Lecture Notes on Methodology.

Unit I. Teaching Science.

Teaching of Science.

( Source book – First Year D.T.Ed. ).

District Institute of Education and Training.
Lawspet, Puducherry – 605008.
What is Science?

Science has been defined as a body of knowledge obtained by scientists. The body of knowledge includes facts, concepts, theories and laws that are subjected to rigorous testing. Scientific information is constantly modified, rearrange and reoriented in the light of recent developments.
Science: Definition.

The word `Science` is derived from the Latin word termed as “Scientia” which has the meaning `to Know`.

Science can be defined in a number of ways. A few definitions are given below.

Science is concerned with understanding the properties of external world of nature.
Science is a body of knowledge and a method of obtaining it for wider usage.
Science reveals that knowledge is tentative and constantly changing.
Scientific ideas are the result of experimentation and observation by scientists.
Scientific ideas are subject to modification in the light of further empirical observation.
Scientific Methods have given trustworthy science through the experimental learning.
Science is both a product and a process

Important Characteristics of Science.

From the definitions and we can summarize the important characteristics of Science.

1. Science helps us to understand our environment.
2. Science is nothing but truth.
4. Science reveals that knowledge is tentative and changing.
6. Science is not only classified knowledge but also a method of acquiring it.

Hence the Science is both a product and a process.

The importance of science can be realized from the way scientific knowledge has expanded and the impact that it has made in our daily life. The science has widely spread its dynasty all areas. With the advent of science in improving the comforts and welfare of the people, the study of science acquires lot or importance.

Teacher-Student can summarize the ideas and concepts regarding the contribution of science and technology towards the Mankind.
The relationship / interaction between the Science and Technology with mankind.

Teaching Science: – importance and values

Teaching Science is an important for every teacher also it has its own influence over the personal life of an individual as well as his / her social life. From the Ancient days the Science and teaching and learning science subjects have been an integral part of the human society. The teaching Science is felt important for the following reasons:

- The science helps an individual to be a self seeker of knowledge and develop curiosity.
- It satisfies the inquisitiveness of an individual and helps to discipline his character.
- It is only Science that reveals the use of the natural phenomena.
- The study of science helps us to understand the most modern gadgets and its proper usage.
- The impact of science in our civilization and modernization can be appreciated only by studying Science.
Teaching Science: importance.

The curriculum renewed in the light of NCF 2005, aims at the preparation of committed teachers whose professionalism would enable them to sustain their learning interest through out their career. The present curriculum has a paradigm shift from the teacher to the learner and from the focus on teaching methods to ways and means of facilitating and enhancing learning by children.

Based on the recommendations of NCF 2005, the teaching science has been anticipated to achieve the following objectives.

✓ The scientific principles and methods learnt shall have the links with everyday life.
✓ The scientific approach shall be applied to everyday life.
✓ Create and investigate the new phenomenon for a developing society.
✓ The environment awareness is insisted.
✓ The experiments and projects must have its own place in the curriculum and teaching.

The following values or benefits of studying science are observed in the following domains.

- Intellectual value
- Vocational value
- Aesthetic value
- Utilitarian value
- Moral value
- Psychological value

Objectives of teaching science in Primary Education:

Each and every child shall:
- Have the creativity in learning science
- Acquire the interest in learning science
- Have the awareness of the environment
- Analyse and investigate their activities rationally.
- Develop the scientific aptitude and attitude.
- Do individually simple science experiments.
- Actively engage themselves in Project works.
- Collect data from various sources in the given context.
- Have the ability of decision making and problem solving.
- Classify the data in an organized pattern and confirm the results.

<table>
<thead>
<tr>
<th>Objectives of teaching science in elementary schools:</th>
</tr>
</thead>
<tbody>
<tr>
<td>To create interest in science.</td>
</tr>
<tr>
<td>To help the children in healthy living.</td>
</tr>
<tr>
<td>To observe carefully objects and events in the nearby environment.</td>
</tr>
<tr>
<td>To analyse and investigate the natural objects and specimens.</td>
</tr>
<tr>
<td>To collect all sorts of objects in the environment, and classify them to draw inference.</td>
</tr>
<tr>
<td>To be curious to know about natural objects and appreciate them.</td>
</tr>
</tbody>
</table>
Classification of Objectives of Teaching:

Aim is the ultimate object or action or result to be achieved by the person. It is a broader concept. But the Objective is the trend or roles to be forwarded or implemented to achieve the aim desired.

Objectives are classified in to types, viz: General objectives and Special objectives.

Objectives in Teaching Science

Although the objectives of teaching science are stated in different ways, the objectives formulated by Benjamin Bloom are considered important are as follows:

- Cognitive domain
- Affective domain
- Psychomotor domain

<table>
<thead>
<tr>
<th>Cognitive domain</th>
<th>Affective domain</th>
<th>Psychomotor domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifying and remembering the objects.</td>
<td>Appreciating the objects and events observed</td>
<td>Skills in arranging things</td>
</tr>
<tr>
<td>Developing skills for behavioural changes.</td>
<td>Interests and Attitude changes.</td>
<td>Handling the objects.</td>
</tr>
<tr>
<td>State the reason and relationship.</td>
<td>Behaviour changes relates with values</td>
<td>Manipulative skills.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Skills in drawing.</td>
</tr>
</tbody>
</table>
Interaction between the three types of skills in learning science

Example: 1
Teaching / learning the features of living and non-living things.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive domain</td>
<td>Identification of things given and recalling the similar experiences. Formulating the concept.</td>
</tr>
<tr>
<td>Affective domain</td>
<td>Observing the activities of the given things.</td>
</tr>
<tr>
<td>Psychomotor domain</td>
<td>Differentiating the animals and plant.</td>
</tr>
</tbody>
</table>

Example: 2
Teaching / learning the separation of iron dust from the rice.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive domain</td>
<td>Selection of appropriate experiment (Knowledge)</td>
</tr>
<tr>
<td>Affective domain</td>
<td>Observing and arriving the results from the experiment.</td>
</tr>
<tr>
<td>Psychomotor domain</td>
<td>Setting up or conduct of the experiment proposed.</td>
</tr>
</tbody>
</table>
Cognitive domain

Bloom classified the cognitive domain into three types as follows;

1. Factual knowledge,
2. Conceptual Knowledge and
3. Procedural Knowledge.

The skills to be developed among the learners in the Cognitive domain are classified further into 6 divisions. They are.

- 1] Acquiring the Knowledge
- 2] Comprehending the knowledge
- 3] Application of knowledge and earlier experiences
- 4] Analysis
- 5] Synthesis

Pyramid of skills development in Cognitive domain

(Imaginary diagram of a pyramid with levels from bottom to top: Knowledge, Comprehension/Understanding, Application, Analysis, Synthesis, Evaluation.)
Anderson and Rathhole proposed the Metacognition as an additional type of Cognitive domain proposed by Bloom. The restructured general objectives of metacognition are as follows:

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>It is a basic component of Cognitive domain. It just recalls or remembers the earlier experiences. The names, dates, objects, incidents etc. can be remembered with through knowledge.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding</td>
<td>Comprehends the knowledge of the object observed or the action performed or to be performed. It generally explains or illustrates the principles and laws related to science. Only with the understanding further conceptualization is possible.</td>
</tr>
<tr>
<td>Application</td>
<td>Applies the knowledge acquired and make decisions for problem solving.</td>
</tr>
<tr>
<td>Analysis</td>
<td>This relates or distinguishes the information from the news, objects, activities etc.for the process of Problem solving or decision making.</td>
</tr>
<tr>
<td>Synthesis</td>
<td>Assemblage of the parts or information derived and formulates the new projects and schemes or concepts.</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Feedback of the properties of objects, activities, solutions, methods etc.,</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>General Objectives</th>
<th>Activities concerned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remembering</td>
<td>Define, list out, recall, give an account of</td>
</tr>
<tr>
<td>Understanding</td>
<td>Compare, distinguish, note briefly, guess</td>
</tr>
<tr>
<td>Application</td>
<td>Make models, discuss,</td>
</tr>
<tr>
<td>Analysis</td>
<td>Differentiate, arrange, classify, illustrate with examples</td>
</tr>
<tr>
<td>Evaluating</td>
<td>Experiment, evaluate, test,</td>
</tr>
<tr>
<td>Creating</td>
<td>Plan, modify, formulate, derive</td>
</tr>
</tbody>
</table>
Example:

"Find out the amount of vitamin contents in the food supplied to a person in his / her family environment"

If the general explanation of Vitamins and their availability and list out the functions are given for activities proposed in teaching the learners have received the data only. Such like activities force the learner to memorize the data and remembering skills only. With the activities proposed above the following activities can be done individually or in group activity.

- By providing the diagrams and ask the children to classify the food constituents based on vitamins.
- By providing actual objects / specimens or models or diagram the learner should classify according to the specific vitamin.
- Learner is asked to list out their daily food and it s nutritious values.
- To prepare a diet table of a family ( usually the learner’s) describing the amount of food intake and its nutritious value. Identify the vitamins in their food and amount of vitamin consumption by a particular person in the family.

Such activities may enhance the learnability and positive feed back of the subject taught.

The following table gives the general objectives and the appropriate action verbs that would clearly indicate the behavioural objectives.

<table>
<thead>
<tr>
<th>General Objectives</th>
<th>Action verbs that would explicitly indicate the behavioural objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>1. State the laws, define concepts</td>
</tr>
<tr>
<td></td>
<td>2. List the details</td>
</tr>
<tr>
<td></td>
<td>3. Name the objects</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding</td>
<td>1. distinguish</td>
</tr>
<tr>
<td></td>
<td>2. give examples</td>
</tr>
<tr>
<td></td>
<td>3. explain</td>
</tr>
<tr>
<td></td>
<td>4. compare and contrast</td>
</tr>
<tr>
<td></td>
<td>5. state the relationship</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Application</td>
<td>1. state the reason</td>
</tr>
<tr>
<td></td>
<td>2. solve problems</td>
</tr>
<tr>
<td></td>
<td>3. apply the scientific principles in daily life</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Acquisition of skills</td>
<td>1. Set up experiment, using appropriate science apparatus</td>
</tr>
<tr>
<td></td>
<td>2. observe carefully and note down data</td>
</tr>
<tr>
<td></td>
<td>3. Fabricate the apparatus for the experiment</td>
</tr>
<tr>
<td></td>
<td>4. Measure accurately during experiments</td>
</tr>
<tr>
<td></td>
<td>5. Draws diagrams for explaining scientific principles</td>
</tr>
<tr>
<td></td>
<td>6. Collects scientific objects</td>
</tr>
<tr>
<td></td>
<td>7. Point out the different stages of development of objects</td>
</tr>
<tr>
<td></td>
<td>8. Classify scientific objects and display them</td>
</tr>
<tr>
<td></td>
<td>9. Dissect biological specimens</td>
</tr>
</tbody>
</table>
Affective domain:

This is concerned with the development of emotions and feeling among students. The following are the objectives in this domain. In teaching science, children have to develop

1. Appreciation
2. Interest
3. Attitudes
4. Value system and
5. Character formation

Usually these are long term objectives. The behavioural changes in this domain are not explicitly evaluated. A continuous effort in teaching and the follow up activities alone can change or modify the behavioural changes. The moral values can be inculcated in this domain. Example: Disposal of degradable and non-degradable wastes in its appropriate places

The stages of Affective domain.

The kernel of this teaching objective is to make the learner to manage the wastes in a proper way. It is very difficult to illustrate the solid wastes management, the oral instructions and the lectures make tired of the learner also arouse no interest towards the topic dealt. The illustration through the drama or puppets make effective. The good characters and the goodwill will be appreciated in these will give a positive effect.
Appreciating the activities of sincere learner enhances the motivation of teaching objective. The learners themselves trained to classify the wastes as degradable and non-degradable. The activities assigned (The degradable wastes must be kept in green colored bin and the non-degradable wastes to be placed in red colored bin) to the learners need be followed and appreciated. The proper appreciation makes the learner to achieve the long term goal or objective. The appreciation can be done among the other children motivates them to continue their activity.
Psychomotor domain

The purpose of this psychomotor domain is to develop the mind and muscular skills.

The following are the objectives:

1. Skill in arranging experiments
2. Skill is arriving at accurate results
3. Skill in drawing the sketches and diagrams
4. Manipulative skills

The above stated objectives are called general objectives. The attainment of these general objectives can be observed and measured only when they are stated in the form of behavioural objectives. Before teaching any lesson to the students, it is absolutely necessary to state clearly the learning outcomes in terms of general objectives and behavioural objectives.

Benjamin Bloom had not given much attention and gave little explanation to this Psychomotor domain. The Psychomotor domain is explained and classified its objectives by Harey (1972) as follows:

1. Perception
2. Imitation
3. Manipulation
4. Precision
5. Articulation
6. Naturalization

The creativity of child is developed by the behavioural changes of psychomotor domain. The keen observation and the active participation only develop the creativity. The teacher should demonstrate and give the hands on experience while learning science. The projects and experiments develop the creativity of the children. The activity based learning is also an one of the method allows the behavioural changes among the children and fulfill the main objectives of teaching Science.
Example:

The demonstration of the experiments related to transformation of energy.

1. Teacher demonstrates the concept through simple experiments: making models for wind energy. Mechanical energy to Electrical energy etc.

2. Giving low cost materials to build fan, anemometer, wind mill etc., and demonstrating them for children.
The main objective of Teaching Science is to bring about desirable changes in the behaviour of pupils and develop the scientific attitude. This is possible only when the teacher is having adequate knowledge in Science and its teaching methods. The student teachers need to be aware of different teaching methods in a detailed way in the science subjects. If the teacher selects and uses an appropriate teaching method according to his/her attitude and environment, in accordance with the age and ability of the pupils, teaching-learning process will be an excellent one.

Guidelines for the Selection of appropriate Teaching method.

- A Teacher must choose the teaching method that
  - should satisfy the teaching objectives.
  - can be able to handle in the current classroom conditions
  - should made an impact in the behavioural changes of students.
  - should be flexible with the quality and ability of the learners.
  - should use the local resources (from the class room, school and nearby locality)
  - should be appropriate with the present socio-economic conditions.
  - should reflect the actual needs of the learners in the teaching-learning process.

Classification of Methods of Teaching Science

In the purview of Teaching – Learning environment the Teaching methods can be classified on the basis of learners’ orientation as follows.

- Teacher centred approach
- Learner centred approach.
Teacher centred methods:

In this Teacher centred methods of teaching, the learners receive a lot of information from their teachers. An active participation by the learners in the Teaching and Learning process is minimized. Teachers’ role is monopolized. This is a subjective method. Only a resourceful teacher can make it effective and benefit for their learners. This is useful for the learners who need information and instructions from their higher authorities. The historical data and contemporary notes on scientific information can be delivered easily with these methods.

Example:
1. Lecture method
2. Lecture cum demonstration method
3. Team teaching.

Lecture method

Lecture method is generally not suitable for the lower classes. But, this is the method most liked by teachers. Thinking and observation which result from science teaching do not get developed. This method can be made interesting to students by the eminent lecturers through their knowledge, style of presentation of information and presence of mind with sense of humour.
Merits of Lecture method:

- Teacher oriented method find useful to narrate the subject knowledge through the stories for lower classes.
- Vast data and information can be delivered to the learners in a short period of time.
- This method can handle a large population of learners.
- Teacher can correlate his / her experiences with the subject they taught.
- Current and Latest information can be provided by the teacher.
- Only a good orator or teacher with pleasing attitudes can do well in lecturing.
- Teaching and Learning Materials expenditures are minimized (almost nil).

Limitations of Lecture method:

- Learners’ feedback is ignored.
- It is not advisable for lower classes.
- The learners’ participation is very low.
- Learners got data only from their teachers.
- Creativity and manipulating skills are not developed.
- Lazy and inefficient teacher spoils the entire teaching and learning process.
- There will be no provision to maintain the attention of learners in learning process.
- Teachers have to spend a lot of energy and time in teaching and collection information.

Lecture cum Demonstration method:

This method has both the benefits of lecture and demonstration methods. In this method, teacher gives the explanation regarding the experiment and performs the experiment. If teacher plans these methods well, that would be one of the best methods of teaching science.

Team teaching:

In this method, 3 to 5 teachers join as a group and teach a particular portion of the subject in different teaching methods. This method helps the teacher to come out best in their competencies. They jointly plan, teach and evaluate the learners’ requirement and activities.
Learner centred methods:

This method enhances the learning skills and achieves the most of teaching objectives. The learner centre methods include collection, handling, classification, analysis Observation, and experimentation, evaluation of objects, data and information. The students are trained or exposed to the various methods and approaches of this learner centred teaching through the teacher. This method gives no burden to learners and exchanges the activities related to the teaching and learning process in Science subjects.

Examples:
1. Learning by doing (Activity Based Learning method)
2. Project method
3. Observation & Experiments.
4. Discussion
5. Field trips
6. Inductive method.
7. Deductive method
8. Assignments
9. Play way method
10. Seminars.
Merits of Learning centred method of teaching.

★ The curiosity of children at primary schools leads to the motivation of learning and skill oriented activities.
★ There will be ample opportunities to learn beyond the school texts.
★ Relates the off campus experience with the school lessons.
★ Collection and analysis data by children makes their knowledge wider.
★ This makes retention of concepts in mind for long time.
★ Decision making skill can be developed.
★ Problem solving skills also developed among the learners.
★ Attention deficiency disorders become low.
★ Activity based learning develops the manipulating skills of children.
★ Children can learn with its ability.
★ Science teaching becomes easier and effective.
★ Teachers' time, resources and energy is saved.
★ Group activities develop the social values.
★ Team work, cooperative venture can be understood by the students.
★ Makes the children self reliant and self confident.

Limitations:

- Costlier in terms of money and time.
- The equal opportunity for every child in collection of resources, data and information is hardly available.
- Teacher should have a sound knowledge in their subject and have special skills.
- Abstract concepts must be explained by the teachers.
- Collecting the relevant data and observing them closely and formulating appropriate hypothesis is not a simple task. Sometimes teachers also facing the difficulty when arriving an appropriate hypothesis.
- Learners need more resources, guidance and time to learn the science subjects or concepts.

Learning becomes best and vivid, depending upon the teaching method, the teacher selects. Teachers should become aware of various science teaching methods to improve their professional skills. Teachers can select his / her teaching methods, according to the learning environment and teaching objectives.
Sample Questions:

- Define Science.
- Write the characteristics of Science.
- Why Science is important?
- Mention the values of Science.
- What are the objectives of teaching science in primary schools.
- Mention the classification of teaching objectives.
- Write the classification of Cognitive domain.
- What is metacognition?
- What is called affective domain?
- Write the classification of affective domain.
- What are the objectives of Psychomotor domain proposed by Harey?
- What are the guidelines to choose appropriate method teaching science?
- List out the methods proposed for Learner centred teaching methods in science.
- Write down the limitations of lecture method.
- What are the merits of Project method.
- Is there any limitations for learner centred teaching? If yes, Discuss.
- What is called lecture cum demonstration method?
- What is Team teaching?
- Write down the merits of learner centred teaching.