Module 11

Pedagogy of Science (Upper Primary Stage)

1. Overview

The module on pedagogy of science has been developed for teachers teaching science at upper primary stage. In this module focus is on how children learn science at upper primary stage. The module focuses on the following points—

- Learning objectives
- What is science?
- Curricular expectations at upper primary stage
- Learning outcomes in science at upper primary stage (Classes VI,VII & VIII)
- Suggestive pedagogical processes for achieving the learning outcomes
- Examples from NCERT, Science Textbook at upper primary stage
- Suggested activities for KRPs in the training programme

2. Learning Objectives

After going through this module, the learner is expected to

- have basic understanding of science as a subject at upper primary stage
- have basic understanding of curricular expectations and learning outcomes at upper primary stage
- apply science as a process of inquiry and knowledge construction
- explain how teacher can facilitate learning
- integrate content, pedagogy and assessment during teaching-learning process
- design various learning situations for students to transact concepts

3. What is Science?

Human beings have always been curious about the environment around them. One kind of response from the earliest times has been to observe the physical and biological environment carefully, look for any meaningful patterns and relations, and build conceptual models to understand the world on the basis of observations and thus arriving at theories, laws and principle. This human endeavour is science.

Science is a dynamic, expanding body of knowledge covering ever new domains of experiences. It is an organised

system of knowledge which is based on inquiry evolved out of natural curiosity, logical reasoning and experimentation. In a progressive society, science can play a truly liberating role, helping people escape from the vicious cycle of poverty, ignorance and superstition. People today are faced with a fast changing world where the most important skills are flexibility, innovation and creativity. These different imperative have to be kept in mind in shaping science education.

3.1 Curricular Expectations at the Upper Primary Stage

At the upper primary stage, children get their first exposure to 'science' as a discipline. Science at this stage provides a gradual transition from environmental studies of the primary stage to the elements of science and technology at upper primary stage. Concepts of science to be taught at this stage should be chosen so as to make sense of everyday experiences. Activities and experiments should form the essential component part of the teaching-learning process.

Science concepts at the upper primary stage should not be governed by disciplinary approach. Science at this stage should be taught as an integrated subject and it is not to be regarded as a diluted version of secondary stage. The child should be engaged in learning the principles of science through familiar experiences, working with hands to design simple technological units and models. Focus should also be given to learn more about the environment and health, including reproductive and sexual health. Scientific concepts are to be derived mainly from observations, activities, experiments and surveys. Group activities, discussions with peers, teachers and community members, surveys, collection and organisation of data and their display through exhibitions, etc., in schools and the neighbourhood should be important components of pedagogy. Technological components such as design and fabrication of simple models, practical knowledge about common mechanical and electrical devices and local specific technologies are to be included in science curriculum.

Apart from simple experiments and hands on experiences, an important pedagogic practice at this stage is to engage the students (in groups) in meaningful investigations particularly of the problems they perceive to be significant and important. This may be done through discussions in the class with the teacher, peer interactions, gathering information from newspapers, talking to knowledgeable persons in the neighbourhood,

collecting data from easily available sources (books, journals, magazines, television, internet, etc.) and carrying out simple investigations of which the students have a major role to play.

Science curriculum at the upper primary stage is intended to develop

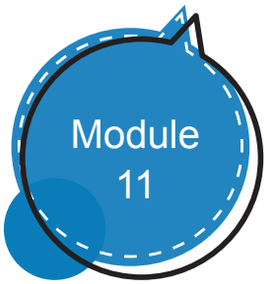
- scientific temper and scientific thinking
- process skills of science which includes
  - observation(s)
  - posing question(s)
  - searching various resources of learning
  - planning investigations
  - hypothesis formulation and testing
  - using various tools for collecting, analysing and interpreting data
  - supporting explanations with evidences and justifications
  - critically thinking to consider, weigh and compare alternative explanations
  - reflecting on their own thinking
- appreciation for historical aspects of evolution of science
- sensitivity towards environmental concerns
- respect for human dignity and rights, gender equity
- values of honesty, integrity, cooperation, concern for life and public property.

The science curriculum at the upper primary stage as per NCF-2005 has been organised around the following themes that are cross disciplinary in nature—

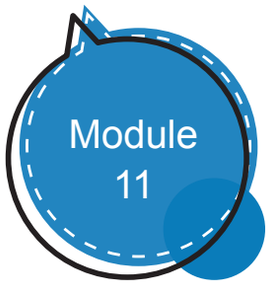
- Food
- Materials
- The World of the Living
- How Things Work
- Moving Things, People and Ideas
- Natural Phenomena
- Natural Resources

4. Learning Outcomes in Science at the Upper Primary Stage

Learning outcomes identify what the learner will know and be able to do by the end of a course or class. Detailed class wise learning outcomes along with the examples are on the next page.



Class VI
The learner— • identifies materials and organisms, such as, plant fibres, flowers, on the basis of observable features i.e. appearance, texture, function, aroma, etc. • differentiates materials and organisms, such as, fibre and yarn; tap and fibrous roots; electrical conductors and insulators; on the basis of their properties, structure and functions. • classifies materials, organisms and processes based on observable properties, e.g., materials as soluble, insoluble, transparent, translucent and opaque; changes as can be reversed and cannot be reversed; plants as herbs, shrubs, trees, creeper, climbers; components of habitat as biotic and abiotic; motion as rectilinear, circular , periodic. • conducts simple investigations to seek answers to queries, e.g., What are the food nutrients present in animal fodder? Can all physical changes be reversed? Does a freely suspended magnet align in a particular direction? • relates processes and phenomenon with causes, e.g., deficiency diseases with diet; adaptations of animals and plants with their habitats; quality of air with pollutants, etc. • explains processes and phenomenon, e.g., processing of plant fibres; movements in plants and animals; formation of shadows; reflection of light from plane mirror; variations in composition of air; preparation of vermin-compost, etc. • measures physical quantities and expresses in SI units, e.g., length. • draws labelled diagrams/flow charts of organisms and processes, e.g., parts of flowers, joints, filtration, water cycle, etc. • constructs models using materials from surroundings and explains their working, e.g., pinhole camera, periscope, electric torch, etc. • applies learning of scientific concepts in day-to-day life, e.g., selecting food items for a balanced diet; separating materials; selecting season appropriate fabrics; using compass needle for finding directions; suggesting ways to cope with heavy rain/ drought, etc. • makes efforts to protect environment, e.g., minimising wastage of food, water, electricity and generation of waste; spreading awareness to adopt rain water harvesting; care for plants, etc. • exhibits creativity in designing, planning, making use of available resources, etc. • exhibits values of honesty, objectivity, cooperation, freedom from fear and prejudices.



Class VII
The learner— • identifies materials and organisms, such as, animal fibres; types of teeth; mirrors and lenses, on the basis of observable features, i.e., appearance, texture, functions, etc. • differentiates materials and organisms such as, digestion in different organisms; unisexual and bisexual flowers; conductors and insulators of heat; acidic, basic and neutral substances; images formed by mirrors and lenses, etc., on the basis of their properties, structure, and function. • classifies materials and organisms based on properties/characteristics, e.g., plant and animal fibres; physical and chemical changes. • conducts simple investigations to seek answers to queries, e.g., Can extract of coloured flowers be used as acid-base indicator? Do leaves other than green also carry out photosynthesis? Is white light composed of many colours? • relates processes and phenomenon with causes, e.g., wind speed with air pressure; crops grown with types of soil; depletion of water table with human activities, etc. • explains processes and phenomenon, e.g., processing of animal fibres; modes of transfer of heat; organs and systems in human and plants; heating and magnetic effects of electric current, etc. • writes word equation for chemical reactions, e.g., acid-base reactions; corrosion; photosynthesis; respiration, etc. • measures and calculates e.g., temperature; pulse rate; speed of moving objects; time period of a simple pendulum, etc. • draws labelled diagrams/flow charts e.g., organ systems in humans and plants; electric circuits; experimentalset ups; lifecycle of silk moth, etc. • plots andinterprets graphs e.g., distance-time graph. • constructs models using materials from surroundings and explains their working, e.g., stethoscope; anemometer; electromagnets; Newton's colour disc, etc. • discusses and appreciates stories of scientific discoveries. • applies learning of scientific concepts in day-to-day life, e.g., dealing with acidity; testing and treating soil; taking measures to prevent corrosion; cultivation by vegetative propagation; connecting two or more electric cells in proper order in devices; taking measures during and after disasters; suggesting methods for treatment of polluted water for reuse, etc.

- makes efforts to protect environment, e.g., following good practices for sanitation at public places; minimising generation of pollutants; planting trees to avoid soil erosion; sensitising others with the consequences of excessive consumption of natural resources, etc.
- exhibits creativity in designing, planning, making use of available resources, etc.
- exhibits values of honesty, objectivity, cooperation, freedom from fear and prejudices.

Class VIII

The learner—

- differentiates materials and organisms, such as, natural and human made fibres; contact and non-contact forces; liquids as electrical conductors and insulators; plant and animal cells; viviparous and oviparous animals, on the basis of their properties, structure and functions.
- classifies materials and organisms based on properties/characteristics, e.g., metals andnon metals; *kharif* and *rabi* crops; useful and harmful microorganisms; sexual and asexual reproduction; celestial objects; exhaustible and inexhaustible natural resources, etc.
- conducts simple investigations to seek answers to queries, e.g., What are the conditions required for combustion? Why do we add salt and sugar in pickles and *murabbas*? Do liquids exert equal pressure at the same depth?
- relates processes and phenomenon with causes, e.g., smog formation with the presence of pollutants in air; deterioration of monuments with acid rain, etc.
- explains processes and phenomenon, e.g., reproduction in human and animals; production and propagation of sound; chemical effects of electric current; formation of multiple images; structure of flame, etc.
- writes word equations for chemical reactions, e.g., reactions of metals and non-metals with air, water, and acids, etc.
- measures angles of incidence and reflection, etc.
- prepares slides of microorganisms; onion peel, human cheek cells, etc., and describes their microscopic features.
- draws labelled diagram/flow charts, e.g., structure of cell, eye, human reproductive organs; experimental set ups, etc.
- constructs models using materials from surroundings and explains their working, e.g., *ektara*, electroscope, fire extinguisher, etc.
- applies learning of scientific concepts in day-to-day life, e.g., purifying water; segregating biodegradable and non-biodegradable wastes; increasing crop production; using appropriate metals and non-metals for

various purposes; increasing/reducing friction; challenging myths and taboos regarding adolescence, etc.
- discusses and appreciates stories of scientific discoveries.
- makes efforts to protect environment, e.g., using resources judiciously; making controlled use of fertilizers and pesticides; suggesting ways to cope with environmental hazards, etc.
- exhibits creativity in designing, planning, making use of available resources, etc.
- exhibits values of honesty, objectivity, cooperation, freedom from fear and prejudices.

In National Achievement Survey 2017, which was based on Learning Outcomes, percentage of correct responses (on an Average) for class VIII in Science at the National level was found as follows—
Class VIII — 44%
Do we know about state average achievement and district average achievement? Details are available on
http://www.ncert.nic.in/programmes/NAS/SRC.html. We need to reflect on how to improve learning outcomes of our students in science.

5. Suggestive Pedagogical Processes for Achieving the Learning Outcomes

The learner is to be provided with opportunities in pairs/groups/individually in an inclusive setup and encouraged to

- explore surroundings, natural processes, phenomena using senses viz. seeing, touching, tasting, smelling, hearing.
- pose questions and find answers through reflection, discussion, designing and performing appropriate activities, role plays, debates, use of ICT, etc.
- record the observations during the activity, experiments, surveys, field trips, etc.
- analyse recorded data, interpret results and draw inference/make generalisations and share findings with peers and adults.
- exhibit creativity presenting novel ideas, new designs/patterns, improvisation, etc.
- internalise, acquire and appreciate values such as cooperation, collaboration, honest reporting, judicious use of resources, etc.

The pedagogical processes listed above are suggestive and intended to give directions to teachers to design various learning situations for students. It is expected that teachers will provide opportunities to children to engage in the practice of science and construction of knowledge by children. Learning as a process of construction of knowledge requires connecting new ideas to the existing ideas on the basis of materials/activities presented to them. Hence, teachers' understanding of learners' experiences and ideas are very important for designing teaching-learning situations. Thus, it is expected that teachers will design appropriate learning situations as per the experiences of the children and availability of resources and taking care of local context.

Some exemplar concepts to integrate learning outcomes while transacting concepts in a classroom are discussed.

6. Examples from NCERT Science Textbooks — Upper Primary Stage (Classes VI–VIII)

Various strategies on how to transact concepts from NCERT Science Textbooks have been given. Teachers may have other ways of transacting the same concept. It is expected that teachers will use locally available material while transacting concepts. Various resources such as Science Kits, Information and Communication Technology (ICT), art education, etc., may be judiciously employed to enrich teaching-learning of science.

6.1 Example 1

Class VIII

Chapter 4—Metals and Non-metals

Key Concept—Physical Properties of Metals and Non-metals (Page 44 Section 4 .1)

Learning Outcomes
The learner— • Conducts simple investigations • Classifies elements into metals and non-metals on the basis of their properties • Explains processes • Draws labeled diagram • Applies learning of scientific concepts in day to day life • Exhibits honesty, cooperation and creativity • Makes effort to keep surrounding clean

Know Your Students

The availability of resources has always been a matter of great concern for activity based teaching-learning. The teacher may

try to manage it by taking help of students who have always proved to be one of the greatest resources.

The first requirement for a teacher is to know about her students and establish a rapport with them. This will help her to plan students' involvement in various activities during teaching-learning process. Some students are good at art and craft, creative writing and some may be good in collecting materials and conducting investigations. If students show such kind of behavior, this means they have involved themselves in the learning process of science.

In the given examples efforts have been made to integrate pedagogy, content and assessment in a meaningful way.

To Begin With!

In a science class, a teacher is thinking that students would have some idea of the word 'metal' from their daily lives and they have also studied about it in class VI. To gauge students' view of metals and their previous knowledge, she asks in the class. "Can you name some metals?"

Students may come up with answers like iron, silver, gold, aluminium, steel, copper, etc.

The teacher asks—What makes you call these things as metals? What do you think is the reason?

Students may say—They are hard. They shine. They give sound when we hit them.

Student 1 (who is visually impaired), teacher gives him iron key, lock, etc., in his hands so that he can feel and give his observations too.

Teacher motivates one of the students to hit wooden table with a wooden ruler and encourages all the students to observe. They observed that it also made sound. It is also hard and shining. Will you call it a metal?

Students may or may not be sure about the answer.

This helps the teacher assess that their concept of metals is based on daily experiences but is not yet a clearly established concept. So she decides to encourage students to do some activities to help establish the characteristics of metals.

Activity 1

The teacher asks one of the students to get a metal plate in the class and hit it with a wooden stick first and then with a metal spoon and motivates students to listen to the sound carefully.

Student 1 (visually impaired)—When you hit the plate with a spoon, it produces a loud ringing sound but the sound is dull when hit with wooden stick.

Fig. 1—Objects made up of metals

Teacher—Can any one of you tell about some property of metals from this?

Student 2—Yes, when two metals hit each other the sound is sharper. When one metal hits a non-metal, it is less sharp and when there is no metal the sound is not sharp at all.

Teacher—Very good. We call this sharp ringing sound as sonorous. Metals are generally sonorous materials. Can you think of some use of this property of metals?

Student 3—All bells are made from metals, for example, school bell, *payal*, *ghungroo* are also made up of metals (Fig. 1).

Learning Outcomes—Conducts simple investigations to seek answers to queries that metals are usually sonorous; applies learning of scientific concepts in day to day life.

Teacher—Provides materials such as aluminium wire, copper wire, iron nail, coal, sulphur powder. Out of these materials can you separate the materials with shiny surfaces?

Students are encouraged to work in groups of three to four.

Teacher makes sure that groups are heterogeneous in nature with children from different backgrounds and abilities.

They separate materials as Group I—shiny and Group II—without shine/dull.

Student 4—Group I materials are mostly metals because they shine and produce sonorous sound whereas Group II mostly includes other materials.

Student 5 is in cognitive conflict, she brings a rusted iron nail and asks "If iron is a metal, then why is the surface of this iron nail not shining?"

The teacher is very happy at her observation and questions to clear her doubts. This gives encouragement to other students that asking questions or expressing dilemma is an important aspect of teaching- learning.

The teacher gives sand paper to student 5 and asks her to rub the rusted iron nail with sand paper.

Student 5 (Starts rubbing with sand paper)—Wow! It is shining now.

Teacher—Metals often lose their shine and appear dull because of action of air and moisture on them. Most of the metals shine but shining is not the only property that metals show. When we see a collection of many properties, we conclude it's a metal.

Activity 2

Before investigating, teacher motivates students to hypothesise if the given materials change their shapes on hitting. After hypothesising, she encouraged students to investigate.

Students take the materials and hit them one by one with hammer and record their observations. She also advices students to be careful and not to get hurt in this process.

Since there was only hammer, one of the students gets a big stone from outside to hit the materials.

Students—Shape of iron nail, aluminium wire and copper wire change on hitting, whereas coal, sulphur roll break into smaller pieces on hitting.

Student 1—feels that iron nail, aluminium wire and copper wire etc. are very hard, whereas coal, sulphur can break easily on pressing.

Teacher appreciates the alternative given by student — using stone instead of hammer. She observes that how students are very particular in helping Student 1 by giving him materials to feel before and after hitting the materials with hammer, so that he can also observe the change.

Teacher—Can anyone tell me anything general about metals from your observation?

Student 6—Metals are not easy to break into small pieces, whereas some other materials are.

(Learning Outcome—Conducts simple investigations to seek answers to queries and concludes that metals are generally hard; exhibits cooperation)

Teacher—Can you think of a metal beaten into very thin sheets?

She shows them sweet covered with silver foil. She can also show video film to the students that how malleable are metals.

This is a characteristic property of metals, if they are beaten hard and uniformly, they can be changed into thin sheets without breaking into small pieces. This property of metals is called malleability.

Student 6 takes out aluminium foil in which her chapatti is wrapped.

Involving community/parents

- Students can be suggested to accompany her/his parents to a blacksmith or a goldsmith where tools or ornaments are

made or school can arrange a visit to a shop of a goldsmith/ black smith.

- A skilled blacksmith or a goldsmith may request to visit the school and interact with students.

Activity 3

The teacher now asks students to recall how they made an electric circuit in their previous class with cell, wires and a small bulb. She motivates them to complete a circuit with one of the materials such as, iron nail, copper wire, aluminium wire, piece of coal, sulphur, pencil lead as part of the circuit and then observe if they allow current to flow through the circuit or not. She encourages them to record their observations in the Table 1 and also draw labeled diagram (Fig. 2).

Fig. 2—Simple electric tester

Students start doing the activity in groups of three to four. She makes sure that groups are heterogeneous in nature with children from different backgrounds and abilities. Teacher notices that some students are patiently doing the activity, some are helping others. Students are discussing among themselves.

Record of this table can be kept in students' portfolio for future reference

Table 1—Electrical Conductivity of Materials

S.No	Materials	Bulb glows	Bulb does not glow
1.	Iron nail		
2.	Copper wire		
3.	Aluminum wire		
4.	Piece of coal		
5.	Suphur		
6.	Pencillead		

Students—On placing iron nail, aluminum wire, copper wire and pencil lead, bulb starts glowing; whereas, by placing coal and sulphur, bulb does not glow. Student 1 with the help of peers could feel the bulb glowing by touching as it was little warmer than before. After discussion they could conclude that iron nail, aluminum wire, copper wire and pencil lead are good conductors of electricity, whereas coal and sulphur are poor conductors of electricity.

Teacher may explain that metals are good conductors of electricity, whereas non-metals are not; however, pencil lead (Graphite), which is a non-metal is a good conductor of electricity. The reason of its conductance is availability

of free electrons in the allotropic form of carbon which students may understand in higher classes.

Using ICT for further exploration

Teacher may also allow students to interact with simulations/ videos/animations related to the concept and explore the concept further. One such link of a simulation for electric circuit is given for the reference—
https://nroer.gov.in/55ab34ff81fccb4f1d806025/page/5b4d793e16b51c01e4ec660a

Assessment

Teacher—

1. Where do you find use of copper and aluminum wires?
2. Can wires be made up of coal?

Teacher is amazed to see the discussion going on among students. She observes that students are placing the materials at their original places and taking care of cleanliness.

(Learning Outcome—Conducts simple investigations—provides explanation; draws labeled diagram; exhibits honesty by recording and interpreting data; exhibits cooperation and makes effort to keep surrounding clean).

Fig. 3—Cooking in metallic utensil

Teacher—

1. Can you guess why metallic pans are usually provided with plastic or wooden handle (Fig. 3)?
2. Why do we find wooden/plastic handles less hot than metallic utensils?

Children start discussing about this. Teacher tries to listen to the discussion going in the class. After having a discussion, they collectively arrive at a conclusion that metals are good conductors of heat.

Once the discussion is over, Student 7 comes up with a Poem/Riddle

I am 1600 years old
My hometown is in Delhi
My Guardian is Chandragupta II
I am 7 meters tall
And my weight is 6.5 tonnes
My body is made up of a metal
I am still standing erect

and not turned into a pile of rust?
Who am I?
Who am I?

Teacher encourages the student 7 to read the Riddle loudly so that Student 1 (visually impaired) can also participate. She motivates other students also to compose poems, songs, riddles, anecdotes, etc.

Learning Outcome—Applies learning of scientific concepts in day to day life; exhibits corporation, creativity by posing a riddle.

Teacher concludes that metals are hard, lustrous, sonorous, malleable, ductile, good conductor of heat and electricity, whereas, non-metals are not. Teacher may also inform students about some exceptions that metals like sodium and potassium are soft and can be cut with knife. Metals are usually solid but mercury is an exception, which is in liquid state at room temperature.

Once students have understood the properties of metals and non-metals along with their exceptions, teacher encourages them to do role play to strengthen the concept in a joyful way. She may also show them the video to know about important metals that we use in our day to day lives discuss about it. The link of one such video is given below.
https://nroer.gov.in/55ab34ff81fccb4f1d806025/file/58871312472d4a1fef810dbc

Assessment

- Motivate students to draw Venn diagram to show all possible relations between physical properties of metals and non-metals and discuss in class.
- Encourage students to find the locations of the deposits of iron and aluminium in India. In which form are the deposits found? Discuss in the class.

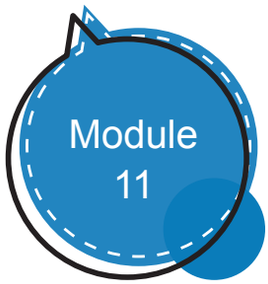
6.2 Example 2

Class VI

Chapter 7—Getting to know plants

Introduction

Children are familiar with plants which grow all around them. They are also aware that all plants are not same but they differ in several ways such as height, flowers, fruits, shapes, color, texture of leaves, stem, trunk, etc. However, they might not be aware of the uniformity exhibited by some plants or the



differences they exhibit when compared with other groups of plants. They are also not able to appreciate the diversity that exists amongst plants in terms of its forms and functions. This section of the module will focus on the concept of diversity that exists in the plant world. It is envisaged that through the activities provided here, students will be able to appreciate the diversity that exists in plants, recognise them and group them into herbs, shrubs and trees. It will also provide them opportunities to build competencies in other aspects.

Key concept—Diversity exists in plant world

Learning Outcomes
The learner— • appreciates and recognises the diversity of plants in their locality • classifies plants into herbs, shrubs and trees • measures height of plants • draws labeled diagram of their observation • exhibits care and concern for plants • exhibits creativity by planning, drawing and making cards using paper • exhibits values of honesty, objectivity and cooperation • discusses and appreciates diversity of plants around the world

Before the activity

The teacher may introduce the topic of plant in the class through some probing questions. She may ask the students if they have ever paid attention to see the plants around them. For example, whether some plants were small throughout their life and some plants keep growing? Whether the plants were similar or different? In what ways they were similar or different? Whether they thought about the reasons for the similarities or differences?

It is likely that students will respond and share their views in different ways. For example, some students may say that some plants are small while some plants are huge. Some will identify based on the flowers or leaves. Some may even make a mention of Bonsai plants.

The teacher appreciates all the answers and will take special care to give opportunity to students who are otherwise non-responsive or shy or introvert. Since this is a common topic, they will have no problem to share their views. After a few

discussions on the topic, the teacher will now let the students do the following activities.

Activity 1—Exploring surroundings

The teacher may divide the class into groups. Each group may consist of about five students each. Teachers may give instruction to students to explore their school campus to observe the different plants that grow.

The teacher may give a clear instruction to students not to disturb the plants as far as possible and not to uproot the plants, break the stem or pluck the leaves or flowers.

The teacher may ask students to observe and note down the different plants based on various categories as they can think of. For example, height, whether they grow horizontally on the ground or they climb on other plants/walls/other structures, etc., texture of leaves and stem, flowers, smell, color of flower and stem, from where the branches grow, etc. Students may be given the opportunity to come up with as many different categories as they can think of to collect the information.

Every group may be asked to note down their own observation. It is likely that students may differ in opinion about what they observe. Hence, students in each group may be asked to discuss as they observe and come to a consensus about their observation. They may note down their observations accordingly in their observation sheet.

Students take extra care not to disturb the plants as they move around the school campus.

About 20 minutes may be given to students to explore their campus.

Assessment

Each group may be asked to share their observations in the classroom.

The teacher may ask the students to prepare a table (Table 2) and fill them. Students may be asked to add more columns based on their observations. Students may also compare their tables with their friends in other groups and discuss. This can form part of the assessment of students' understanding of the broad classification of plants. Teachers may note that there may be some confusion in grouping trees as shrubs or trees since the plants have not fully grown. This may be clarified by the teacher. It may be noted that this division is based broadly on the height of mature plants, the texture of the stem, and the position from where the branches appear (Fig. 4). It

may be remembered that trees can be made very short e.g., Bonsai plants.

Some groups may have noted plants such as money plant, water melon plant, gourd plants, etc. but they are not sure where to categorise them. The teacher may help them in grouping such plants as climbers and creepers.

Table 2—Categories of plants

Plant name	Column 1 Height of a fully grown plant	Column 2 Stem				Column 3 Where do the branches appear		Column 4
		Green	Tender	Thick	Hard	At the base of the stem	Higher up on the stem	Category of plant
Mango	Very tall	No	No	Yes	Yes	No	Yes	Tree

(Note—This activity may be given as a project to be done by students at home before the class, especially if the school campus does not have plants around. In such case, it will be an individual activity).

(a) Herb *(b) Shrub* *(c) Tree*

Fig. 4—Types of plants

(Learning Outcome—appreciates and recognises the diversity of plants in their locality; classifies plants into herbs, shrubs and trees; measures height of plants; exhibits care and concern for plants; exhibits creativity by planning, drawing and making cards using paper; exhibits values of honesty, objectivity and cooperation)

Activity 2—Drawing a plant

Students may be asked to draw a colorful, labelled diagram of their favorite plant and write its name in whatever languages they know. They may also be asked to write a few lines on why they like the plant.

Assessment

More than the artistic skill, the teacher may pay attention to the observation skill and detailing in terms of leave venation, position of leaves in the stem/trunk, flower, etc. and see how proportionately the student has drawn in terms of size of the stem/trunk and leaves etc.

If the schools can afford, the teacher may provide a chart paper to each student to make the drawing. Students can use such cards to wish friends or relatives during festivals, birthdays or on different occasions instead of spending money on expensive cards.

Learning Outcome—exhibits creativity by planning, drawing and making cards using paper.

Activity 3—Plants of the world

The teacher may show photos or videos of the diversity of plants that are found in other parts of the country or in different parts of the world. Such diversity may also be shown in terms of the climatic condition, geographical locations, etc. For example, diversity of plants in deserts, coastal regions, mountains, polar regions, etc. If audio visual (AV) facilities are not available in the class, teachers may prepare cards containing pictures of plants, their names, where they are found, etc. Teachers may laminate such cards and use them as a permanent resource to teach the topic year after year. This will avoid wastage of paper. Such efforts will widen the horizon of the imagination of students about diversity of plants. This activity also nurtures students towards becoming global citizens as they appreciate diversity around the world.

Assessment

Students may be asked to write a few lines about the differences or similarities that they see in the plants in their surroundings

Fig. 5—Plants of some countries

and those that they see in the pictures or videos. Alternatively, students may be asked to share with the class about the different plants that they see in the pictures or videos. The teacher may provide additional information wherever necessary.

The teacher may assign a project to students to gather information about one plant found in other countries. Each student may be assigned one country. Students may be asked to gather information on the following—Name of the plant, place where it is found, whether it is a herb, shrub or a tree, their importance, etc. Students may be asked to write the information in their notebook and also draw a diagram of the plant. Let students put these up in the board in their classroom.

The teacher may also provide the students with some additional and useful information. For example, it may be interesting for the students to know that plants are also brought from one country to another for various reasons. Some of these plants that were brought to India from other countries are today integral part of our diet or economy. For example, cashew, tomato, chilli, potato, etc. But some plants such as *Lantana camera* which are invasive species have caused havoc. They prevent native undershrubs and other plants from surviving.

Lantana was brought to India by the British as an ornamental plant more than 200 years ago.

Learning Outcome—appreciates and recognises the diversity of plants around the world.

6.3 Example 3

Class VIII

Chapter 13—Sound

Key concept—How sound is produced!

Learning Outcomes
The learner—
• Conducts simple investigation to find the ways of producing sound
• Relates process and phenomena with causes
• Applies learning of scientific concepts in day to day life
• Exhibits creativity in making use of available resources

Fig. 6—Various musical instruments

Students are already familiar with sounds they have heard from their surrounding such as the sound produced by animals, musical instruments, etc. Teacher may proceed classroom discussions with students as follows—

Think of an object that produces sound. You must have various experiences of sound produced by people, automobiles, gadgets, etc. in your daily life.

In this process teacher may ask students to

- share their experiences on sound in their surroundings.
- make a list of sounds they hear in their surroundings (of persons, animals, birds, breeze, rivers, mobile, school bell, transports, gadgets, etc.).
- name some musical instruments they have seen in the music room of the school or at other places.

Activity 1

Different ways of producing sound.

Students may be arranged in groups for doing this activity.

Learning Outcome—Explores surroundings; performs appropriate activities.

All the groups may be asked to explore different methods for producing sound.

Teacher will monitor the group work but in general will not intervene in the discussions carried out by the students, but she will try to make all the students actively participate in the discussion.

After allowing few minutes for discussion within the group teacher may ask different groups to summarise their findings.

Students may come out with different ways of producing sounds, such as by hitting a table, by plucking a rubber band, by scratching a rough surface, by blowing, etc.

(For summarising the findings of the students, teacher may ask each group to present it. Due care should be taken by the teacher to ensure active participation of all students).

Teacher may help them in grouping different ways in broader groups such as, sound produced by hitting, by plucking, by scratching, by blowing, etc. After grouping some of the ways she may involve students in completing Table 3.

Table 3

S.No.	Method of producing sound	Examples given by the students
1.	By hitting	By hitting a table with duster, ...
2.	By plucking	By plucking a string of *sitar*, ...
3.	By Blowing	.....
4.	By Scratching	.....
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For further exploration of this concept i.e., for finding out the most common thing in all these methods of producing sound, teacher may engage students by performing Activity 2.

Activity 2

To show sound is produced by a vibrating object (The activity is to be performed by involving a student).

Learning outcome—Conducts simple experiment; relate process and phenomena with causes.

Teacher may involve students in arranging materials for performing the activity. Students may be asked to bring objects producing sound in the classroom. The activity described below is one among the many activities that a teacher can perform.

Materials Required—Metal plate, steel spoon

- Take a metal plate and place it as shown in Fig. 7
- Now strike the rim of the metal plate with a steel spoon.
- What do you observe? Can you hear any sound?

Fig. 7—Sound produced by a vibrating metal plate

Teacher should link this concept with other concepts/topic such as the sonorous nature of metals, which students have already studied in chapter of metals and non-metals. In this way there may be integration of different concepts. She may also encourage student(s) with visual impairment to give his/her observations.

- Now, strike the rim of the metal plate again with a steel spoon. As soon as you strike, touch the rim of the metal plate with your finger. What do you feel?
- Do you feel the vibration on touching the steel plate?
- What can be inferred from the observation?
- Strike the rim of the metal plate again. Touch the plate after it stops producing sound. Can you feel the vibration now?

Teacher asks students, which part is vibrating? (Metal Plate) Teacher may help students conclude that sound is produced due to the vibration of the metal plate.

For further strengthening of the concept Teacher may ask students to perform the following activitiy in group and help them in arriving at the concept by performing Activity 3.

Activity 3

Learning outcome—Relate process and phenomena with causes, conduct simple experiment.

Materials Required—Rubber bands, two pencils and a pencil box.

Teacher facilitates this activity using two rubber bands, two pencils and a pencil box.

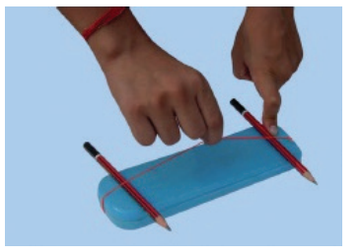


Fig. 8—Plucking the rubber band

- Take a pencil box and stretch a rubber band over it.
- Insert two pencils between the box and the stretched rubber bands as shown in Fig. 8
- Pluck the rubber band in the middle.
- Do you hear any sound?
- Does the rubber band vibrates?

Teacher may help the students in concluding that the vibration of the stretched rubber band produces sound.

Open Ended Questions

After this activity teacher may involve students in discussion by posing a question that 'What do you think, do all sound producing objects vibrate?

Students may give some of the examples of sound in which they do not easily find anything vibrating. Now teacher may allow students to engage in further discussion.

She will monitor the discussions and this will help the teacher to understand their thinking process or to check the development of alternative conceptions.

Teacher may help students in concluding that even if we are hitting an object such as table top by a scale/duster then also there is vibration associated with it, although we may not be able to see it. Vibration of the objects such as table top may be verified by sprinkling some chalk dust/green gram (Moong)/any type of grains on the table top and then hitting it with a scale or a duster. You can easily see the jumping of the chalk particles/grains on hitting the table. Visually impaired student(s) can observe the sound of jumping of grains while hitting the table.

Similarly examples of vibration of air columns may be shown using some animations.

After discussing and showing some examples using ICT tools, students may conclude that sound is produced by vibrating objects. Teacher may also use sound box/speakers and pop corn/thermocol balls for showing vibrations of the object by sound producing objects.

Likely misconception which may arise during the course of discussion could be—

All vibrations produce sound that are audible to humans.

Teacher may give extended activities/projects to address these misconceptions.

Assessment

Teacher encourages students to discuss among themselves and note down the vibrating part of various musical instruments in Table 4. The musical instruments given may be added or replaced.

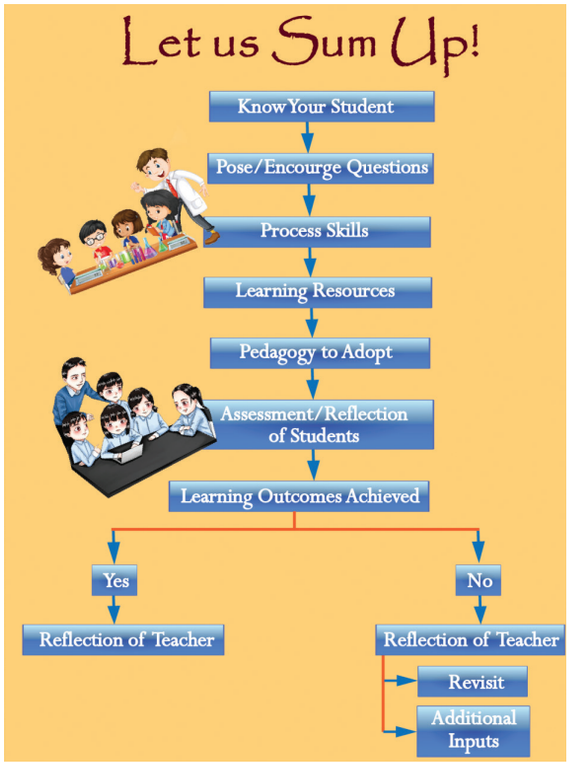
Learning outcome—Identification and classifying of sound producing objects.

Table 4

S.No.	Musical Instruments	Vibrating part producing sound
1.	*Veena*	Stretched string
2.	*Tabla*	Stretched membrane
3.	Flute	Air-column
4.	Guitar	---
5.	*Ektara*	---
6.	---	----

Teacher may motivate students to prepare simple musical instrument using locally available resources.

Learning outcome—Exhibits creativity in making use of available resources; applies learning of scientific concept in day to day life.



7. Suggested Activities for KRPs/Teachers

A. Teacher may design a classroom plan for transacting one or two concepts of his/her interest from Science at upper primary stage focusing on

- learner centric approach
- linking with learning outcomes
- in built assessment
- enhancing gender sensitivity, inclusion and sensitivity towards environment

The following points may be kept in mind while designing a classroom transaction plan

- Classrooms must provide a suitable environment for interaction between students and teachers, so that meaningful learning can take place.

- The effectiveness of a class depends on the methodology adopted by the teacher and the extent of interactions the teacher plans and holds with the students.
- It is of utmost importance to recognise and value each learner and his/her diverse intelligence to provide an opportunity to bloom.
- There are various methods which can be used during teaching-learning process to sustain the inquisitiveness and interest among students, which may also help in recognising the abilities of the learners.
- Teachers may think over their teaching practices, analysing how concepts were taught and how the practices can be improved or changed for achieving better learning outcomes.

B. Teachers may also take up planning of any one of the given task during the training programme

Performing activities/Demonstrations—Activities motivate and nurture students' observations and experimental skills. A general discussion on the process and outcomes of the activity/ demonstration enhances the interpretative and communication skills of the students. If learners are allowed to express their findings, it will enable them to develop good communication skills.

- Project work—Project work in science is usually an organised search, construction or task directed towards a specific purpose. It provides an opportunity to the students to identify a problem, to design a work plan, to address the problem, to search for appropriate resources, to carry out their own plan and to draw conclusion on the basis of data/ information collected. In the process, the students learn fundamental principles of science, methods and processes of science, and are exposed to the phases involved in a scientific investigation.
- Cross-word puzzles—Cross-word puzzles engage the students in a fun-filled and participatory form of teaching-learning process, students love to take up the challenge of filling up crossword puzzles.
- Quiz—Quiz is an entertaining mind game which tests students' mental ability, attention, general awareness and speed with which a person can recall and process the information. It expands a person's horizon of knowledge, sharpens memory and prompts spontaneous communication. It is of equal interest to the participants and to the spectators.

- Science exhibitions—An exhibition can provide a forum for the display of the work done by the students throughout the year. It serves to motivate the students and provides a feedback to parents about their child's progress. It can also help students share their work with one another in order to build a better understanding of the concepts involved. The display of various models can provide a spark to other students to participate in such events. In addition this will also provide viewers a glimpse of what science can do.
- Field trips—Field trip is an educational activity that gives outdoor experience which cannot be provided in the classroom. It helps to relate concepts of science learnt in the classroom with real life and with the environment. It enhances their observation and data recording skills. Students are active, motivation is elevated and critical thinking is also enhanced. It is not necessary that a field trip be always conducted at a far off place. Even a visit to the school garden can be rewarding. There may be many interesting places in the vicinity of the school which may be worth visiting for the students.
- Science journals—The teacher may advise students to maintain a Science journal. She/he may encourage students to write their experiences and ideas on daily basis and collect information by consulting resources available to them. On topics related to the concepts dealt with in the class, science journal will help foster a sense of scientific inquiry in the child.
- Role plays—Role play among students develop the skills to handle social and scientific interactions. It builds confidence and communication skills among students. As a fun activity, it also allows students to get into character and act out real life roles Students when engaged in role play help to develop their way of thinking.
- Creative writing—The purpose of creative writing is to share human imagination, experience and innovation to tell a story, poem, song etc., through strong written visuals with an emotional impact.
- Portfolios—Student portfolio provides evidence of students' knowledge, skills and attitudes. It is a documentation of the students' growth. Portfolios are portraits of the students during a term or throughout the year. All tasks assigned to

the students and assessed by the teacher should go into her/his portfolio.

- Anecdotes—Anecdotal record refers to written description of a child's progress that a teacher keeps on a day-to day basis. It provides observational narrative records of significant incidents in a child's life. During teaching-learning process, the teacher sometimes comes across enquiry-based questions, observed by the children whose validity is much beyond the classroom. The records of such anecdotes and the response of children to these anecdotes can be a powerful tool for assessment and guiding them to the right path.

8. Evaluation

Evaluation may be done on the basis of following points—

- A performa may be given to the teachers for self evaluation.
- A concept may be asked to transact and observations can be made.
- An assignment can be given to test the understanding of the concepts.
- A task may be given to prepare the test items.

9. Suggested Readings

National Council of Educational Research and Training. 2005. National Focus Group Position Paper on *Teaching of Science.* New Delhi.

——. 2012. *Source book on assessment in science classes VI-VIII.* New Delhi.

——. 2006. *Textbook of Science, class VI.* New Delhi.

——. 2008. *Textbook of science, class VII.* New Delhi.

——. 2008. *Textbook of science, class VIII.* New Delhi.

——. 2015. *Continuous and Comprehensive Evaluation Exemplar Package in Science for the Upper Primary Stage.* New Delhi.

——. 2017. *Learning Outcome at the Elementary Stage.* New Delhi.

10. Web-based Resources

- https://nroer.gov.in/55ab34ff81fccb4f1d806025/page/5b4d793e16b51c01e4ec660a

- https://nroer.gov.in/55ab34ff81fccb4f1d806025/file/58871312472d4a1fef810dbc
- https://www.youtube.com/watch?v=gbwCX011vFo&feature=youtu.be
- https://www.youtube.com/watch?v=oIP4MqRQiSc&feature=youtu.be