UNIT 2 APPROACHES AND METHODS OF TEACHING SCIENCE

Structure

2.1 INTRODUCTION

In Unit 1, you have learned about 'Nature of Science', 'Objectives of Teaching Science' and 'Science Curriculum'.

Nature of Science: What is Science, and why should we teach science? We live in a scientific and technological age, and no citizen can survive in a developed society without basic scientific literacy and certain elementary skills. We depend upon scientific knowledge and understanding for economic and material advancement. Science is fundamentally concerned with exploring and interpreting the physical worked through three fundamental areas of Physics, Chemistry and Biology. One has to be trained to use it. This training comes from teaching. Which helps in developing power of thinking and reasoning, curiosity, open-mindness, and ultimately to develop scientific temper.

Objective of Teaching Science: There are many objectives for teaching of science. According to NPE-1986, science education should be strengthened so as to develop in the child, well defined abilities and values such as the spirit of enquiry creativity, objectivity, the courage to question, and aesthetic sensibilities. Science education programmes will be designed to enable to learner to acquire problem solving and decision-making skills and to discover the relationship of science with health, agriculture, industry and other aspects of daily life. Every effort will be made to extend science education to the vast numbers who have remained outside the preview of formal education.

Science Curriculum: Science has two basic components, viz. content and processes. In Science texts, you can very easily find out, 'What is content?' and 'What are processes?'. 'Law, Theories, Principles, Hypotheses. Equations and concepts can be categorized, as *content.* Skills such as 'Observing, Classifying, Using numbers, Measuring, Using space- time relationships, Communicating, Predicting, Inferring, Defining operationally, Formulating hypotheses, Communicating, Predicting, Inferring, Defining operationally, Formulating hypotheses, Interpreting date, Controlling variables and Experimenting' comprise *processes.*

Teaching a particular content and process has to be compatible with the 'Nature and Objective of Science' with the cognitive level of child and existing classroom conditions. In this unit, we will discuss various Approaches/Methods of teaching science which helps in matching the objectives and cognitive level of child. You must have frequently come across the terms, 'Approach' and 'Method', they are not same but have a fine line of difference between them.

An approach may be explained as a comprehensive way of dealing with a particular problem. It is a general plan of action, on the basis of which, various methods and models have evolved. However, a method is an orderly and logical arrangement of ideas based on a particular approach. It is a procedural illustration of systematic and clearly defined steps of accomplishing particular objectives. An approach, hence can be called as a premise or precursor on which a method is designed.

There are a variety of approaches and methods for teaching science. We will discuss the following:

— Enquiry Approach

— Problem Solving Approach

— Lecture-Cum-Demonstration Method

— Laboratory Method

— Scientific Method, and

— Project Method

2.2 OBJECTIVES

After completing this unit, the trainees will be able to:

- describe and use the various approaches/methods of teaching Science,
- elaborate the advantages and disadvantages of each approach/method,
- identify when to use a certain approach/method, with reasons,
- differentiate various approaches/methods from one another.

2.3 ENQUIRY APPROACH

If you want to develop in the child the spirit of enquiry, use 'Enquiry Approach' while teaching science. Enquiry Approach begins with a puzzling event like 'blowing out of an electric bulb in the class'. Children enquire when there are explanations to be given/ obtained. After the puzzling event (problem) is presented to the children, they may ask the teacher (you) some questions. You should not give the children the readymade answers. Let them enquire. You may answer the children's question with a 'yes' or 'no'. Each question may be in the form of a small hypotheses. Such teacher-student interaction may continue till the children begin to formulate hypotheses about what happened in the puzzling event. Then, the children verify these hypotheses after searching through reference material, and doing little experiments.

2.3.1 How to Use this Approach?

Select a topic, say 'construction of an electric bulb'. Think of some event regarding the topic, which may puzzle the children, like 'blowing up the electric bulb'. Children will enquire when they get puzzled, and will ask you some question. Answer the childrens' question in 'Yes' or 'No'. Continue this interaction between you and the children till the children begin to formulate hypotheses about what happened when the electric bulb blew up. Encourage and motivate children to verify their hypotheses. Let them search through some reference material and let them do little experiments.

2.3.2 Some Examples

One day an electric bulb blew out in the class. "What happened?" Asked the children. The teacher took out the bulb from the bulb holder and showed it to the children. The children gathered around the teacher. The teacher passed the bulb around the children, and said, "Look at it any try to develop a hypotheses about what happened?", "What is inside the bulb?", asked one of the child. "I do not know". Said the teacher. "Is there air inside the bulb?", asked another child "No", said the teacher. "Is there any other gas inside the bulb?", asked another child. 'No', said the teacher. The children were puzzled, and they started looking at one another finally one child asked, "Is it a vacuum inside the bulb". "Yes", said the teacher. "Is it complete vacuum?", one child enquired. "Almost", replied the teacher. "Is that little wire make of some metal?", asked one child "Yes", the teacher said.

Such interaction of "Yes", "No" continued between teacher and child, (teacher learner interaction), till the children identified the materials inside the electric bulb (vacuum, metallic filament) and the event (blowing of bulb burns/breaks the filament).

Finally, children begin to formulate hypotheses about what had happened. After the children come up with some hypotheses, they start searching through 'reference books', 'doing little experiments', 'collecting and interpreting data (observation) from experiments', in order to verify these hypotheses.

2.3.3 When to Use this Approach and Why?

If you want to develop spirit of enquiry in children, use enquiry approach of teaching science, as children will find out themselves by enquiry instead of getting readymade information from the teacher

2.3.4 Advantages and Disadvantages

Advantages

— Children are proactive and work under the guidance of their teacher.

— They learn to formulate hypotheses, and also to verify the hypotheses.

— They are trained to learn on their own.

Disadvantages

— This method is slow and time consuming.

— Not suitable for the children of all age groups.

— Require practice for teachers to teach science by this approach.

Check Your Progress

Notes: a) Write your answers in the space given below.
b) Compare your answers with those given at the end of the unit.

1) Write two components of Science Curriculum.

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2) Name any five effective transactional ways of Science at elementary stage.

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3) Write four advantages of teaching of Science by enquiry approach.

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4) Enlist three disadvantages of enquiry approach.

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2.4 PROBLEM SOLVING APPROACH

Problem Solving Approach for teaching science is a technique which provides children an opportunity to solve scientific problems quite independently or through guided approach by following systematic steps. When you want use this approach to teach a science topic, you will have start your lesson with a problem. The children then, will think of some possible solutions of the problem (hypotheses) based on their previous knowledge. To test this hypotheses, children are engaged in self study, mutual discussion (learner- learner interaction, and teacher-learner interaction), and practical work. They test their hypotheses one by one, and finally they are able to find out the best possible solution for the problem i.e. conclusion.

Steps in Problem Solving Approach

1. ***Problem***

   a) Identification of the problem.

   b) Statement of the problem — clear description.

   c) Explanation of the problem — by discussing it with fellow students (learner-learner interaction), so that they co understand the nature of problem.

   d) Delimitation of the problem — concentrating on only those parts of the problem which are within the reach of students.

2. ***Hypotheses:*** Formulating hypotheses for investigation.

3. ***Experiment:*** Testing the hypotheses.

4. ***Conclusion:*** Inferring which hypotheses is the best solution of the problem.

2.4.1 How to Use this Approach?

Select a topic, say 'condensation'. Do not tell the children, what condensation is? Take a glass tumbler. Wipe outer and inner surfaces with a dry and clean piece of cloth. Now, fill the glass tumbler with ice cubes. Wait for some time, till some water droplets are visible on the outer surface of the glass. Ask the children, from where does these water droplets have come. This is the problem. The children will come out with different hypotheses like: -

1. A glass tumbler may have small pores as in some earthen vessels like surahi or gharha. The water has come out through these pores.

2. Water has spilt out from the top of glass tumbler.

3. Air has water vapour. When this vapour touches the cold glass surface, it becomes cool and changes into water droplets.

Then, children may do experiments to test which hypotheses is right. For Eg. heat water in a kettle, till it boils, and steam starts coming out. Bring the glass tumbler close to the steam. When the steam strikes the outer cold surface of the glass tumbler, becomes cool and changes into water.

With the help of this experiment, children will find hypotheses is correct, and will conclude that water vapours on cooling, condense, and change into water drops.

2.4.2 When to Use this Approach and Why?

When you want to develop problem solving skill in your children, use this approach while teaching science. This will enable the children to find out themselves what you could give

them as readymade information. This is helps to develop independent thinking amongst the children.

Caution: Be careful while giving a problem. A problem is not if a child can solve it by his previous knowledge.

2.4.3 Advantages and Disadvantages

Advantages

1. Students do their own learning under the guidance of their teacher.
2. They learn to propose and structure problems.
3. They learn to collect varied pieces of information relevant to the problem from different sources.
4. They learn to formulate hypotheses.
5. They learn to test the hypotheses, and collect the evidence to prove or disprove the identified hypotheses.
6. They learn to solve problems of their everyday life.
7. They are very closely familiar with various objects and phenomena around them, their applications and relationships instead of having mere knowledge.
8. They establish a healthy and favorable relationship with their teachers and peers, and
9. They develop scientific attitude and scientific temper.

Disadvantages

1. This approach is very slow, long and time consuming. Therefore, if we always use this approach, we cannot complete the syllabus.
2. There is too much emphasis on practical work which may give a wrong concept of the nature and philosophy of science in general. Learning science is a joyful process but too much practical work make it dull and routine type of affair.
3. Most of the teachers are perhaps not able to teach by this approach, as they have not experienced practical teaching of science by this approach.
4. Not suitable for learning for all age groups.

2.4.4 How it Differs from the Enquiry Approach?

In both the approaches, the lesson begins with a problem. But both differs in terms of who poses the problem. In Problem Solving Approach, the teacher poses a problem to the children, while in Enquiry Approach, children pose question, which takes form of a problem. Secondly, in Problem Solving approach, children formulate their hypotheses on their own but in Problem Solving approach, the answers from the teachers form a hypothesis. Thirdly, in enquiry Approach children verify these hypotheses after searching through reference material, and doing little experiments. While in Problem Solving Approach, children test these hypotheses experimentally and draw some conclusions.

Check Your Progress

Notes: a) Write your answers in the space given below.
b) Compare your answers with those given at the end of the unit.

5) What is problem solving approach?

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6) What are the steps of problem solving method?

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7) What caution should be taken while using this method? (Any two.)

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8) Write two advantages and disadvantages of this method over other methods?

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2.4.5 Teacher Centred Approach and Child Centred Approach

Teacher Centred Approach (TCA)

Studies on classroom dynamics revealed that on an average 95% of the time, the teacher speaks and 5% of the time, the children are given a chance to speak. Where the children either are given no opportunity to speak or have a very little opportunity to ask questions or interact. This is Teacher Centred Approach of teaching. Lecture Method and Lecture-Demonstration Methods are the examples of Teacher Centred Approaches to Teaching. This is a very effective approach for teaching skills, such as reading a Thermometer, reading a spring balance, preparing gases like hydrogen and carbon-dioxide, salt analysis, volumetric and graviometric exercise, setting up a microscope, making a slide and seeing it through a microscope, setting the experiment for photo synthesis etc.All these skills can be developed through teacher centered approach. Teachers tell children "what to do" and "how to do". Until they learn. Cooking, sewing, driving a scooter, motor cycle, car, repairing things; playing musical instruments; dancing etc. are some other examples of skills of daily life. For them, we need Teacher Centred Approach.

Example

Reading a thermometer is a skill. According to a study, children and even teachers who have not been taught this skill by Teacher Centred Approach, generally read the thermometer wrong. If the reading is 35°C, they read 30.5°C. Then, comes the teacher to teach this skill. He points at 30 and asks "What is the reading?" The child says "30°C". Then he points it 40 and asks "What is the reading?" The Child says "40°C", then the teacher asks "How many marks are there between 30°C and 40°C?" When the child fails to answer, the teacher himself counts 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. The teacher asks "How much is one marks"? Now the child replies "1°C". (This is actually the least count of the thermometer which the child does not know, and therefore he reads 30.5°C instead of 35° C). Now the teacher asks "How many marks is the mercury above 30.5°?" And the child counts "1, 2, 3, 4, 5". Then the teacher asks "Now tell, what is the reading of thermometer?" and the child counts again "31, 32, 33, 34, 35, and they say "Thermometer reads 35° and not 30.5° C".

Now, as you must have understood how a teacher can use this technique to learn a fundamental skills to the child.

Child Centred Approach (CCA)

Some innovative teachers themselves speak less in the class, and give opportunity to their children to speak and do more. Here, child is a center of all activities in classroom. So, this approach is called the Child Centred Approach. While teaching science by Lecture Method or Lecture-Demonstration-Method, these innovative teachers involve their children in interaction through question-answer sessions that even their lecture and Lecture-Demonstration, becomes child centred. Enquiry approach, Problems solving approach, Laboratory method, Scientific method and Project method are the examples of Child Centred Approaches.

Example

If a teacher is teaching the concept "Air has weight" by Scientific method. It involves weighing by a spring balance, which is a skill. The teacher has taught this skill to the children, one day before by Teacher Centred Approach.

Then he starts the lesson with,

1. **Problem:** Does air have weight? (This is TCA). Then children formulate their own answers to the question.
2. **Hypotheses:** Yes, no (This is CCA). Then children (who already know the skill of weighing or reading a spring balance) test their hypotheses themselves with an experiment.
3. **Experiment:** They weigh an empty football bladder and the same football bladder full of air (this is CCA). Then they themselves *observe* that an empty football bladder weigh less than a bladder full of air. After making this observation, they draw conclusion (CCA).
4. **Conclusion:** Air has weight. The hypotheses 'yes' is right and the hypotheses 'no' is wrong.

Here, step-1 is Teacher Centred as teacher asks the question or poses a 'problem'. Steps-2, 3, 4 are child centred. This is an example of Scientific method which is 25% teacher centred and 75% child centred. Thus, we can say on the whole, Scientific method is Child Centred Approach.

Note, that 'weight' is a concept, and 'weighing' is a skill. When skill of 'weighing' has already been taught by the teacher using Teacher Centred Approach, the concept of 'weight' is to be developed by Child Centred Approach, (Do not tell 'air has weight', Let the children find out themselves whether or not 'air has weight' by scientific method.)

2.5 DEMONSTRATION METHOD

Demonstration means 'to show'. In lecture method, the teacher just talks but in demonstration method, he shows or illustrate certain phenomena, concept, or principles. Demonstration provide concrete experiences to students. Thus, it helps to understand abstract ideas to students.

Using demonstration method the teacher (you) can:

1. illustrate abstract ideas in concrete form.
2. coordinate theory with practicals.
3. do those demonstrations which are dangerous for students to perform themselves.
4. teach how to solve a problem.

A problem can be solved by using demonstration using the following steps:

a) pose a problem to students.

b) invite their hypotheses.

c) provide concrete experiences (demonstration of experiments) for the solution of the problem.

d) enable students to reach on some right conclusion.

2.5.1 How to Use this Method?

When using this method, the teacher (you) should keep in mind the following characteristics of a Good Demonstration:

1. It should be clearly visible to all students, even to the back benchers.
2. Students should be fully involved.
3. If there are more than one demonstration in a lesson, they should be done in proper logical sequence .
4. In a demonstration only one idea should be taken at a time. Too many ideas in one demonstration may confuse the students.
5. As far as possible result of the experimental demonstration should not be known to students.

2.5.2 Advantages and Disadvantages

Advantages

1. There is a possibility of using more sophisticated apparatus, which generally students cannot handle in laboratory.
2. More difficult experiments may be undertaken.
3. More hazardous experiments may be attempted.
4. Expenses may be minimized compared to laboratory method.
5. There is a possibility of demonstrating manipulative and allied practical skills.
6. There is a possibility to draw attention of all the students of the class simultaneously.
7. It takes less time compared to laboratory and other innovative methods like enquiry approach, problem solving approach, scientific method and project method.

8. This method is more efficient in way compared to laboratory method as a teacher is more competent than students to handle apparatus.
9. All students can see the same operation and techniques simultaneously.
10. Teacher is in a position to explain each and every step and to ensure that all students see and interpret all the work in the same manner.

Disadvantages

1. All students do not do the experiment with their own hands. It is a substitute for laboratory work.
2. When the demonstration is complex or there are too many demonstrations in one lesson, students feel difficulty in understanding the basic concepts, principles and skills.
3. Various details of the apparatus, significant reactions and other essential steps undertaken by the teacher in drawing conclusions are not necessarily visible to all the students of the class equally well.
4. It deprives students of many of the advantages of laboratory method such as handling of the apparatus and other materials as well as making their own interpretations.

2.6 LECTURE-CUM-DEMONSTRATION METHOD

In essence, a lecture consists of one person talking to many about a topic or theme. The talk may be augmented by the use of demonstration being performed by the teacher, then we call it a lecture-cum-demonstration. The main purposes of a lecture-cum-demonstration are:

a) To convey information

b) To generate understanding

c) To stimulate interest.

2.6.1 How to Use this Method?

When using this method, the following factors have to be kept in mind:

a) A Lecture-cum-Demonstration should have clarity. The use of explicit language (devoid of gaps or fumbling), repetition of main points, statements delineating the beginning and end of subtopics, adequate examples and introduction of the demonstration at appropriate juncture bring clarity.

b) It is essential that the Lecture-cum-Demonstration should not be monotonous. It can be interesting by using appropriate stimulus variation techniques (voice tone. questioning, facial expressions etc.) are important. Also, the structure of the lesson can be made problem centered.

c) Too many or demonstrations should not be taken up in one go. A 35 minute lecture can be interspersed with about 2 demonstrations taking up about 15 minutes.

2.6.2 Advantages and Disadvantages

Advantages

a) A lot of knowledge can be imparted in less time.

b) Theory and practical aspects can be taken up side-by-side.

c) Examples can be illustrated verbally as well as in front of the eyes of the students.

d) In small group, Lecture-cum-Demonstration method can be used for developing problem solving skills and scientific attitude.

Disadvantages

a) Student involvement is quite less. This method is essentially teacher centred.

b) It is not always possible to hold students attention while using this method.

c) The teacher cannot receive immediate feedback as to the effectiveness of the lesson.

2.6.2 How is it Different from Enquiry Approach and Problem Solving Approach

Both 'Enquiry Approach' and 'Problem Solving Approach' start with the problems which lead to the hypotheses and then their testing. In lecture-demonstration-method, starting with the problem is not necessary, although the innovative teacher may pose the problem indirectly inviting children's hypotheses, but for testing the hypotheses, but for testing the hypotheses, the teacher will demonstrate the experiments instead of students doing the experiments themselves. This method is mostly teacher centred, while 'Enquiry Approach' and 'Problem Solving Approach' are child centred.

2.6.3 How to Use this Method and Why?

There is a very popular talisman in science education which state, "I listen, I forgot; I saw and remembered; I did and I understood". If you will use just lectures for teaching science, children will forget after sometime. It you will teach by lecture-cum-demonstration method, children will remember for years to come. Then, if children are also fully involved during lecture demonstration method, it will help them to understand quickly, and they will really enjoy the lesson.

Check Your Progress

Notes: a) Write your answers in the space given below.

b) Compare your answers with those given at the end of the unit.

9) Is lecture-cum-demonstration method better than lecture method? Why?

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10) Write any two differences between Lecture-Cum-Demonstration and Enquiry Method.

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2.7 LABORATORY METHOD

In laboratory method, students perform laboratory experiments by their own hands individually or in small groups, under the supervision and guidance of their science (Physics, Chemistry, Biology) teacher. So, here students are more ative and involved as compared

to Lecture-Demonstration method, where teacher was performing experiments and most of the students in the class were just passive observers. The role of the teacher when using this method is that of a facilitator. The teacher goes to different individuals or small groups, observes them what they are doing, corrects them if they are doing something wrong, and he is always available to students when they really need him for any guidance.

Unless, students perform experiments themselves, they will never get to know what science really is? In this method, they get an opportunity to do experiments individually in small groups.

Generally, lab experiments are of five kinds:

1. Experiments to illustrate scientific principles.
2. Experiments of find numerical results.
3. Experiments to produce something such as preparation of gases or biological slides.
4. Experiments to verify experiments carried out by other scientists like verification of Ohm's law.
5. Original work like investigatory science projects or open ended experiments.

In our science course, there are usually the first four types of experiments. Presently, little importance has also been given by CBSE to the 5th type-investigatory science project at school level.

When teaching science by laboratory method, the following **objectives** should be kept in mind:

1. to develop manipulative skills,
2. to arouse and maintain interest in science,
3. to encourage accurate observations and careful recording,
4. to make biological, chemical and physical phenomena more real through actual experience,
5. to train students in science processes,
6. to give training in problem solving,
7. to verify facts and principles already taught in theory,
8. to give training in open-ended experiments, scientific method and investigatory science projects (discussed under 2.7 and 2.8).

2.7.1 How to Use this Method?

In our schools at secondary (ix-x) and senior secondary (xi-xii) stage, students go to science laboratories to do practical work. Usually, in every school there are three science laboratories — Physics, Chemistry and Biology. For laboratory work, two continuous periods (of about 30 minutes each) are given. At secondary stage, students go to laboratory work once a week. At senior secondary stage students go to laboratory work twice a week in every subject. Generally, students work in groups of about 20. So the ***first step*** to, is to divide the students into groups, and make the laboratory time table in such a way that each group get equal number to periods for practical work.

Whether,you have good laboratory facilities or poor, you will have to make some adaptations to make your laboratory really fit for teaching science by laboratory method. So, the

second step to use laboratory method in teaching science, is to follow some guidelines to make this method feasible and successful, like.

1. Equipments must be accessible to the students when needed
   a) waiting time should be minimum.
   b) material should be placed in such a manner that they can be easily found by students.
2. There shold never be shortage of equipment and material needed for practical work.

2.7.2 Advantages and Disadvantages

Advantages

1. Promotes learning by doing.
2. Provide opportunity to handle material by their own hands.
3. Learn to follow directions carefully.
4. Help to learn skills to performing experiments, recording observations and results, summarizing data and drawing conclusions.
5. Provide opportunity for critical thinking, scientific attitude and scientific temper.
6. Provide opportunity of training in scientific method and investigatory science projects.

Disadvantages

1. More expensive as separate equipments is to be provided to each student.
2. Difficult to schedule in the school time table as double periods are to be provided in groups.
3. More time consuming compared to Lecture-Cum-Demonstration method as students are unskilled workers and are not as competent to handle apparatus as their teachers.

2.7.3 How is it Different from Enquiry Approach, Problem Solving Approach and Lecture-Cum-Demonstration Method

'Enquiry Approach' and 'Problem Solving Approach' start with the problem, and students find the solutions themselves under the guidance of their teacher. But in laboratory method it is not necessary, through this method has a lot of scope of hypotheses formulation and drawing conclusions on part of students. That, all depends how innovative you are as a teacher. All the three methods are child centred.

In lecture-cum-demonstration method, the teacher perform the experiments therefore it is teacher centred. Where as in Laboratory method, children perform the experiments. Hence it is child centred.

2.7.4 When to Use this Method and Why?

If our objective is to help our the children to by learn by doing, should handle apparatus and material by their own hands, and should learn science processes, we should use laboratory method. Remember, the science teaching talisman. If your objective is that children should remember for some time, use lecture method. If your objective is that children should remember for a long time, use lecture-demonstration method. If your objective is that children should understand and thus, retain forever, use laboratory method.

Check Your Progress

Notes: a) Write your answers in the space given below.
b) Compare your answers with those given at the end of the unit.

11) What are the essential requirements to adopt laboratory method in Science?

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12) Write any two advantages and two disadvantage of laboratory method.

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2.8 PROJECT METHOD

A project is a any purposeful activity. It may be preparation of a model static or working, a chart or performing an experiments. Here are examples of some good science projects-improved bullock cart, solar cooker-cum-solar power generator, computer controlled car, a simple device to prove Newton's third law of motion, working model of the solar system, determination of the time of a falling body, a device for conversion of waste mechanical energy to electrical energy, sewage treatment and re-use of water, extraction of oil from rice bran, very cheap symbiotic bacteria rhizobium substantial for expensive nitrogenous fertilizers, cheap record player, digital clock, kitchen flask, milk plant, multi purpose cherkah, food feeding machine for physically handicapped, low cost tricycle for handicapped children and so on.

When your students make or work on a project they explore and use lot of scientific knowledge. They do their own learning. You, as a teacher are there to facilitate and guide them whenever they need you.

Investigatory Project

A project which involves investigation, discovery and finding out something which was not known to the students before, is called an investigatory project. An investigation is much more than the repetitions of a standard experiment. Here, the student is to decide what experiments are necessary and how he is going to carry them out. He may have to design his own apparatus, if that is not available in the laboratory. He has to search for the appropriate principles, laws, formulae, apparatus and data, and originate a solution to a problem. Here, the student works like a scientist.

Working on an investigatory project is the way a student can learn science by project method. It involves four as found in scientific method or problem solving approach.

1. Identification of Problem
2. Hypotheses
3. Experiment
4. Conclusion

2.8.1 How to Use this Method?

In this method, a group of students select a problem in consultation which their teacher and formulate their hypotheses. Then, through discussion and reading, they develop the plan of action and design their type of equipment to carry out the experiments for testing the hypotheses, in order to reach the right conclusion,

Teacher's Role

As a teacher you should clearly know your role when your students learn science through investigations.

1. When a group of students come to the teacher with their problem, he encourages them by suggesting various books and sources relating to their problem. It is possible that the group of students may not find the solution of their problem through the readings, however they will be able to find at least some important information relating to their problem. The teacher encourages the students to do further readings so that they will be familiar with all available information relating to their topic.

2. The teacher also motivates the group of students to consult competent people who could guide them in their project, like scientists, college and university teachers, medical technicians, doctors or nurses who may have practical knowledge related to their problem.

3. At every step of the investigation, the teacher guides and counsels the group of students and does not give readymade answers to their questions. This is their investigation and they carry it out themselves.

4. Investigatory projects are usually selected by the group of students, but occasionally they might be assigned by the teacher. The teacher helps the students in selecting an investigatory project. It a group of students is unable to select a problem, then the teacher assigns them one problem according to their interest and capacity.

Designing an Investigation

After identifying the problem and formulating the hypotheses, the design of the investigation, (experiment) is most important. The group of students should plan for each stage of investigation, under the guidance of their teacher, and they should be quite clear about the following:

a) dependent and independent variables

b) direct and indirect controls

c) control and experimental groups

d) criteria of experimental designing — validity of the experiments, reliability of the test and adequacy of the instruments.

Simple Themes for Selecting a Problem

1. Technology in rural development
2. Man and environment
3. Energy and fuels
4. Nutrition and health
5. Population and food
6. Space science
7. Communication and transport

8. Man and machine
9. Innovations in teaching of science.

2.8.2 Advantages and Disadvantages

Advantages

1. It creates interest in science.
2. It develops understanding of various scientific concepts and generalizations.
3. It promotes curiosity and develops scientific temper, interest and appreciation.
4. It develops abstract and concrete scientific skills.
5. It develops scientific hobbies for the right use of leisure time later on in life.
6. It develops self-confidence, co-operation, leadership and emotional stability.

Disadvantages

1. This is the most difficult method as it requires more planning and effort for execution for the teacher, if she/ he is not trained, can face problem in using this method.
2. It is very time consuming.
3. It needs proper coordination as different groups of students will be working on different projects.
4. It requires more materials and equipments.
5. Not suitable for large classes.

2.8.3 How is it Different from Other Methods?

Project method is a discovery method like Enquiry Approach, Problem Solving Approach and Scientific Method. All the three are child centred. But this method may involve more than one experiment and also field work.

Project method may be carried out in the laboratory. May require more apparatus and materials which may not available in the laboratory.

Project method is different from lecture-cum-demonstration method as project method is child centred and lecture-cum-demonstration method is teacher centred.

2.8.4 When to Use this Method and Why?

If you want to make your students learn through project method, then they have to work together in a small group under your supervision and guidance. This method not only helps them in learning content bt also helps in developing qualities like co-operation, concentration, and sincerity.

Check Your Progress

Notes: a) Write your answers in the space given below.
b) Compare your answers with those given at the end of the unit.

13) What is a Project? Write any four examples?

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14) What are the different steps of Project Method?

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15) What do you mean by a Investigatory Project?

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16) Write two merits and two demerits of the project method.

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2.9 LET US SUM UP

There are various approaches and methods of teaching science like — Enquiry approach, problem solving approach, lecture-cum-demonstration method, laboratory method, scientific method, and project method. Each method has its own advantages and disadvantages. You should be very careful in selecting a method for teaching science. You should be very clear in how to use different approaches and methods, when to use and why to use. All this, will depend upon your objectives, your resources and classroom conditions and of course, on the topic you're going to teach. It is advisable to practice each approach and method as far as possible, in your practice teaching.

2.10 UNIT-END EXERCISES

1. What is science? Why should we teach science?
2. What are the objectives of teaching science?
3. What do you mean by science curriculum?
4. 'Science Curriculum should be compatible with the nature of science, objectives as well as with the cognitive level of children and existing classroom condition'. How far do you agree with this statement. Justify your answer.
5. (a) Describe the following approaches/methods of teaching science-enquiry approach, lecture-cum-demonstration method, laboratory method, scientific method, and project method.

   (b) How will you use each of the approaches/methods when teaching science?

   (c) What are the advantages and disadvantages of each approach or method?

   (d) When will you use each approach/method in science teaching, and why?

(e) Select (Physics, Chemistry, Biology) topics of your choice from science classes VI to X, for each approach/method, make lesson plans, and teach them during your practice teaching.

(f) What are the similarities and difference of these approaches/methods?

6. Identify a problem for an investigatory project. Write the plan of action. Carry out the project and write the project report.

2.11 ANSWERS TO CHECK YOUR PROGRESS

1. Science Curriculum has two important components :

   Content — it includes: laws, theories, principles, hypotheses concepts etc.

   Process-it includes: observation, classification, estimation, prediction and generalization.

2. Five effective transactional ways of science at secondary stage are :

   1. Lecture-cum-demonstration method
   2. Enquiry approach
   3. Problem solving method
   4. Project method
   5. Laboratory method

3. Advantages of Enquiry approach are:

   — Children develop ability of learning.

   — This approach make learner's mind more experimental.

   — It develops the ability of critical thinking and open- mindedness.

   — Independent learning skill can be strengthened through this approach.

4. Disadvantages are:

   — It is slow and time consuming approach.

   — Teachers are not being oriented on this approach.

   — Books and learner-based material to this approach are not available.

5. Problem solving is basically child-centred approach which provides children an opportunity to solve problems systematically and scientifically.

6. The steps are:

   - Identification of the problems — Sensing
   - Statement of the problem — Defining
   - Analysing the problem — Explaining
   - Collecting relevant information — Gathering
   - Making Hypotheses — Stating
   - Experimentation — Testing

- Verification — Confirming
- Conclusion — Proving inference

7. The two important precautions to be taken are:

   1. Whatever problem is being identified must not be based on previous knowledge.
   2. Teacher's role only as a facilitator or guide not as a instructor or teacher.

8. Advantages

   1. Learning by doing and learning by experience: cardinal principles of learning are fulfilled by this method.
   2. It makes the child open-minded, a keen observer and critical thinker.

   Disadvantages

   1. Time consuming method, it requires lot of time to finish the content.
   2. Ambitious: it expects too much from children and demands devotion of teachers.

9. Yes. Because in lecture method teachers only talks and in Demonstration method they only show or illustrates the things. Lecture-Cum-Demonstration method removes the demerits to the two.

10.

Lecture Method	**Enquiry Method**
1. Lecture method is teacher centred method where teacher role is direct.	1. This method is learner centred where Student role is more direct and dominating.
2. Concepts are not being developed through by experience.	2. Concepts are developed through learning by doing and learning by experience.

11. Essential requirements:

   — Laboratory is required instead of classroom.
   — Availability of material for activities.
   — Supervisor (for safety purpose).
   — No, of students will be less.

12. Advantages

   - Opportunity to handle instruments on their own.
   - Training to learners to follow directions carefully.
   - Experimental skills are being improved and developed.

   Disadvantages

   - More expensive method.
   - More time consuming and hence no teacher follows this method at secondary stage.

13. A project is a purpose is a purposeful activity which could be imparted to fulfil the requirement of the chosen project. The examples are:

   — Developing solar-cooker-cum-solar power generator.

— Improving Bullock Cart.

— Working model of the solar system .

14. The steps are :

— Providing a situation

— Choosing and proposing

— Execution

— Recording

— Discussion and Evaluation

15. A project which involves activities to discover something that is not known to students is known as investigatory project.

16. Refer to sec. 2.8.2.

2.12 SUGGESTED READINGS

NCERT, (1982):;*"Teaching of Science in Secondary Schools"*.

Mangel, S.K.,(1995); *"Teaching of Physical and Life Science"*, Arya Book Depot, Delhi

Siddiqui, N.N. & Siddiqui, M.N., (1994); *"Teaching of Science Today and Tomorrow"*, Doaba House, Delhi.