UNIT 7 METHODS IN SCIENCE TEACHING-LEARNING

Unit Structure

7.1 INTRODUCTION

As a science teacher, when you plan your teaching-learning, apart from approach and media, you also plan the method which is appropriate to transact the content in classroom. Previous units of this block i.e. Units 5 and 6 have provided you a fair understanding of various steps of planning and learning approaches being followed across the globe by science teachers. Present unit will discuss in detail about various methods, which you can use in your science classroom. You are advised to go through the Unit 10 of course BES-123: Teaching and Learning, where we have discussed in detail about various teacher-centered, learner centered and group centered methods. In this unit, our discussion will be on those methods which are of more use to a science teacher. In present unit, our focus will remain on application dimension i.e. which method is appropriate for what kind of content and how can you use it in your science classroom effectively.

7.2 OBJECTIVES

After going through this unit, you will be able to:

- dentify the appropriate method for science teaching-learning;
- improvise traditional teacher-centric methods for effective teaching-learning;
- use suitable learner-centered method for specific nature of content;
- promote cooperative learning methods for science teaching-learning; and
- examine the effectiveness of various method of teaching-learning in Science.

7.3 TEACHER CENTRIC METHODS

Recall the discussion held in unit 10 of BES-123: Learning and Teaching, you will find that we have discussed in details about merits and demerits of methods like lecture, demonstration and team-teaching. In Science teaching-learning at secondary level, teacher centric methods are not being promoted much but keeping in mind the situation of classroom in Indian schools, few methods are still being suggested, which are being used frequently by teachers. Let us discuss few of them in details.

7.3.1 Demonstration Method

Demonstration method is an activity-centered method which is being used frequently in a science classroom. There are a number of concepts and theories in science, which can be explained to learners only by demonstration. Demonstration helps learners to learn through observation. Demonstration method in general has been discussed in unit 10 of BES 123. The question is how you can use it effectively as a science teacher. You will agree that a well planed demonstration can help learners to understand a concept/process or mechanism better. Here are some important considerations, suggested by O'Brien, (1990), which you can keep in your mind while planning for demonstration:

- The concept which you want the demonstration to illustrate
- What kind of demonstration will help better learning of the concept?
- Where should the demonstration take place i.e. in the class, laboratory or field?
- What should be known to learners before the demonstration?
- What should be the role of learners(i.e. participatory or only active observer)?
- How will the demonstration take place (i.e. steps and process)?
- What kind of questions should you ask to learners for active engagement of learners in demonstration?
- What should be assessment technique/ follow-up questions to assess the learner's understanding about the concept?

You should also be careful about size of the class, place of demonstration and risk involved, so that all learners can benefit through your demonstration.

Steps of Demonstration

Let us try to understand the steps of demonstration with the help of an example.

Kamya, a Science teacher in a secondary school at Siliguri (Assam) decided to demonstrate an experiment on change in state of matter due to temperature. She identified the content from Class IX textbook, arranged required material from Science Laboratory and arranged a demonstration table at a platform so that all learners in her class can see it.

Before starting the demonstration, she enquired about states of the matter. She asked questions to develop enquiry and to motivate learners and give directions for observation and its recording to all learners. She arranged the apparatus and demonstrated the experiment, in which:

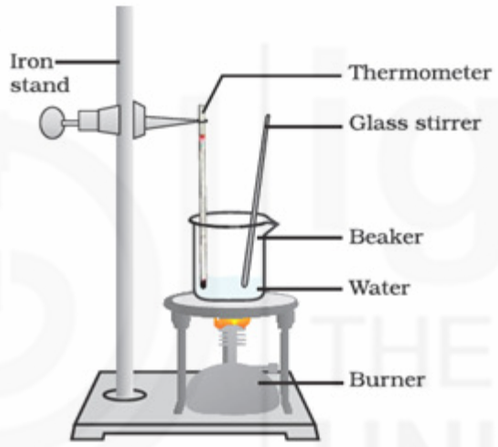

Figure taken from NCERT Textbook, Class IX

Ice melted into water while increasing the temperature and later water converted into vapors. Learners keenly observe the changes and noted down the change in temperature along with change in state. She asked them to explain their observation and then introduced the concept of melting point and boiling point.

Read the above example and try to fill the columns in the table given below:

Steps	**Activity**
Planning	
Introduction	
Preparation	
Demonstration	
Recording	
Discussion	

When you fill the table, you will be able to comprehend the steps involved in a demonstration.

Activity 1

Identify a topic for demonstration from Class IX or X textbook of science and execute it. Prepare a report highlighting your as well as learners' observation at every step of demonstration.

7.3.2 Lecture-cum-demonstration

Lecture-cum-demonstration is an improvised version of both the methods, as there are chances that learner may remain passive during demonstration. If a science teacher uses lecture-cum-demonstration method in a science class, it helps a lot in explaining the concepts and theories associated with the demonstration. Some times, teacher uses lecture-cum-demonstration when s/he blends a short demonstration during lecture to explain any concept. Lecture-cum-demonstration can be used in two ways i.e. primarily a lecture with some demonstration or a demonstration with some lecturing/discussion or explanation. It depends upon nature of content and level of learners.

Most of the steps of demonstration remain similar as discussed in point 7.3.1 but teacher and learners become more active verbally also as they question/answer/explain/discuss the events/phenomenon along with demonstration.

For example, a teacher while teaching about properties of colloidal solution, demonstrate the Tyndall effect and asks learners to site examples from their experiences of cinema hall or scattering of light in a dense forest.

Activity 2

Identify a topic for lecture-cum-demonstration from Class IX or X textbook of science and prepare a plan how you will use it in your classroom. What are the precautions you will keep in mind while executing it?

7.3.2 Laboratory Method

Laboratory method is one among the most widely used teacher-centric methods for teaching science. This method is being used to provide hands-on experience to each and every learner; as in demonstration or lecture-cum-demonstration there are little chances of learner getting an opportunity to do or feel the experiment.

Laboratory method follows the principle of '**learning by doing'** and it is a common saying that the best way **'to learn science is to do science'**.

Though in this method, learners are more active and doing experiments on their own but they are fully guided and instructed by their teachers. They mostly follow the instructions given by the teacher or written in the experiment manual, which has

also been prepared by some teacher. That's why; this method is a teacher-centric method.

Learners can be provided the opportunity to work in small groups or individually in the laboratory; it depends upon nature of experiment, availability of equipments and objectives of the learning.

It is the teacher who decided when to use the laboratory. Teacher decided the nature of experiment, nature of laboratory activity (individual or group), time and place. Teacher prepares the instructions for the learners to be followed in the laboratory. According to Hodson (1993), laboratory method helps teachers in:

- motivating learners through stimulating their interest and increasing their enjoyment
- teaching laboratory skills
- assisting concept acquisition and development
- developing and understanding of scientific inquiry and developing expertise in conducting inquiries
- encouraging social skills development
- inculcating the scientific attitudes

How to Use Laboratory Method?

Generally in a secondary school, there is a common science laboratory whereas you may find separate laboratories of physics, chemistry and biology in a senior secondary school.

- For using laboratory method, it is advised that learners should be divided in to small groups not more than 20 in a group. A timetable should be made so that each group can have equal opportunity to work in the laboratory.
- You have to enlist and identify the equipments and resources available in your laboratory and accordingly identify the concepts for which experiments are possible in your laboratory.
- Equipments and other materials (chemicals, specimens, etc.) should be placed in such a way so that learners can get them easily and there is no wastage of time.
- Prepare a list of do's and don'ts in the laboratory so that safety of learners can be ensured.
- Always provide instructions to learners before handing over them the equipments and materials for experimentation.
- A teacher generally provides a manual or steps to be followed while doing experiments.
- Learners are asked to record the observation while doing the experiments.
- Though learners do the experiments on their own but a vigilant teacher's presence is necessary in the classroom.
- Generally learners test the hypotheses; they framed during discussion on any topic/problem. It is advised that you should ask learners to test their hypotheses one by one and record their observations.

Activity 3

Suggest some topics/concepts for which laboratory method is appropriate. Also enlist the equipment required and process to be followed in the laboratory.

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) Compare the role of a teacher in demonstration method and laboratory method?

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7.4 LEARNER CENTRIC METHODS

In the teaching-learning of science, learner centered methods are more in use. We have already discussed in the unit 10 of the course BES – 123, that learner centric instructions grew out of the humanistic movement in psychology. In these methods, learners acquire skills and abilities through activities under guidance of teacher. Here, teachers' role is more of a facilitator. We have discussed few learner centered approaches like inquiry and problem solving. In this section our focus will be on methods like investigatory projects, heuristics method, discussion, and experimentation, which are being used for developing science process skills among the learners.

7.4.1 Investigatory Projects

In science teaching-learning, investigatory projects is method, which provides opportunity to learners to examine and explore their ideas in their surroundings. This method helps learners to explore science in their immediate environment on their own.

In this method, learners frame their questions and test them in various situations to arrive at a conclusion. Their question may be like:

- Do plants grow in dark?
- What are the factors affecting environmental temperature?
- Does sound pass equally from different material? etc.

Learners are asked to follow the steps of scientific method to find out the answers of their questions.

How to do an Investigatory Project in Science?

- Investigatory projects use scientific method. It starts with asking questions about something learners observe. When learners frame questions about their observation, they should be encouraged to arrive at a testable and precise question or the question on which they do their project.
- After this, they are advised to carry out some research i.e. searching and searching books in school library. Learners identify the resources required, process to be followed, support required from peers/teacher/parents or other members of the society etc.
- After researching, they frame hypotheses, i.e. the possible answers for their questions. Generally, learners use the terms like 'if'/ 'then' to convert the question into hypothesis.
- When they frame hypotheses, they started thinking on the experimentation. How will they carry out the experiment? They plan and do the experimentation.
- While doing experimentation, learners record the observations and analyze them in order to find out the answer of their question. Sometime, the hypotheses may be right and some times it may be wrong. If the hypothesis is wrong, they again reframe a new hypothesis and test it.
- Learners report their findings in clear terms in either case i.e. hypothesis is accepted or rejected.

Activity 4

Here are few suggestive topics on which you can develop investigatory projects for your learners. Complete the following table while planning investigatory projects for your learners.

S#	Topic	Investigatory Question	Hypothesis
1	Types of Tissues		
2	Cropping Pattern		
3	Forms of Energy		
4	Methods of separation		

You can develop projects on many other topics from Class IX and X Science curriculum. Give any one project to few learners of your class as group project and prepare a report on how they carried it out.

7.4.2 Heuristics Method

Term 'Heuristic' has its origin in a Greek word 'Heurisco' means "I find out'. In this method learners are independent investigators. It has a distinguished difference from project method where learners do their work in continuous observation and guidance of teacher but in heuristic method no help or guidance is provided by teachers once problem is identified. Teachers only help to find a problem by creating an environment or exposing learners to a problematic situation. In the words of H. E.Armstrong, ***"Heuristic methods of teaching aremethods which involve our placing students as far as possible in the altitude***

of the discoverer - methods which involve their finding out instead of being merely told about things".

While using this method, teacher should present every lesson to learners in form of an inquiry. Learners are asked to identify the problem and work as independent enquirers. They can discuss with their peers, teachers and other before starting their investigations. Teacher may provide them some written instructions like what should be followed and what should be avoided. Learners are asked to keep the record of their each and every step and show it to teachers after finishing their investigation.

Steps of Heuristic Method

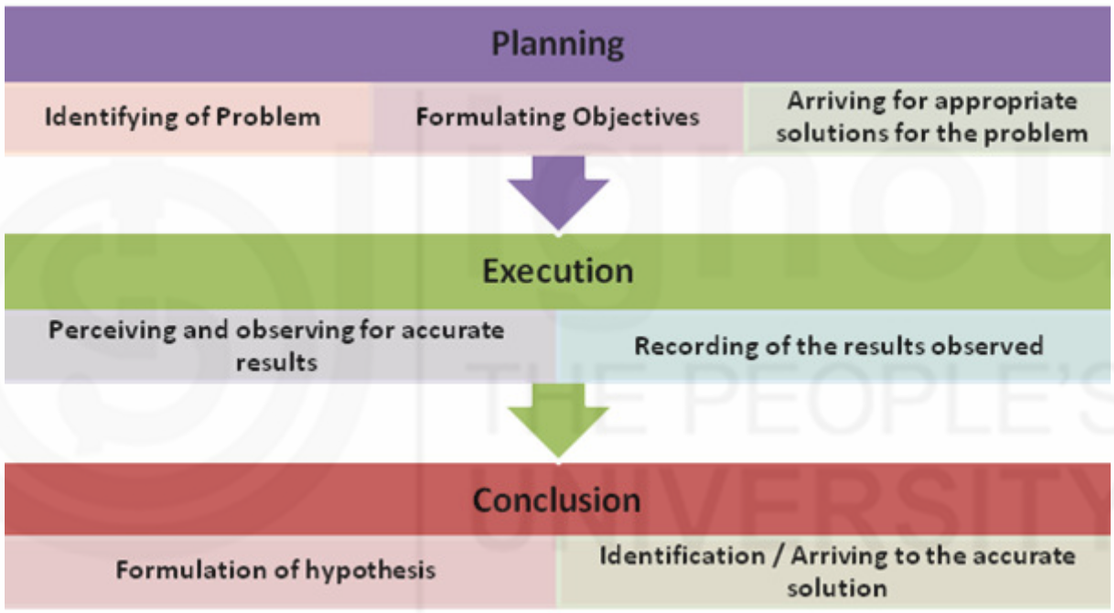

Figure 7.1. Process of Heuristics Method

Role of Teacher

- Teacher helps in indentifying the problem, which is to be investigated by the learners.
- Teacher encourages learners to give ideas, to test ideas and to challenge their own ideas.
- Teacher never gives any suggestion or solution to the learners.
- Teacher remains sympathetic, courteous and open for all types of views and ideas.
- Teacher supports and guides only if learner requires it and s/he asks for it but always supervise learners work without any interference.

This is to be noted here that this method is good when number of learners in a class are less. This method is good for developing scientific skills and scientific temper among learners.

Let us understand this method with the help of an example:

Mr. Atif, a science TGT in a Government Inter College of Uttar Pradesh decided to use heuristic method in his class. He selected the topic "Acid, Base and Salts".

In **First step**, Mr. Atif prepared an **Information Sheet**, in which he depicted problems like:

- What are foods which may be of acidic nature?
- Name the fruits which are acidic in Nature.
- Which acid is present in orange juice? etc.

He also provided some notes to the learners mentioning that the food items of sour taste are of acidic nature. And learners can use blue litmus paper to confirm that the food item is acidic or not.

In **Second step**, learners were asked to conduct the experiment to find out the answer/solution of the questions given in the worksheet by teacher.

Learners conducted the experiment and recorded their observations as follows in their worksheet/assessment sheet.

Experimenting:

Learners were aware of the fact that sour tasting food items will be acidic in nature. They tasted substances like lemon juice, orange juice, vinegar, curd, tamarind solution and found that these are acidic in nature.They confirmed the acidity of these substances by using blue litmus paper. They put all substances in separate beakers and blue litmus papers were inserted in each beaker. They observed that blue litmus changed its color to red, which confirmed that the substance which they tested, are acidic in nature.

Third Step: Recording and Reporting

Learners reported the objective, material/apparatus used, process of experimentation, observations and conclusions in the worksheet/assessment sheet. Learners confirmed that acidic substances are sour in taste and turn blue litmus to red.

Example adopted from https://jtmadhavan.files.wordpress.com/2009/09/heuristic-method1.pdf

Activity 5

Identify some topics/themes from science textbook at secondary level and use heuristic approach for teaching-learning. Report your experiences while using heuristic method in Science.

7.4.3 Natural Exploration

Natural exploration is another learner-centered method which is suggested for science teaching-learning. National Curriculum Framework-2005 emphasized that learners at secondary stage should be engaged in learning science through analysis on issues surrounding environment and working on locally significant projects.

In Science teaching-learning, there should be ample opportunities for exploration of the environment, to interact with it and to talk about it. Science learning starts with curiosity and learners are always curious about the nature, their experiences through various encounters with nature. They want to find the cause and establish a cause-effect relationship. Natural exploration helps learners in arousing and maintaining their curiosity about science behind natural events/happenings.

As a science teacher, you should promote their curiosity and provide them opportunity for exploration.

Concepts, Principles or Laws in Science were not indentified or developed in isolation. They emerged as explanation of various events. For example, Law of Gravitation is an outcome of an observation of falling of apple on ground.

As science teacher, it is your responsibility to identify such incidents/situations/events where learners can get the opportunity to explore some scientific concepts/theories/laws through natural observation.

While using natural exploration as method of teaching-learning in science, role of teachers is only to identify some situations/events to which learners can be exposed.

Learners are asked to get first-hand experience of the situation/event. They formulate their own questions and explore the situation/event to find out the solution. As it takes place in natural setting, learning outcomes are also natural so that there is no artificiality of knowledge.

Steps of Natural Exploration

- Identification of Situation/Event
- Exposure to Learners
- Recording the Observation
- Linking Observation with Scientific principals/theories/laws
- Explaining principals/theories/laws

From second to last step, it is the learner who is active, whereas in first step, a teacher is active. Let us see an example:

> Kaiesha, a Science Teacher in Meghalaya, tried to use natural exploration as a teaching method to explain concepts of "Forms of Energy" in her IXth class. There was a "tribal fair" to be organized near her town in coming days where various tribal communities will come and showcase their talents, traditional equipments, war-techniques, music, etc. Kaiesha thought it will be an exciting event and learners will be able to learn many things along with some examples on various forms of energy.
>
> She sent the learners to the event in small groups of 4 each and asked them to enjoy the events along with exploring the examples, where they feel energy is being used in various forms.
>
> When learners returned from the event, they cited examples of a Bow made up of bamboo Stick, Sling, Use of 'Y' shaped Pellet Bow (Gullail) made up of branches and many such things, which they found being used by various tribal communities. They explained the concept of kinetic energy, potential energy and transfer of energy with such examples.

As a science teacher, you can also identify many such events/incidents where learners can learn the scientific principles/laws/theories through natural exploration.

Activity 6

Identify the opportunity of natural exploration for following Laws/Principles:

- Bernoulli's Theorem
- Laws of Reflection
- Classification of Animals
- Monocot and Dicot Plants

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.

2) How are the investigatory projects useful for science learning? Explain.

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3) The best way 'to learn science is to do science'. Justify the statement in light of learner-centered methods of science teaching-leaning.

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7.5 COOPERATIVE LEARNING METHODS

Cooperative learning methods are being advocated as it has been established that learners learn better with cooperation. There is a paradigm shift from competitive learning environment to cooperative learning environment in schools. Cooperative learning has gained momentum and being practiced in classrooms around the globe. As a science teacher, you need to be aware of these methods so that you can use these for effective teaching-learning in your science class.

In General terms, Cooperative learning is an instructional method in which learners are supposed to work in small groups to achieve a common learning goal under the guidance of a teacher.

Cooperative learning methods are different from traditional group work as there are some distinct features of these methods:

- Learners positively depend on each other in a team to achieve a mutual learning goal.
- Learners engage in face-to-face interactions.
- Learners are assessed individually and held accountable for equally sharing and contributing to the mastery of learning goals.
- Learners use and develop appropriate collaborative and interpersonal skills to teach and encourage each other to learn.
- Learners reflect and assess the effectiveness of group functioning for future learning (Johnson and Johnson 1999; Kagan 1994).

Cooperative Learning in Science

Cooperative learning methods help science learners in following ways:

- Cooperative learning helps learners to construct their own understanding of scientific phenomenon by examining, sharing, and learning from peers which results in strengthening their knowledge of the topic.
- Cooperative learning provides opportunity to learn through sharing of ideas, exploration, refining, and questioning their ideas as well as new ideas of others.
- These methods encourage learners' involvement and engagement. Learners start taking responsibility for their own learning and are not dependent solely on the teacher.
- Cooperative learning allows learners to make their thought/ideas public as they share it with other and refine after getting benefited from other's views.

There are number of cooperative leaning methods, which are being practiced. We will discuss few important one here to facilitate you in your teaching learning.

7.5.1 JIGSAW

JIGSAW is most common cooperative learning method, in which learners work in groups to achieve a common group goal. In Science teaching-learning, this method is useful for exploration, experimentation as well as for project work.

In JIGSAW, learners share their expertise with other members of the group and contribute in completion of a group task.

Let us see an example:

> Mr. Ashish, a TGT (Science) in Uttarakhand decided to use JIGSAW technique in his science classroom for the topic "Types of Tissues'.
>
> He divided his class in JIGSAW Groups of 4 learners each. While formulating the groups, he kept in his mind that each group is heterogeneous in nature i.e. out of four learners, one may be good in communicating things, one may be good in collecting information, one may be good observer and one may be good writer. He appointed one member of each group as group leader and asked groups to choose the sub topics of their choice. He distributed topics

like Plant tissues: Meristematic tissue, Permanent tissue, Animal tissues: Epithelial tissues, Connective tissue, Muscular Tissue, Nervous Tissue, etc.

In next step, each member of the group is asked to choose the task form him/her like collection of information, examples, explaining structure of the tissue and its use. The group one was working on Meristematic tissue distributed the work as follows:

Member 1: will bring onion bulbs with some roots

Member 2: will prepare slides.

Member 3: will draw the figure on chart paper

Member 4: will explain the function of tissue

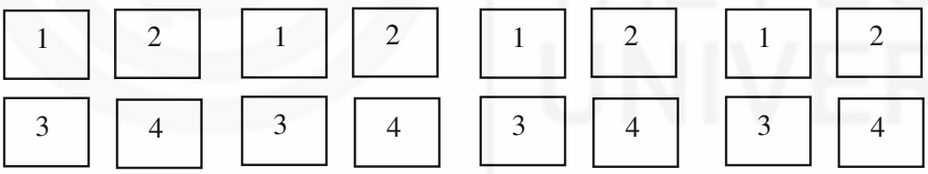
Similarly, members of other groups also distributed the tasks among themselves.

Each group completed the tasks, distributed within their groups and gained knowledge about one tissue.

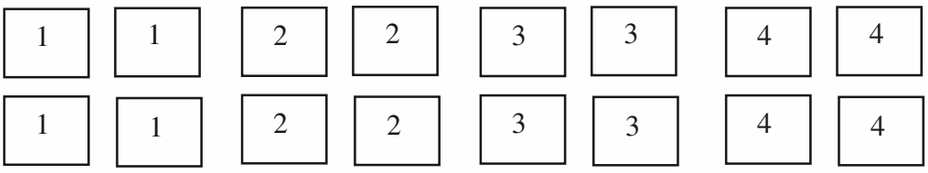
Again, Groups are redistributed so that one member from each becomes part of new group where they shared with each other their group findings.

Jigsaw Group Formation

1) Formations of Groups



2) Reformation of Groups to Share the Group Findings with Others



IN JIGSAW, role of teacher is very important. Here teacher plays role of a facilitator who helps learners in identifying the topics, framing the groups, explaining the nature of activity and create an environment where free flow of ideas is being encouraged. S/he monitors the progress of groups and helps them to share with each other.

Activity 7

Identify a topic from a secondary level Science textbook and plan a JIGSAW Activity. Execute it and report your findings.

7.5.2 Think-pair-share

It is another popular cooperative learning method, which is being used in science classroom quite frequently. Teacher's role is of a facilitator but all the tasks are to be accomplished by the learners themselves.

Think-Pair-Share is a three step method.

Think: Learners are asked to think independently on the question/problem/issue which has emerged. Learner does brainstorming, survey, collection of ideas and frames his/her own ideas about the problem.

Pair: Once thinking is over, learners are asked to make pairs with their peers to share their ideas with each other. In this step, both the learners in the pair listen carefully to each other's/ ideas. They question, argue, challenge, explain and arrive at a conclusion by considering views of both.

Share: Learners are asked to share their ideas as pairs with whole class. Presenting ideas as a pair help learners as they become more comfortable and partnership support is in it. Group is asked to reflect on the ideas presented by pairs in this way the ideas of individuals get more refinement and they comeout with a better solution.

Role of Teacher: While using think-pair-share method, it is expected from you as a teacher that you act as a facilitator and facilitate learners in pairing, allotting time for each step and organizing classroom discussion during sharing in a conducive learning environment. You can record their ideas on blackboard to facilitate them in summarizing the discussion.

As a science teacher, you should be very clear that for what kind of topics you can use think-pair-share method. For example, you can use this method to introduce the concepts of weather, formulation of chemical equations, explaining a natural phenomenon or disaster like earth quake, cyclone, etc.

7.5.3 Other Methods

Apart from this, there are many other cooperative learning methods, which a teacher can use in her/his classroom while teaching science. Let us discuss in brief about all these.

Three-Step Interview

This is a method which is used when learners are dealing with a problem which has no definite answer. This method involves three steps:

Step I: Teacher presents the issue/topic in front of class along with various views/explanations available on the issue. S/he asks several questions to initiate the process.

Step II: Learners form pairs. One member in pair becomes the interviewer and other one, interviewee. They interview their peer and record his/her observations/views on the issues.

Step III: Learners switch their role with in the pair i.e. Interviewer become interviewee and vice-versa. After this second round of interview, every pair presents the views in front of the class. Class discusses, argues and questions the ideas so that whole class can arrive at a consented view.

Round-Robin Brainstorming

This is also known as Rally Robin. In this, class is divided into small groups and one learner is assigned the duty to act as a recorder. Teacher raises a query or a question with many possible answers and learners are asked to think about answers in their group. Each member in the team presents his/her views one after other in round-robin style and recorder takes note of each response. After all learners present their views in the group, one member from group (generally the one who is acting as recorder) present the views of the group in whole class.

Three-minute Review

This method can be used by science teachers when they are explaining or discussing about some complex processes. For example, if you are explaining the respiratory system in your biology class, you can stop in between your discussion anytime and ask learners to form the teams and review in three minutes about what has been discussed so far? Learners can discuss within their groups and ask questions to clarify their doubts to other members of the group, or other group or to you.

Numbered Heads Together

Numbered Heads Together is another cooperative learning method, in which learners are arranged in small groups. Each member of a group is assigned with a number. When teacher asks a question, learners with same number come together and start discussing the possible answer of the question. They work in groups. The specific numbered learner as suggested by teacher or decided by the group becomes the group leader and presents group's idea to whole class. As learners with specific assigned number come together, this strategy is known as "put heads together" strategy.

Team Pair Solo

In this method, a problem is identified by the learners or sometimes may be assigned by the teacher. All learners work on the problem as a team. Later they regroup themselves as pairs and work on same problem and at the end they started thinking solo. This method is used when a problem is initially beyond the capacity of an individual. Learners explore the possible solutions in groups and then discuss in pair and experiment on their own as an individual. This approach is very useful in laboratory experiments in science teaching.

Circle the Sage

This method is used when a specific knowledge or information is available with very few learners. For example, a few learners of your class have visited a Science Museum or a wildlife Museum. You can ask the learners who can explain all the things they have witnessed in the museum. The learners ready to share their views will be marked as "sage". Rest of the class will be divided into small groups and each group will encircle one sage i.e. one learner. The sage will explain to the group around him/her all the details. When learners will be back to their group, they share what they have learnt from sage and thus by sharing ideas, their knowledge will enhance.

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.

4) Cooperative learning methods help to develop collaborative and interpersonal skills. How?

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5) What are the steps of JIGSAW?

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7.6 INCLUSION IN SCIENCE CLASSROOM*

As a teacher to teach science in an inclusive classroom, you need to understand the best inclusive practices. A diverse classroom having different types of learners is no more an exception; rather it is a reality and the norm. The changing face of our classroom is the trend towards inclusion.

7.6.1 Adaptation in Inclusive Classroom

In an inclusive classroom, you have to bring many types of adaptations in your classroom. Adaptations made in the regular classrooms often include four main categories: time, learning styles and instructional delivery, environment, and adjustments in content. You can consider the following modifications and examine oneself how these points help us in our classroom teaching learning process:

- **Modifying instruction**: This includes classroom demonstrations, adjusting lesson pace, and using multiple instructional modalities;
- **Modifying class work and homework**: This includes providing models, reducing amount of work and lowering difficulty levels;
- **Accommodating the student's difficulty**: Adapt the time allowed for learning, task completion or assessment and increase the amount of individualized assistance for the child;
- **Altering instructional materials**: This includes providing alternate materials, audio-visual aids, worksheets and even use ICT;
- **Varying instructional grouping**: This includes the use of peer tutoring and cooperative groups.

* This section has been taken from Unit 9 of BES-019, IGNOU

- **Enhancing behaviour**: This includes praise, behavior contracts, and reward systems.
- **Altering curriculum**: This includes lowering the difficulty level of content.
- **Facilitating progress monitoring**: This includes reading tests orally, providing study guides, retaking tests and modifying grading criteria.

Teachers in effective inclusive classrooms may use one or a combination of several of these adaptation types to meet the needs of diverse learners in the content areas. Classroom teachers should choose adaptations that allow children to remain actively engaged and participating in the lesson and any corresponding activities whenever possible.

Since science classrooms often involve hypothesis development, research, experimentation, data collection, analysis, and conclusion-drawing, a high degree of organization is needed. Organization of materials, procedures and data are all important parts of a science classroom. Often, children are required to do large amounts of reading and comprehension, apply mathematical concepts, handle equipment and recall and communicate concepts. This places a burden on the teachers when planning for effective accommodations for students with special needs. Some of these accommodations are easier than others to provide in the regular classroom.

Table 7.1: Examples of Some Accommodations

Difficulty	Benefits from Accommodation
Following multiple step instructions	Simplify, repeat or clarify directions; call attention to key words in directions; have student repeat or paraphrase directions
Understanding concepts	Provide additional activities (which accommodate for multisensory learning styles) and which help to clarify content information; extend background information with organization of materials, thoughts, data. Provide charts and graphs which might help to organize collected data
Reading and comprehending material	Extend background information; provide audio tapes, outlines, and/or study guides of reading material with language and/or vocabulary Suggest advanced organizers which help students focus on necessary vocabulary or help them utilize previous knowledge; reduce content information and vocabulary required to critical items only.
Recalling and communicating information learned	Provide mnemonics to aid in prompting memory of concepts taught; provide additional review (in game format to motivate)
Applying math concepts	Limit math skills required to functional concepts only; allow use of calculator
Completing tasks on time	Provide additional reminders of due times/dates; help students organize tasks by setting small goals leading to accomplishment of task
Staying in class and focusing on task	Organize activities into smaller chunks, limiting the number of materials in front of a student and limiting the number of multi-step procedures to follow

Difficulty in hearing	Allow preferential seating, outlines of information provided in class, and visual cues from teacher to signal key events such as class transitions
Difficulty with vision	Provide alternative procedures which allow for greater use of the other senses - especially the sense of touch
Performing gross and fine motor tasks	Provide for use of additional or alternative materials which are increased in size, are of lighter weight, do not require fine motor skills, or provide greater safety.

The above ways of content presentation shall be appreciated by all students in your classroom. When a teacher presents the science content through different ways by involving multi-sensory approach and also by taking care of affective aspect; then this can be referred as good teaching not only for children with special needs but also for those who do not have. In the next section we have discussed various techniques in detail for those students who are more challenging.

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.

6) What accommodation techniques you would use while teaching science to slow learners or children with learning difficulties?

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7.6.2 Strategies of Teaching Science in Inclusive Classroom

Inquiry

Inquiry is the most appropriate vehicle for accommodating all learning modalities. Inquiry teaching is a means by which all children are able to construct processes, products, and attitudes in a unique and valid ways that result in meaningful and lasting learning. Constructivism says that all children learn in different ways and inquiry provides the means. Inquiry methodology allows children to develop their own investigations to address questions they raise themselves. It encourages children to take charge of their own learning and children who take charge of their own learning have a greater tendency to develop an internal locus of control.

There are 10 inquiry skills that you should include regularly in science instruction. The first is *observation*. Children must employ this sense to find out/ take information about a topic/subject. Next is *measurement* so they can make observations that are quantitative. Children will need to *classify* things according to similarities and differences and be able to *communicate* their information and ideas to others. They need to *collect, organize*, and *graph* data and explain (*infer*)

their findings. Then they will be better able to *predict* future events and conditions based on their findings. The ability to *interpret data* (find patterns) will help them *construct hypotheses* and conduct *experiments* to test these hypotheses. When teaching science to all learners, these guiding principles are offered. We have already discussed about inquiry based teaching learning in unit 6 of this block.

Peer Tutoring

The children with better knowledge are used as coaches/tutor for their classmate. We know that the child who is the tutor will also enhance his/her knowledge and performance levels as well his/her classmate who is being tutored.

Science classes are great places to implement peer buddies or peer tutoring. Children can be paired with matching of their physical, cognitive and social needs. You may pair a child who is very active with someone who is less active. Some guiding principles for you to use peer tutoring are:

- You need to clearly establish the goal (what exact activity that the pair would do);
- Use a peer as tutor that who you think has mastery over the concept or skill to be taught;
- You must talk to the tutors about kinds of questioning, prompts, feedback or any special adaptations a child (classmate) might need;
- Last but not the least; you must monitor the progress systematically.

You as a teacher can search more strategies which could be beneficial for teaching science in an inclusive classroom.

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.

7) Write any three benefits of peer tutoring strategies while teaching science in inclusive classroom?

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7.7 ADOPTING CRITICAL PEDAGOGY

In Indian teaching-learning scenario, critical pedagogy is advocated through National Curriculum Framework (2005). It states:

> *Critical pedagogy provides an opportunity to reflect critically on issues in terms of their political, social, economic and moral aspects. It entails the acceptance of multiple views on social issues and a commitment to democratic forms of interaction. A critical framework helps children to see social issues from different perspectives and understand how such issues are connected to their lives. Critical pedagogy facilitates collective decision making through open discussion and by encouraging and recognizing multiple views.*
>
> -(NCF, 2005, p. 23)

As a science teacher, you should understand that when we are talking about adopting critical pedagogy in science teaching-learning, our focus is on facilitating learners to challenge, question and analyze the established beliefs. Critical pedagogy nurtures the learners' ability to enquire about things/events/incidents. It helps in contextualization of scientific knowledge. Science is not something which comes from some other world. Learners should be encouraged to enquire about the happenings around them in their immediate environment and adopt scientific method to analyze, question and explore them.

There is a term "Praxis", which is one of the most important elements of critical pedagogy. Praxis means thoughtful examination. Critical pedagogy helps learners in questioning and challenging established norms and motivate them for testing. Recall the discussion held in Unit 3 on process skills in science, critical pedagogy advocates development of process skills among science learners. Critical pedagogy focuses on one more dimension i.e. analyzing in social context and sharing of knowledge.

As a science teacher, you have to provide such environment to your learners where they can learn through variety of ways, like experimenting, exploring, discussing, reflective-thinking, sharing ideas with peers, teachers and other community members.

You should adopt the teaching methods which are promoting critical thinking, observation, analysis of events, inductive-deductive reasoning, critical observation, problem solving etc. so that they can internalize scientific concepts and principles with a critical understanding.

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.

8) Enlist the teaching methods, which you will use for adopting critical pedagogy in Science?

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7.8 LET US SUM UP

As a science teacher, discussion of teaching methods will help you to identify and adopt suitable teaching method for your-teaching learning. Teacher centered teaching methods are not being encouraged much at secondary and senior secondary level in science teaching, but methods like demonstration, lecture-cum-demonstration and laboratory are being used extensively in Indian schools. You can use these methods with caution and improvisation. Learner-centric methods like investigatory projects, heuristic, natural exploration are of much use. You should use these methods more as these methods facilitate construction of knowledge by learners themselves. Cooperative learning methods facilitates social cohesion and learning with cooperation. You can use many methods as part of your classroom teaching. Now-a-days, every classroom is an inclusive classroom. Discussion on adaptations and strategies will facilitate you in making your science classroom inclusive. You should adopt critical pedagogy as it facilitates in acquiring process skills among your science learners.

7.9 UNIT END EXERCISES

1) Compare Lecture and Lecture-cum-demonstration methods. Enlist the merits and limitations of both methods.
2) How will you organize investigatory projects in your secondary level science class? Explain with help of a project plan.
3) Identify few topics in which natural exploration can be used as method of study? Explain the process with the help of any one topic.
4) How can you integrate cooperative learning methods in your science teaching-learning? Explain with examples.

7.10 SUGGESTED READINGS AND REFERENCES

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7.11 ANSWERS TO CHECK YOUR PROGRESS

1) Answer on the basis of your understanding.
2) This method helps learners to examine and explore their ideas in their surroundings. This method asks learners to explore science in their immediate environment by using scientific methods.
3) Answer on the basis of your understanding.
4) Answer on the basis of your understanding.
5) Identification of topic, formation of groups, discussion within group, regrouping, discussion in new group, presentation to whole class
6) Enlist the techniques, which you will use in your science class.
7) & 8. Answer on the basis of your understanding.