Chapter 5. Practical work & experiments

1. Importance of inquiry in science education. How to answer a scientific question?

Science is concerned with the development of knowledge and understanding of the biological, chemical and physical aspects of the world. Scientific activity is the process to develop such knowledge and understanding. Science is a human endeavour that depends on the creativity and imagination of people as they reflect critically to make sense of their experience. For children, as well as for scientists, science involves imagining, testing, changing or confirming ideas about things and how they work. Scientific theories are used to explain observed phenomena or to predict events. These ideas and theories are subject to review and change and will be modified as new evidence comes to hand.

Scientific method

What distinguishes a scientific activity from other forms of enquiry is the process to develop these ideas. A scientific approach involves a sequence of processes such as: making observations, hypothesising, predicting, planning tests, analysing the results and arrive at conclusions.

The first-hand investigation is a crucial element in how young children learn science. Activities in science will involve the pupils in exploring, planning, making and evaluating objects that have a practical purpose. They can provide their answers to problems, and they can learn from their interaction with things around them.

2. Problem solution activities and experimental assumptions.

Children will learn to investigate the world around them through processes such as defining hypothesis observing, predicting, experimenting, analysing, testing, concluding… These

processes belong to the procedural content (or scientific skills) of the science curriculum. We apply them when we are working scientifically.

What do we assume as the meaning of these skills in our students?

Observing

Observing, using all the senses separately or in combination, is a fundamental skill in science. It requires focusing the attention on objects or events in our environment, where materials and living things are identified, described and classified into different categories.

At all class levels children will be asked to compare and describe similarities and differences between objects, such as their shape, size, colour, pattern and texture. They should develop safe observational techniques and made observations by using all the senses, not only the sight but also tasting, smelling or touching. However, observing activities requires several of the other skills, such as classifying and communicating.

Classifying

Classifying involves children in sorting what they have observed according to one or more characteristics. The youngest children will recognise properties such as colour, shape and size and will be able to sort similar objects based on one property. Children will determine their criteria for sorting and will be able to explain them. As they are progressing, children will group objects into sets and sub-sets.

Recognising patterns

The ability to see patterns in objects and processes depends on the capacity to perceive links, to detect similarities and differences, and to recognise sequences. Detecting patterns involves the pupil in linking observations with ideas and possible explanations.

Examples: In (6-9) classes children may associate falling leaves in autumn with a decrease in temperature. In (10-12) classes children will suggest explanations and make generalisations, as, for instance, relating overweight to a sedentary lifestyle and eating habits.

Estimating and measuring

Estimating and measuring are basic skills used to obtain information during observations. The emphasis is on using appropriate ways of measuring that are suitable to the children's stage of development and the activity.

In the (6-9) classes children will compare objects and describe them as large or small, heavy or light. They will examine a range of objects and arrange them in order, for example from

the smallest to the largest. They will begin to use standard units of measurement to measure length, area, time, temperature and weight. In the (10-12) classes, as the activities increase in complexity, the need for more accurate measurement will be necessary. Children will use a range of measuring instruments (ruler, balances and thermometers) and will recognise the need to measure and repeat measurements during an investigation.

Questioning

Asking questions is an essential part of exploring and performing experiments. It is also a way of linking previous knowledge to new experiences. Children have to learn to formulate questions in a way that becomes the starting point of designing an experiment to find an answer.

Formulating hypotheses

A hypothesis is an idea or explanation, that can be tested. It is a supposition, based on prior experience and knowledge. Posing questions about problems encourages children to attempt to formulate hypotheses. These hypotheses or tentative explanations become the basis for further investigation. During their experimental activities, children can gain awareness of the need to revise or reject their hypotheses in light of new evidence.

Predicting

Pupils make predictions to forecast what might happen in certain circumstances. Patterns identified in observations or experimental activities can form the basis for a prediction. The teacher should prompt these predictions.

3. Experimental design activities.

Investigating is the systematic search for evidence that tests an idea or hypothesis. For children, investigating and experimenting will involve them in planning and conducting fair tests to check their predictions.

A fair investigation will involve children in processes as:

a) Identify the problem to be investigated: for example: Which shoes have the best grip?

b) Identify variables: which variables will change and measure or compare. It will be important that children realise that they must change or vary only one condition or variable at a time.

c) Select appropriate equipment and materials for an investigation

d) Order of various steps of the investigation

e) Select the most appropriate methods of recording

f) Analyse the results of the investigation; pupils will refer to the original problem and plan any further experimental work.

Finally, pupils record the results of the experiment systematically and state the conclusions-.

Identifying variables in designing a fair test

In carrying out appropriate tests, pupils should be encouraged to ask:

a) What will be changed? (Identify the variable that they will change)

b) What will be kept the same? (Identify the variables that will be controlled or held constant).

c) What will be measured or compared? (the variable that will be measured or judged) Example:

Designing a fair test where the most absorbent kitchen towel, children will involve in identifying: a) the variable that will be changed and b) the variables that will be controlled or kept the same.

What will be changed? The type of kitchen towel tested

What will be kept the same? The amount of water dropped onto each towel; the size of towel tested, and the amount of time given to measure the water absorbed

What will be measured or compared? The volume/amount of water that was absorbed by each of the towels.

Recording and communicating

Children will record and communicate their observations and the results of their practical work through a variety of media, for example, drawings, collage, written and oral reports, and using information and communication technologies. They also need opportunities to report to others how they plan their investigations, how they control or change variables, the observations and measurements made, and the results of their investigations. Through this process, they may refine their thoughts and identify new problems to investigate.

4. Experimental resources.

The provision of a range of resources will be necessary to enable children to undertake experimental activities in science. Some science topics will require consumable materials such as sand, sugar, salt or dried foods. Other topics will require to collect items of domestic

reclaimable waste, for example, plastic bottles, jars, tins, lids, thread spools, and yoghurt pots.

The table below proposes examples of units and resources materials required in their experimental activities. Some are everyday materials, but others will only be obtained from specialist science suppliers.

Examples of Units and Resources required
Unit: Myself-Human life. Resources: mirrors (plastic); meter sticks, height chart, thermometer, measuring tape, bathroom scales
Unit: Animals and plants. Resources: flower pot, insect cages, aquarium tank, old spoons, sheets of plastic, watering can, plastic tubing, magnifying glass, microscope, binoculars, bird table.
Unit: Magnetism and electricity. Resources: magnets, bulbs and appropriate batteries, iron filings, clips, needles, wires, a range of magnetic materials, electric motor, a selection of metals, wire stripping pliers, steel wool, screwdrivers
Unit: Light. Resources: torches, curved mirrors, plane mirrors, triangular prism, shiny objects that will act as mirrors: spoons, biscuit tin lid, sheet metal, transparent, translucent and opaque materials, colour filters
Unit: Heat. Resources: thermometers, candles, objects made of different materials.
Unit: Sound. Resources: tuning forks, rubber bands (different sizes and thicknesses), guitar strings
Unit: Forces. Resources: wheeled toys, inclined plane, sandpaper, springs, weights, marbles, balls, timers, stop clocks and watches, balloons, plastic syringes, pulleys
Unit: Materials. Resources: funnels, polystyrene sheets, blocks, balls and beads, sieves, plastic, various meshes, samples of different fabrics, food colorings, samples of soaps and detergents, dyestuffs, materials from the kitchen or bathroom (sugar, salt, soda, chalk, oil, soda water, lime water, tea, coffee, bath salts, flour), samples of different metals, pebbles, stones, bricks and rocks, samples of different woods and wood products, samples of different types of paper (blotting paper, tissue paper, paper towels, waxed paper, greaseproof paper, newsprint, corks.