

Learning Indicators in Science at Upper Primary Stage

Introduction

Science is a human endeavour to understand the world by building-up conceptual models on the basis of their own observations of surroundings and connect it to a meaningful patterns and relations to interact with nature. It involves processes like observations, making hypotheses, performing activities, collecting and analysing data, drawing inferences and making generalisation.

As consistent with the stage of cognitive development, science is being taken as core subject in the curriculum at upper primary stage. At this stage, it is a gradual transition from environmental studies of the primary stage to the elements of science and technology. At this stage, it is important to expand the horizon of child gradually and start with the things that are within the direct experience of the child.

In view of NCF 2005 the syllabi of Upper Primary Stage has been developed following broad curricular expectations:

- At upper primary stage science concepts relate to the everyday experience of children and learnt through hands on activities/experiments utilising local resources.
- The pedagogy of science at this stage reflects an approach that include tasks such as making simple models, meaningful investigations, surveys, peer interactions, field studies and group activities.
- Child at this stage is encouraged to collect, organise and reflect on the information so that science learning becomes meaningful in social context.
- Greater emphasis have been laid on the learning process of science (process skills). These skills include observation, hypothesis, measurement, data collection and analysis, drawing inferences, making generalisations that promote analysis, critical thinking and creativity.

The development of process skills in science enables children to learn by themselves so that they can continue to be creative and develop lifelong learning attitude.

- At upper primary stage learners are encouraged to explore and seek varied resources to facilitate conceptual clarity and to establish relationship with day to day life applications.

Continuous observation of the child's learning is an essential component of a teaching learning process. It gives a teacher an idea that as a facilitator what are necessary requirements to enhance the teaching-learning process. Teacher adopts several parameters through which she assesses continuously learning progress of the child. These parameters are taken as learning indicators that enable the teacher to identify learning gaps. Thus, learning indicators (LI) facilitate strategies to deliver curriculum and assess learner's progress continuously with a focus on curricular expectations.

The learning indicators in consonance with curricular expectations and pedagogical processes are presented in tabular form namely curricular expectations, pedagogical processes and learning indicators class wise (classes 6,7&8).

Guidelines for users

- (i) The columns in the Table-1 reflect curricular expectations and pedagogical processes.

The first column, curricular expectations provide learning goals as the child moves from class VI to class VIII through content and themes mentioned in this column are perceived as a vehicle to achieve the goals of science curriculum at upper primary stage. The teaching-learning process or pedagogical process are built along the science content keeping in the mind the cognitive reach of a child. It imbibes active participation of learner and provide opportunity to construct knowledge utilising multiple resources. The major focus of the process is to create learning environment.

- (ii) The columns in Table-2 highlights learning indicators class wise which reflects the progress of learning. These are suggestive and may be adopted or adapted as per the need and context.

These pedagogical processes and learning indicators would help in implementation of CCE effectively.

Children with special needs requires to be taken along with class and it is desired to design alternate activities keeping in view the learning objectives similar to those to the others. The teacher should take into account the specific problem of the child and plan alternate strategies for teaching learning process. A healthy inclusive classroom environment provides equal opportunity to all the students, those with and those without learning difficulties can learn together. The measures to be adopted may include:

- Develop process skills through group activities and use of ICT for simulation, repeated practices and evaluation.
- Assess learning progress through different modes taking cognizance of the learner's response.
- Observation of the child's engagement in multiple activities, through varied ways and levels of involvement.
- Use of adapted equipments/devices (for eg. Visual output devices should have aural output and vice versa)
- Use of embossed diagram in the pedagogical process and learning progress.
- Use of adapted equipments in observation and exploration.
- Use of multiple choice questions to get responses from children who find difficult to write or explain verbally.

Table-1

<i>Curricular Expectations</i>	<i>Pedagogical Processes</i>
<p>Science syllabi at upper primary stage identifies age appropriate content that is being utilised as a vehicle to develop scientific temper and scientific thinking for example:</p> <ul style="list-style-type: none"> • Develops process skills of science such as observation, inquiry, constructing hypothesis, collecting data, recording observation, drawing inference • Making generalisation, proving or disproving hypothesis, developing explanation, communicating and applying. • Imbibes the development of historical perspectives; environmental concerns and sensitivity. Develop and respect for human dignity and rights; gender equity; values of honesty, integrity, cooperation and concern for life • The content consistent with the cognitive development of learner at upper primary stage. <p>For example:</p> <ul style="list-style-type: none"> - Identification of materials on the basis of their properties - Idea/ experience about exhaustible and inexhaustible 	<ul style="list-style-type: none"> • Observes surroundings, natural processes, phenomena through visuals, touch, smell, feel and echo etc, For example Wooden furniture, metallic lunch-box, spoon, pencil, stones, mirror, magnet, eraser, coal, plants, animals, sea breeze, land breeze, storms, cyclones, lightening, night sky • Shares her observations with others (peers /adults), seeks information and formulate hypothesis on the basis of observations • Attempts to prove the hypothesis by designing and performing activities/experiments/ surveys For example <ul style="list-style-type: none"> - Separating different parts of flower such as sepals, petals, stamens and carpel etc. - cutting with knife, beating of materials with hammer, to check the hardness of materials - Heating materials to check their conductivity - Using electric tester to check electrical conductivity of materials

<p>natural resources</p> <ul style="list-style-type: none"> - Sources and components of food - Nutrition in plants and animals - Useful and harmful microorganisms - Conservation of plants and animals - Cell structure and functions of animal and plant - Sexual and Asexual reproduction in animals - Idea of Motion, Force and Pressure - Electric current and circuit - Reflection and dispersion of light - Ideas about celestial objects 	<ul style="list-style-type: none"> • Observes the changes/ findings during the activity For example <ul style="list-style-type: none"> - Distinguishes between different parts of flower on the basis of colour, shape, size, number, etc - Some materials are easily cut with knife - Some materials change into flat sheets on beating - Some materials break down into a powdery mass. - Some materials heat up quickly and some hardly heat up. - The bulb of tester glows in case of some materials and does not glow for others. • Analyses data, interpret results and draws inference For example: <ul style="list-style-type: none"> - Differentiates between different parts of flowers by comparing with figures/ pictures - Identifies materials on the basis of hardness, softness, appearance, transfer of heat, flow of electric current
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The learning indicators corresponding to class VI, VII and VIII with respect to the above mentioned curricular expectations involving pedagogical processes is highlighted by taking examples.

Table-2

<i>Learning Indicators/ Class</i>	<i>Class VI</i>	<i>Class VII</i>	<i>Class VIII</i>
Explore surrounding and shares experiences with others	<p>Explores</p> <ul style="list-style-type: none"> - Plants and animals as sources of food such as, wheat, rice, egg, milk, fish etc. - identifies food ingredients, such as Chapati has two ingredients <i>Atta</i> and water; <i>Dal</i> has more than two ingredient etc; and food components such as potato is rich source of carbohydrates while eggs and fishes are rich in protein and fats is a component of nuts. - Various plant fibres such as cotton, jute etc - Materials on the basis of physical properties such as soft, hard, soluble, insoluble, appearance, 	<p>Explores</p> <ul style="list-style-type: none"> - Modes of nutrition in plants such as autotrophic in green plants, heterotrophic in non-green plants and in animals - Identify various parts of digestive tract in human such as buccal cavity, oesophagus, stomach and intestine etc. - Process of digestion such as saliva breaks down starch into sugar in buccal cavity. Digestive juices break down the proteins into simpler substances - Various animal fibres such as wool, silk etc - Changes as physical and chemical such as dissolving sugar in water, setting of curd from milk etc 	<p>Explores</p> <ul style="list-style-type: none"> - Various cropping patterns such as Rabi crops and Kharif Crops - Various practices of crop production, such as, soil- preparation, irrigation etc. and animal husbandry - Roles of Microorganisms in our life - Various synthetic fibres such as artificial silk, nylon etc - Physical and chemical properties of materials - Result of application of force on an object such as change in its state of motion or its shape - Factors affecting friction such as nature of surfaces - Pressure exerted by fluids such as water in a bottle, air in inflated balloon - Sources of sound such as stretched strings, membranes, air columns - Chemical effects of current such as electroplating

	<p>transparency etc</p> <ul style="list-style-type: none"> - Changes as reversible and irreversible such as melting of wax, making of chapatti, burning of paper etc - Types of movement, such as motion of a vehicle on straight road, falling stone, hands of a clock, blade of an electric fan, swing - Behaviour of magnets such as magnets attract materials like iron, attraction and repulsion between two magnets - Shadow formation of objects of different shapes, sizes and colours in sunlight and candle light - Reflection from surfaces such as water of a pool, mirror - Air and water as a natural resource with focus on components of air, water cycle, loss of water by 	<ul style="list-style-type: none"> - Nature of substances as acidic, basic such as lemon, tamarind, baking soda, soap etc - Flow of heat such as metal spoon kept in hot tea becoming hot. - Heating effect of electric current such as electric heater or iron becoming hot after switching on electric current. - Magnetic effects of electric current such as electromagnetic crane, electric bell - Reflection of light from mirrors such as plane mirrors, convex mirrors, concave mirrors - Issues related to Water Management such as treatment of polluted water, arrangement for sewage disposal, sanitation at public places - Forest as a resource, deforestation, soil erosion, various products obtained 	<ul style="list-style-type: none"> - Laws of Reflection and multiple images - Ways by which air and water gets polluted, green house effect, ways of purification of water
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<p>Asks questions leading to investigations</p>	<p>plants and rain water harvesting</p> <ul style="list-style-type: none"> - Recycling of waste products, emphasis on recycling of paper and vermin-composting <p>For example:</p> <ul style="list-style-type: none"> - Is chicken curry/honey an animal product? - Do carbohydrates present in plants sources only? - Why do living things need food? - What are our clothes made of? - Why are we advised to wear cotton cloths in summer? - How do plants/animals get their food? - How does a torch work? - How is magnet used to find directions? - What will happen if it does not rain or rains 	<p>from forest, forest as a life line for the forest dwelling communities</p> <p>For example:</p> <ul style="list-style-type: none"> - Why does pitcher plant feed on insects? - How do animals utilise their food? - Do some of our clothes come from animal sources? - What kind of clothes helps us to keep warm? - Why does turmeric stain become red on applying soap? - What gets deposited on a <i>tawa</i> / <i>khurpi</i> if left in a moist state? - How do we know how fast something is moving? - How does a fuse work? - Where and how do you get 	<p>For example:</p> <ul style="list-style-type: none"> - Why is weeding necessary in agricultural farm? - Why is wheat not cultivated during summer? - How do vegetables and food get spoilt? - What helps make curd? - Do we use clothes (fabric) for purposes other than making clothes to wear? - Why does a burning candle get shorter? - What happens when we push or pull anything? - Why needles are made pointed? - How is sound produced? - Why are ringing bells not
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<p>Performs activities</p> <ul style="list-style-type: none"> • Suggests different ways of doing activities • Selects appropriate materials/tools/instrument • Collects and assembles materials appropriately for performing activities • Improvises materials/tools/instruments as per the need • follows relevant precautions such as handling objects/chemicals/equipments carefully • Repeats activities to 	<p>heavily?</p> <ul style="list-style-type: none"> - Can fruits and vegetable peels be reused? <p>For example:</p> <ul style="list-style-type: none"> - Find and list out various food items, their ingredients and their sources, such as, ingredients of idly are rice, <i>urad dal</i> and water - Perform test for starch, protein and fats in various food items. - Materials will be identified by doing various activities such as dissolving materials into water, by compressing or scratching materials, by immersing material into water, by looking through materials by using the available resources - Measures lengths using 	<p>water for your domestic needs?</p> <ul style="list-style-type: none"> - What are the products we get from forests? <p>For example:</p> <ul style="list-style-type: none"> - Collect information about plant nutrition from various resources such as news paper, internet etc. - Perform iodine test to confirm the presence of starch stored during the process of photosynthesis in leaves of different colours. - Collect information on structure of digestive tract via books, posters, news paper and internet etc. - Nature of materials in surrounding will be identified by testing with different indicators such as litmus paper, flower indicators - Studies transfer of heat by 	<p>made of wood?</p> <ul style="list-style-type: none"> - What makes things visible? - What are the various activities which makes air and water impure? <p>For example:</p> <ul style="list-style-type: none"> - Gather material such as, potted earthen pots, manure, fertiliser, water etc. to carry out activity by adding different manure and fertilizers to the soil of potted plants and comparing it with the plant lacking treatments. - Manages ice-cream cups and germinate seedlings instead of earthen pots. - Uses spatula for using urea and other manure. - Using only a little dose of urea at a time. - Replicate the activity many times. - Physical and chemical properties of materials will be tested by performing various activities such as beating the material with hammer, burning of metals and non-metals in
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reproduce results	<p>hand span, strings, metre scale, etc</p> <ul style="list-style-type: none"> - Lights up an electric bulb using electric cell and wires - Using conduction tester identifies materials as good and bad conductors of electric current - Locates poles of a magnet using iron filings 	<p>conduction, convection and radiation by heating metal strip, water and keeping a hand on top of candle flame</p> <ul style="list-style-type: none"> - Measures time period of a pendulum and speed of a ball. - Observes heating effect of electric current by using some metal wires and battery - Forms images by plane, convex and concave mirrors 	<p>air reactions of metals and non-metals with water, acids, bases and salts.</p> <ul style="list-style-type: none"> - Observes effect of force on speed and direction of moving object - Performs various activities to study pressure exerted by water on the bottom and walls of container - Tries out different ways of reducing and increasing friction - Performs activities to establish that a medium is needed for propagation of sound - Makes a conduction tester and uses it to test electrical conductivity of liquids
<p>Reporting and Recording</p> <ul style="list-style-type: none"> • Records findings in different ways, such as, table, graph, figure, etc • Organizes scientific findings using 	<p>For example: Records observations of various food items for the presence or absence of carbohydrates, protein and fats.</p> <ul style="list-style-type: none"> - Draws figures of the collected materials and records their properties in a tabular form 	<p>For example: Records observations of iodine test with different coloured leaves and variegated leaves for the presence or absence of starch</p>	<p>For example: Records name of various tools and their uses in agricultural practices in tabular form, such as, plough for tilling and loosening the soil, leveller to level the soil etc. Records effect of green manure and urea on plant growth by recording length, number of leaves etc every</p>

<p>appropriate tables, charts, graphs, diagrams and symbols</p> <ul style="list-style-type: none"> Identifies relationships in the findings Applies appropriate mathematical skills to interpret quantitative data 	<ul style="list-style-type: none"> Draws diagram of various parts of flower <p>For example: relates the observations with the physical properties of materials and differentiates materials as soluble, insoluble, hard, transparent, translucent, conductor, insulator, etc</p> <p>For example:</p> <ul style="list-style-type: none"> counting of floral parts Identifies different parts of flowers on the basis of position and structure 	<p>in the tabular form.</p> <p>Records</p> <ul style="list-style-type: none"> makes cards/ charts using natural indicators records the observations regarding nature of substances in a tabular form makes distance-time graphs Draws diagram of a simple electric circuit using symbols <p>For example: identifies the nature of materials as acidic, basic and neutral by observing different colours with indicators</p>	<p>day of seven days</p> <p>-Records the observations related to the physical and chemical properties of materials(metals and non-metals) in a tabular form</p> <ul style="list-style-type: none"> Records the action of force on the state of motion and shape of objects <p>For example:</p> <ul style="list-style-type: none"> differentiates between metals and non-metals by observing their physical and chemical properties <p>For example:</p> <ul style="list-style-type: none"> measures the angle of incidence and angle of reflection of light <p>For example:</p> <ul style="list-style-type: none"> Classifies the materials into metals and non-metals on the basis of physical and chemical properties Liquids exert equal pressure at the same depth Friction depends on the nature of surfaces in contact Sound is produced by vibrating objects Most liquids that conduct electricity are solutions of acids, bases and salts.
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<p>Discussion</p> <ul style="list-style-type: none"> • Presents logical explanations and arguments, • Communicates conclusions clearly • Connects scientific concepts to everyday life • Makes effort to 	<p>For example: -Concludes that most of the flowers has four parts. Concludes that rice has carbohydrates in it but ground nut has fat in it.</p> <ul style="list-style-type: none"> - Concludes that hard and lustrous materials are usually metals - Concludes that light travels in straight line <p>For example: - cooking utensils are made up of metals as they are good conductor of heat</p>	<p>For example: Concludes that starch is synthesised only in the green part of variegated leaves Communicates that see starch is synthesised in other different coloured leaves too!!</p> <ul style="list-style-type: none"> - calculates the time period of simple pendulum - calculates speed of an object <p>For example: - Infers that materials which turns blue litmus red are acidic in nature whereas materials which turns red litmus blue are basic in nature</p>	<p>For example: Concludes that urea and green manure enhances growth of plants</p> <ul style="list-style-type: none"> - Metals are used for making aeroplanes, boilers, automobiles etc whereas non-metals are used in fertilisers and in water purification etc - Soles of shoes are grooved for better grip <p>For example: - Visits a commercial electroplating unit</p> <ul style="list-style-type: none"> - Finds out the locations of the deposits of iron, aluminium and zinc in India. Mark these in an outline map of India. Discusses in which form the deposits are found. <p>For example: - Makes kaleidoscope, model of solar system, toy telephone, etc</p> <ul style="list-style-type: none"> - Make model of fire extinguisher.
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<p>acquire further knowledge</p> <ul style="list-style-type: none"> • Displays a sense of interest in science by preparing charts and working models • Participates enthusiastically in role plays, field trips, science exhibitions, etc. • Responds critically to media coverage of issues • Shows innovation and creativity • Shows some problem-solving skills, 	<p>For example:</p> <ul style="list-style-type: none"> - visit a blacksmith, observe and report how metals are moulded <p>For example:</p> <ul style="list-style-type: none"> - Makes pinhole camera, periscope, etc <p>For example:</p> <ul style="list-style-type: none"> - Discussion/ role play/ poster presentation on conservation of water - Survey on waste management <p>For example:</p> <ul style="list-style-type: none"> • Issues such as, noise pollution, gender issues <p>For Example:</p> <ul style="list-style-type: none"> - Suggest methods of rain water harvesting - Suggest ways of recycling of paper 	<ul style="list-style-type: none"> - Concludes that warm air rises up - Concludes that when electric current passes through a wire, it behaves like a magnet - Concludes that white light consists of seven colours <p>For example:</p> <ul style="list-style-type: none"> - Copper vessels are not used to keep acidic materials. - Convex mirror is used as side view mirror in vehicles <p>For example:</p> <ul style="list-style-type: none"> - Visit electric shop to see various types of fuses and MCB 	<ul style="list-style-type: none"> - Discussion on recycling of paper - Discussion on different methods of purification of water, <p>For example:</p> <ul style="list-style-type: none"> - Hazards of electroplating, noise pollution, disaster management <p>For example:</p> <ul style="list-style-type: none"> - discusses on methods of purification of water - discusses on fuel efficiency
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<p>Demonstrates values imbibed</p> <ul style="list-style-type: none"> • Uses resources/materials without wasting • Records and reports findings honestly • Takes responsibility and initiative while performing task • Works cooperatively with peers • Listens patiently to arguments of others • Advises the ways for conservation of environment so that changes in environmental conditions will not affect the survival of entire species. 	<p>For example: Discusses with peers for not to waste food.</p> <p>Switches off electrical appliances when not in use, avoids wasting water, chemicals etc.</p>	<p>For example: Discusses with peers not to pluck flowers, leaves etc.</p> <ul style="list-style-type: none"> - Makes sun dial, sand clock, electromagnetic crane, etc <p>For example: - Brings the soil sample from the nearby area and find out the nature of soil. Discusses with gardener if he/she treats the soil in any manner</p> <ul style="list-style-type: none"> - Discussion on the judicious use of water. <p>For example: Do not cut trees!!it decreases rain-fall and fertility of soil etc. and increases temperature</p> <p>For Example: Discusses on plantation of eucalyptus trees which absorb surplus waste water</p>	<p>For Example: Discusses the harmful effects of agrochemicals in agriculture. Discusses on precautions to be taken while using LPG Discusses on how to use fire extinguishers Steps taken to adopt for conservation of energy. Discusses about the switching off the engine at traffic lights or at a place where one has to wait.</p>
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