irrespective of the distance between them they can collaborate and work together. Many online courses for professional development aimed at increasing the access, equity and quality of education. Teachers can take courses on the topics for which learning resources are not available locally. They can also get ideas for teaching-learning on any topic from a variety of internet sites. They can evaluate website content for their quality and usefulness.

g) **Travel:** Science teachers can get lots of information and materials when they go out even on their visit to other places without cutting down on the enjoyment and relaxation of the travel. Their information and material can be shared with the students and colleagues. Science teachers must always be on the lookout for an opportunity to visit science parks, science museums, planetariums, industries, mines, refineries, national laboratories and institutions, power stations, etc. During such visits, they should try to observe, learn and gather as much information as possible. During such visits, science teachers should also try to obtain descriptive literatures, collect samples of materials and click photographs. All these resources can be utilized by the teacher while designing teaching-learning experiences. Proper advance planning is needed to obtain the greatest benefit from such visits.

h) **Cultivating science hobbies:** Science teachers can enrich their knowledge in a specific subject by cultivating science hobbies that may be directly or indirectly related to their teaching area. For example, a physical science teacher can pursue hobbies in the field of electronics, robotics, etc. If a science teacher has a flair for writing and she can explain a concept in a lucid style then she may write articles on science topics for spreading scientific awareness among the public and send them for publication in newspapers and magazines.

i) **Mentoring Experienced science teachers may play the role of mentors for less experienced teachers.** Mentoring can be done to improve teaching-learning practices, to encourage lifelong learning, to motivate teachers to work in emerging areas, to plan activities, experiments and projects, etc. A mentor can help in brainstorming problems that a beginner teacher faces. They can evaluate the performance of the beginner teacher in the class and provide constructive criticism for her betterment. Mentors may also provide handholding to teachers taking up action research.

j) **Teacher exchange programmes**: Many teacher exchange programmes enable the teachers to go for a few months to school in another locality or state within the country or even outside the country. The participating teachers get an opportunity to teach and learn in different settings and interact with a different set of peer teachers. Similarly, schools may also play host to visiting teachers and plan how best to utilize the services of visiting teachers. Teachers can share their expertise in science education with each other.

k) **Acquiring higher qualifications**: A physical science teacher may try to improve her qualifications by enrolling for M.Sc., M.Ed., Ph.D. or other such programmes. Some schools allow their teachers to take study leave/sabbatical leave to obtain an advanced degree. Teachers should apply for study leave well in advance so that the school management can recruit a replacement for the teacher proceeding on leave. If obtaining study leave is not feasible, a teacher may pursue these programmes through open universities. Acquiring higher qualifications is beneficial for enriching content and pedagogy knowledge of science and making teaching-learning more effective. It may enhance the possibility of promotion of the teacher in the future.

l) **Collaboration of schools with the university:** Many colleges, universities and institutions conduct training for teachers in various areas of physical science. A teacher herself can visit the laboratory and library and discuss with the professors on the concepts she needs elaborations. This can help her to plan field visits to these places for her students also. She can involve herself in the preparation of training modules, textbook

development, research project, etc. taken up by colleges and other institutions. This would break isolation among science teachers teaching at various stages at the school and college.

Check Your Progress -2

1. Which are the different means of In-service Professional Development?

4.6.4. Let us Summarise

- **Teaching as a profession:**The teacher needs to recognize herself as a professional endowed with the necessary knowledge, attitude, competence, commitment, enthusiasm, the spirit of seeking new ways and means of dealing with teaching-learning situations and the capability of reflection on her own practices. She/he should be sensitive and perceptive not only to the learners and the institution but also to the emerging concerns in a larger social perspective within which one functions. With proper planning, the teacher acquires confidence and presents the content with flexibility.

- **Need and Importance of Physical Science Teacher**
  - Physical Science Teacher is a must in the process of imparting scientific knowledge in the field of education.
  - In this era of science and technology, the future of mankind depends upon science teaching and science teacher.
  - Science teacher is very necessary to realize the aim of all-round development of students.
  - The quality of science education depends on the quality of the science teacher.

- **Functions of a Physical Science Teacher**
  - **Teaching Functions:** Make efforts for successful, meaningful and effective teaching, create interest among pupils for science, create a positive attitude towards science **D**
  - **Departmental Functions:** Organizing and look after the department of science.
  - **Social Functions:** Act as the educational counselor of the society, connect with the parents of the pupils, involve the community in educational processes.

- **Pre-service professional development Programmes for Physical Science Teachers**
  - **Elementary Level (Up to Class VIII)**
    a. Diploma in Elementary Teacher Education
    b. Bachelor of Elementary Education

  - **Secondary and Higher Secondary Level**
    a. Bachelor in Education
    b. Bachelor in Education through Distance Mode
    c. Bachelor in Education for TGTs and PGTs for students with Special Educational Needs.
    d. Four-year integrated B.Sc.-B.Ed. courses

- **Need for In-Service Professional Development Programmes**
  - The pre-service teacher training programme is not always sufficient for her entire career.
  - When a teacher starts her teaching career, the situation faced by each teacher is unique.
  - New developments in science and pedagogy of physical sciences are occurring continuously.

- Science teachers also need to keep track of developments in other curricular areas.
- The teacher has to adapt her teaching-learning strategies to these changes in society.

➢ **Opportunities for In-service professional development**

a) Interacting with peer teachers
b) Reading for professional growth
c) Attending in-service teacher training programmes and workshops
d) Membership in professional organizations
e) Sharing through seminars, conferences, journals and magazines
f) Online sharing and collaboration
g) Travel
h) Cultivating science hobbies
i) Mentoring Experienced science teachers may play the role of mentors for less experienced teachers.
j) Teacher exchange programmes
k) Acquiring higher qualifications
l) Collaboration of schools with university

4.6.5. Answers to 'Check Your Progress - 1 and 2'

Check Your Progress - 1

1. Need and Importance of Physical Science Teacher

- Physical Science Teacher is a must in the process of imparting scientific knowledge in the field of education.
- In this era of science and technology, the future of mankind depends upon science teaching and science teacher.
- Science teacher is very necessary to realize the aim of all-round development of students.
- The quality of science education depends on the quality of the science teacher.

2. Functions of a Physical Science Teacher

- **Teaching Functions:** Make efforts for successful, meaningful and effective teaching, create interest among pupils for science, create a positive attitude towards science **D**
- **Departmental Functions:** Organizing and look after the department of science.
- **Social Functions:** Act as the educational counselor of the society, connect with the parents of the pupils, involve the community in educational processes.

Check Your Progress - 2

1. **In-service professional development**

a) Interacting with peer teachers
b) Reading for professional growth
c) Attending in-service teacher training programmes and workshops
d) Membership in professional organizations
e) Sharing through seminars, conferences, journals and magazines
f) Online sharing and collaboration
g) Cultivating science hobbies
h) Teacher exchange programmes
i) Acquiring higher qualifications
j) Collaboration of schools with university

4.6.6. Unit-end Exercises

1. Enumerate the characteristics of the profession and explain teaching as a profession.
2. Explain the need and importance of a Physical Science Teacher.
3. What are the functions of a Physical Science Teacher? Elaborate
4. Explain the Pre-service professional development Programmes for Physical Science Teachers
5. Explain the need for an In-service Professional development programme.
6. What are the opportunities for In-service development Programmes for Physical Science Teachers?
7. How can interaction with peer teachers help in the professional development of Physical Science Teachers? Explain
8. Explain how will you use travel as a professional development tool to enhance your skill and experience as a Physical Science teacher?
9. Which are the different hobbies that can aid the professional development of Physical Science teachers. Explain
10. Explain the In-service professional development Programmes for Physical Science Teachers

4.6.7. References

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