CHAPTER 2

INFORMATION PROCESSING MODELS.

2.1 What is 'Information Processing'?

Converting raw data into an organized, meaningful and useful form is called 'Information Processing'. Almost all the knowledge that man has gathered over the ages is the result of this 'Information Processing'. The stimuli received from the environment through the sense organs are processed in the brain and the end product is reflected by the body in the form of its response, which may be verbal or non-verbal.

Bruce and Weil (1978) have described information processing as the way people handle stimuli from the environment, organize data, sense problem, generate concepts and solutions to the problems and employ verbal and non-verbal symbols.

All the processes mentioned above in the information-processing pathway require special 'skills'. These are called the process skills. These skills help
In receiving the stimuli (Observation), organizing data (collection and classification of relevant observations), sensing problems (identifying and defining the problem), generating solution to the problem (formulating hypotheses, testing hypotheses by experimenting or other means, drawing inferences and making conclusions), and responding to the stimuli (applying the knowledge attained, predicting). Since most of these process skills are related to the mind or the thinking process, they stimulate thinking.

2.2 The Information Processing Models of teaching.

Information processing models have been designed to increase the students' ability to process information more powerfully. They are based on well tried out theories of learning. These models help the teacher to present the information in such a way that the students are able to learn and retain it more effectively by operating on it more conceptually. The information processing models encourage the students to interact with the data, classify it, label it, form concepts on the basis of positive and negative exemplars, certain essential attributes, observe and ask questions to seek answers to unsolved problems. A number of research studies on information processing models indicate the effectiveness of these models in learning concepts in science.

There are eight models in the information processing family:

<table>
<thead>
<tr>
<th>Models</th>
<th>Developers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Inductive thinking model.</td>
<td>Hilda Taba</td>
</tr>
<tr>
<td>2. Concept Attainment model.</td>
<td>Jerome Bruner</td>
</tr>
<tr>
<td>3. Mnemonics</td>
<td>Michael Pressley, Joel Levin, Richard Anderson</td>
</tr>
<tr>
<td>4. Advance Organizers</td>
<td>David Ausubel</td>
</tr>
<tr>
<td>5. Scientific Inquiry</td>
<td>Joseph Schwab</td>
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<td>6. Inquiry Training model</td>
<td>Richard Suchman</td>
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<td>7. Synectics</td>
<td>Bill Gordon</td>
</tr>
<tr>
<td>8. Cognitive Development model</td>
<td>Jean Piaget</td>
</tr>
</tbody>
</table>
In this study the information processing models have been used in combination. The objective of the study is not to compare any two or three models. The combined effect of these models has been compared with the traditional (lecture) method. Selection of a particular model for a particular topic depended on the nature of the content and its compatibility with a particular model. Though every topic can be taught with using only one model, freedom to use any model as per convenience makes the teaching-learning process easy and effective. All the eight models of the information processing family have not been used in this study. Only four models have been used as they were found to be more suitable for the topics covered in the study.

A brief description of the four models alongwith suitable illustrations (in the form of lesson plans) is being presented here:

2.3 Inductive Thinking Model.

This model is based on three assumptions:

i. Thinking can be taught.

ii. Thinking is an active transaction between the individual and data.

iii. Processes of thought evolve a sequence that is ‘lawful’.

The three teaching strategies developed by Hilda Taba on the basis of these assumptions are:

i. Concept Formation, which involves:

- Identifying and enumerating the data relevant to the topic.
- Grouping these items into categories whose members have common Attributes.
- Developing labels for the categories.

Hilda Taba has listed various overt activities (apparent) and covert mental operations (hidden) taking place during concept formation (see table 2.1).
### Interpretation of data

Interpreting, inferring and generalizing.

The overt and covert activities taking place at this stage (according to Hilda Taba) are:

<table>
<thead>
<tr>
<th>Overt Activity</th>
<th>Covert Mental Operations</th>
<th>Eliciting Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Identifying critical relationships</td>
<td>Differentiating</td>
<td>What did you notice?</td>
</tr>
<tr>
<td>2. Exploring relationships</td>
<td>Relating categories to each other.</td>
<td>See? Find?</td>
</tr>
<tr>
<td>3. Making inferences.</td>
<td>Determining cause-and-effect relationships.</td>
<td>Why did this happen?</td>
</tr>
<tr>
<td></td>
<td>Going beyond what is given</td>
<td>What does this mean?</td>
</tr>
<tr>
<td></td>
<td>Finding implications, extrapolating</td>
<td>What would you conclude?</td>
</tr>
</tbody>
</table>

Table 2.2
Application of Principles to explain new phenomena (predicting consequences from conditions that have been established). The overt activities and covert mental operations, and the eliciting questions for this teaching strategy have been given in table 2.3.

<table>
<thead>
<tr>
<th>Overt Activities</th>
<th>Covert Mental Operations</th>
<th>Eliciting Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Predicting consequences, explaining unfamiliar phenomena, hypothesizing</td>
<td>Analyzing the nature of the problem or situation, retrieving relevant knowledge</td>
<td>What would happen if...?</td>
</tr>
<tr>
<td>2. Explaining and/or supporting the predictions and hypotheses</td>
<td>Determining the casual links leading to prediction or hypothesis</td>
<td>Why do you think this would happen?</td>
</tr>
<tr>
<td>3. Verifying the predictions</td>
<td>Using logical principles or factual knowledge to determine necessary and sufficient conditions</td>
<td>What would it take for this to be generally true or probably true?</td>
</tr>
</tbody>
</table>

Table 2.3

The syntax of the Inductive Thinking Model has been explained below with the help of an illustration (lesson plan). The topic taken up in the lesson plan is from the lesson on ‘Habitat’ given in class IX science syllabus. The concepts covered in the lesson plan are:

- Classification of living organisms on the basis of their food habits.
- Food chains in nature.
- Importance of food chains.
<table>
<thead>
<tr>
<th>Syntax of Inductive Thinking Model</th>
<th>Example to illustrate (Habitat)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concept Formation</strong></td>
<td>Teacher gives some pictures of plants and animals to the students to classify them into categories on the basis of their <em>food habits</em>. Students start working in groups.</td>
</tr>
<tr>
<td>Enumerating data, Differentiation (What did you see? Note?)</td>
<td>Teacher (to the first group): - How many categories have you formed?</td>
</tr>
<tr>
<td>Students: - four.</td>
<td>Teacher: - O.K. Tell me about any one category.</td>
</tr>
<tr>
<td>Students: - Green plants. All of them prepare their own food and do not depend on others for their food</td>
<td>Second group: - We have a category of animals like cow, horse, and deer that eat grass and other plants.</td>
</tr>
<tr>
<td>Teacher: - Right. Plants are the primary <em>producers</em> of food on this earth. We cannot think of a habitat without plants. Let us see what the second group has to tell.</td>
<td>Teacher: - Very good. Such animals are called <em>Herbivores</em>. Now the third group will tell about a different category.</td>
</tr>
<tr>
<td>Second group: - We have a category of animals like lion, bear, and wolf that eat other animals.</td>
<td>Third group: - We have a category of animals like lion, bear, and wolf that eat other animals.</td>
</tr>
<tr>
<td>Teacher: - Such animals are called <em>Carnivores</em>. In almost all the habitats we come across ‘prey-predator relationship in which a prey (mostly a herbivore) is killed and eaten up by a predator (a carnivore).</td>
<td>Teacher: - Now look in to the pictures once again. Do you find a relationship between them?</td>
</tr>
<tr>
<td>So, through this exercise we have come across different types of organisms and their <em>food habits</em>. How many categories did we find in the pictures?</td>
<td>Students: - Three categories. Producers, Herbivores, and Carnivores.</td>
</tr>
<tr>
<td>Students: - (group 1) lion eats deer and deer eats grass (group 2) Tiger eats rabbit and rabbit eats carrots.</td>
<td></td>
</tr>
</tbody>
</table>
3. Making inferences
Going beyond what is given
Finding implications, extrapolating
(What does this mean?
What would you conclude?)

Application of Principles
1. Predicting consequences,
Explaining Unfamiliar phenomena
Hypothesizing, Analyzing the nature
of the problem or situation, retrieving
relevant knowledge
(What would happen if, . . ?)

1. Explaining and/or supporting the
predictions and hypotheses
Determining the casual links leading
to prediction or hypothesis
(Why do you think this would happen?)
1. Verifying the prediction Using
logical principles or factual knowledge
to determine necessary and sufficient
conditions
(What would it take for this to be
generally true or probably true?)

(group 3) Wolf eats goat and goat eats grass
(Different groups tell the food chains they have in their pictures)

Teacher: - Yes. What do you conclude?
Students: - In every habitat, there are producers, herbivores and carnivores. Carnivores eat herbivores
and herbivores eat producers thus forming a food chain.

Teacher: - Very good. Now tell me what would happen
to the food chain Lion \rightarrow Deer \rightarrow Grass if all
the lions were killed?

Students: - Population of deer will increase.
There will be shortage of grass.

Teacher: - Very good. Now you have seen the
importance of a food chain. If we remove one link from
the chain, the whole balance is disturbed.

Think of other food chains and the effect of a missing
link on the other components of the chain.

Students work on different food chains and come out
with different responses.
Instructional and Nurturant effects of Inductive Thinking Model:

2.4. Concept Attainment Model.

Concept attainment is "the search for and listing of attributes that can be used to distinguish exemplars from nonexemplars of various categories" (Bruner, Goodnow, and Austin, 1967). The concept attainment model is concerned with the nature of concepts and the thinking processes that lead to their learning.

The nature of a concept
A concept has a specific name and is known by certain characteristics, which help in its identification, its distinguishing properties, which differentiate it from other similar concepts. These characteristics/properties are called the attributes of a concept. These attributes may be essential (always present) or non-essential (may not be always present). All examples that show these attributes are called the positive exemplars and all examples that do not represent these attributes are called the negative exemplars.
Learning of a concept through concept attainment model requires
(a) identifying the concept through a given list of positive and negative exemplars,
(b) testing whether the concept has been rightly identified, and
(c) defining the concept on the basis of its essential attributes (characteristics which a concept always carries).

The Concept Attainment Model involves presentation of data to the students in the form of sets of items called exemplars and nonexemplars. The exemplars possess the characteristics or attributes to be taught to the students and the nonexemplars do not possess them.

By comparing the positive and negative exemplars, the students develop hypotheses about the nature of the category. They do not, however, share their hypothesis at this point. When most of the students have developed a hypothesis, some unlabelled exemplars are presented to them. If the students are able to identify the positive exemplars, they are asked to produce some of their own. At this stage, the students are asked to share their hypothesis and describe the progression of their ideas during the process. When the students agree on the most likely hypothesis, they generate labels for them.

The syntax of the Concept Attainment Model is given below with an illustration. The topic taken up in the illustration is ‘Motion’ taken up from the science syllabus of class IX. The concepts covered in the lesson plan are:

- Moving objects.
- The starting point of motion- the ‘origin’.
- Definition of motion.
Syntax of the Concept Attainment Model.

<table>
<thead>
<tr>
<th>Phase One: (Focus)</th>
<th>Example to Illustrate (Motion)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction to the model.</strong></td>
<td><strong>Teacher.</strong> Dear students, today we will study about motion. Our method of teaching will be different from the routine method. We will play the game of yes's and no's. You have to think carefully about yes's, what attribute do they have which no's do not have. I will ask you about the concept when I will feel that you have got it in your mind.**</td>
</tr>
<tr>
<td><strong>Presentation Of Data and Identification Of Concept.</strong></td>
<td><strong>Now let's start the game.</strong></td>
</tr>
<tr>
<td>Teacher presents labeled examples.</td>
<td><strong>Teacher provides positive and negative exemplars to the students (at least 8-10 pairs).</strong></td>
</tr>
<tr>
<td>Students compare attributes to positive and negative examples.</td>
<td><strong>Positive exemplars</strong></td>
</tr>
<tr>
<td>Students generate and test hypothesis</td>
<td>Car yes</td>
</tr>
<tr>
<td><strong>Phase Two:</strong></td>
<td>Cycle yes</td>
</tr>
<tr>
<td><strong>Testing Attainment Of The Concept.</strong></td>
<td>Airplane yes</td>
</tr>
<tr>
<td>Students share their thinking.</td>
<td>Horse yes</td>
</tr>
<tr>
<td><strong>Phase Three:</strong></td>
<td>Fan yes</td>
</tr>
<tr>
<td>Analysis Of Thinking Strategy.</td>
<td>Students who have got an idea, please raise your hands.</td>
</tr>
<tr>
<td>Students describe thoughts.</td>
<td>(Students raise their hands. To make the concept clear to all teacher gives more examples.)</td>
</tr>
<tr>
<td><strong>Teacher:</strong></td>
<td><strong>Now look at these examples:</strong></td>
</tr>
<tr>
<td>Students identify additional unlabeled examples as yes or no.</td>
<td>Yes</td>
</tr>
<tr>
<td>Students generate examples.</td>
<td>Train</td>
</tr>
<tr>
<td><strong>Think of the attribute, which is present in the positive exemplars, and absent in negative exemplars.</strong></td>
<td>Hands of a clock</td>
</tr>
<tr>
<td>More students raise their hands. They tell the teacher that positive exemplars are the things that move and negative exemplars are things that don't move.</td>
<td>Dog</td>
</tr>
<tr>
<td><strong>Teacher:</strong></td>
<td><strong>Good. Now I will name certain objects. You will tell me which one is a positive exemplar and which is the negative exemplar.</strong></td>
</tr>
<tr>
<td>Students are able to classify. Teacher asks them to tell examples of positive and negative exemplars.</td>
<td><strong>Hands of a clock?</strong></td>
</tr>
<tr>
<td>Students: Bus, Truck, Rocket, and Moon are positive exemplars. Buildings, mountains, chair, almirah are negative exemplars.</td>
<td><strong>Train?</strong></td>
</tr>
<tr>
<td><strong>Teacher:</strong></td>
<td><strong>Good. Now tell me about the concept.</strong> (Students tell the teacher).</td>
</tr>
<tr>
<td>All positive exemplars are the objects that can move.</td>
<td><strong>All negative exemplars are objects that cannot move.</strong></td>
</tr>
<tr>
<td><strong>Hypothesis</strong></td>
<td></td>
</tr>
</tbody>
</table>
Teacher confirms hypothesis, names concept, and restates definitions according to essential attributes.

Teacher: Very good. All positive exemplars relate to bodies that can move and negative exemplars to bodies that cannot move. Now, how do we say that an object is in motion?

Students: When it moves.

Teacher: When an object changes its position with respect to its earlier position, it is said to be in motion. Can you give me some examples of motion? (Students generate examples)

Teacher: Now tell me what is the difference between the initial stage, the middle stage and the end stage of moving objects? Or, if I say:

Initial stage Yes
Middle stage No
End stage No?

Students: An object starts moving at the initial stage, keeps moving in the middle stage and stops moving at the end stage.

Teacher: The initial stage or the ‘origin’ is the point with respect of which the body is said to have moved. Now look at the following statements:

Avneet went to Goa from Delhi.
Monu went to Karol Bagh from Delhi Cantt.
Vicky went to Bombay from Bhopal.

Tell me what do Delhi, Delhi Cantt, and Bhopal have in common?

Students: They are all the starting points or the ‘origins’.

Teacher: Right. A change of position of an object with respect to the ‘origin’ is called motion.

So, what did we study today?

Students: About moving objects and motion.

Teacher: Very good. In our next class we will study more about motion.
2.5 Advance Organizer Model:

Ausubel's model of Advance Organizers deals with three concerns:

i. How knowledge (curriculum) is organized,

ii. How the mind works to process new information (learning), and

iii. How teachers can apply these ideas about curriculum and learning when they present new material to students (instruction).

According to Ausubel, whether or not material is meaningful depends more on the preparation of the learner and on the organization of the material than it does on the method of presentation. If the learner begins with the right 'set', and if the material is solidly organized, then meaningful learning can occur.

He uses two principles, **progressive differentiation** and **integrative reconciliation**, to guide the organization of content.
Progressive differentiation means that the most general ideas of the discipline are presented first followed by a gradual increase in detail and specificity. Integrative reconciliation means that new ideas should be consciously related to previously learned content.

The advance organizer model has three phases of activity.

**Phase one** is the presentation of the advance organizer, which consists of three activities:

1. Clarifying the aims of the lesson. It helps to obtain students attention and orients them to their learning goals. It is also useful to the teacher in lesson planning.
2. Presenting the advance organizer. Advance organizer is different from introductory comments. The organizer is built around the major concepts and is at a higher level of abstraction and generality than the learning material itself. Whether the organizer is expository or comparative, the essential features of the concept or proposition must be pointed out and carefully explained.
3. Prompting awareness of relevant knowledge. It is important to prompt awareness of the learner's prior knowledge and experiences that might be relevant to the learning task and organizer.

**Phase two** is the presentation of the learning task or learning material.

The learning material is presented in the form of lectures, discussions, films, experiments, or readings. During the presentation, the organization of the learning material needs to be made explicit to the students so that they have an overall sense of direction and can see the logical order of the material and how the organization relates to the advance organizer.

**Phase three** tests the relationship of the learning material to existing ideas to bring about an active learning process. It's purpose is to anchor the new learning material in the student's existing cognitive structure. The four
goals of this phase are (i) promoting integrative reconciliation, (ii) promoting active reception learning, (iii) eliciting a critical approach to the subject matter, and (iv) clarification.

The syntax of the Advance Organizer Model is given below with an illustration. The topic taken up in the lesson plan to illustrate the model is ‘Habitat’ from the science syllabus of class IX. The concepts covered in the lesson plan are:

- Definition of ‘Habitat’.
- Components of a habitat.
- Types of habitats.
- Micro habitat.

**Syntax of the model**

**Phase One**

**Presentation of Advance Organizer**

Clarify aims of the lesson.

**Present Organizer:**

- Identify defining attributes.
- Give examples.
- Provide context.
- Repeat.
- Prompt awareness of learner’s relevant knowledge and experience.

**Example to illustrate**

(Habitat)

The teacher will present the organizer in the form of an incident written on a chart paper. The students will process the information to find out the reason for the given incident. In the process of doing so, they will learn the desired concepts.

*Last year some rare Himalayan birds were brought to the Delhi zoo. The zoo officials tried their best to provide them a comfortable enclosure but it was far from being similar to their native place. The birds died within a few weeks.*

Teacher: What could be the cause of death of birds?

Students: (Different answers are expected) Delhi was too hot for them. Or they could not get the right kind of food.

Teacher: Let us find out. Can you name some animals that you have seen in the Delhi Zoo?

Students: Lion, Bear, Elephant, Monkeys, and Crocodiles.

Teacher: Do you know where they are found in nature?

Students: These animals are found in jungles. Lions and bears live in Caves. Monkeys live on trees. Crocodiles live in water.
Teacher: Yes. All the wild animals are more comfortable in jungles than in the zoo. Every living organism has a choice of the place where it likes to live. The place, which fulfils its requirements of food, shelter and breeding. This **dwelling place of the organism is called its ‘Habitat’**.

Can you name the habitat of a fish?

Students: Yes. The habitat of a fish is a pond, a river or a sea.

Teacher: Very good. Now let us know more about the habitat.

Every habitat has two components:

1. **Physical Components** like air, water, temperature, humidity, sunlight, soil etc.
2. **Biotic Components** like the plant and animal species living together at that place.

Habitats can be classified into three major categories:

- **Terrestrial** (terra – ground): Aquatic (aqua – water) and Arboreal (arbor – tree).
- Organisms living on land are called terrestrial organisms.
- Organisms living in water are called aquatic organisms and organisms flying in air and nesting on trees/branches are called arboreal organisms.

For students: - **Make a list of five terrestrial, five aquatic and five arboreal organisms**.

Teacher: Where would you place a frog?

Students: Frogs live in water as well as on land.

Teacher: Yes. Frogs can live comfortably in water as well as on land. Such organisms are called **Amphibians**.

Within a habitat, organisms have preferences to live in a specific part. For example, farm rats prefer to dig holes in the farms. Desert rats dig deep burrows in the deserts and live there. These small units/dwelling places within a habitat are known as **microhabitats**.
Phase Three

Strengthening of Cognitive Organization.

Use principles of integrative reconciliation.

Promote active reception learning.

Elicit critical approach to subject matter.

Clarify

Teacher: Now that you know all about a habitat and its components, let's find out why the Himalayan birds died in Delhi zoo.

Answer my questions one by one. Look at the chart once again. Now can you explain the term "but it was far from being similar to their native place".

Students: The environment of the zoo was not like that of the Himalayas. Zoo was not their natural habitat.

Teacher: How is the environment of Delhi different from that of the Himalayas?

Students: Delhi is hot whereas Himalayas are very cold. Delhi is a plain whereas Himalayas are high mountains.

Teacher: What were the Himalayan birds missing in the Delhi zoo?

Students: Cool climate, snow, fresh air, clean water.

Teacher: Very good. What else?

Students: Their food. Plants and insects.

Teacher: Yes. Is there anything else?

Students: Their friends. Other birds, animals, plants.

Teacher: Good. Can you classify all these things into the physical and biotic Components of the Himalayan habitat?

Students: Yes teacher. The physical components are air, water, mountains, low temperature snow, rocks etc. The biotic components are the plants, animals and birds living there.

Teacher: Very good. Now that you have learnt the three major types of habitats, to which type do you think the Himalayan birds belong?

Students: The arboreal habitat.
Teacher: Very good. Can you name their microhabitat as well?

Students: Yes. The area, which contains trees and bushes on which the birds live, is their microhabitat.

Find out the habitats/microhabitats of the following: Bengal tiger, rhinoceros, langur, whale, starfish, penguin, seal, and lion. Try to find out details about the physical and biotic components of these habitats/microhabitats.

Instructional And Nurturant Effects of advance Organizer Model.
2.6. Inquiry Training Model.

Inquiry Training model is based on Suchman's theory that:

- Individuals faced with a puzzling situation are naturally motivated to solve the puzzle.
- They can become conscious of and learn to analyze their thinking strategies.
- New strategies can be taught directly and added to the students' existing ones.
- Co-operative inquiry enriches thinking and helps students to learn about the tentative, emergent nature of knowledge and to appreciate alternative explanations.

Inquiry training has five phases.

1. The first phase is the student's confrontation with the puzzling situation. It requires that the teachers present the problem situation and explain the inquiry procedures to the students (the objectives and the procedure of the yes/no questions).

2. Phase two is the data gathering operation of verification. The students ask a series of questions to which the teacher replies 'yes' or 'no'. It is the process whereby students gather information about an event they see or experience.

3. Phase three is the data gathering stage of experimentation. In this phase, the students introduce new elements into the situation to see if the event happens differently. Experiments serve two functions: exploration i.e. changing things to see what will happen, and direct testing, whereby students try out a theory or a hypothesis.
4. **Phase four is organizing and formulating an explanation.** The teacher calls on the students to organize data and to formulate an explanation. If the students have any difficulty in doing so, the teacher may give inadequate explanation, omitting essential details. Together the group can shape the explanation that fully responds to the problem.

5. **Phase five is the analysis of the inquiry process.** The students are asked to analyse their pattern of inquiry. They discuss about the questions that were most effective and those which were not, or the information they needed and did not obtain.

Syntax of the model is presented below with a lesson plan to illustrate. The lesson plan is on ‘Photosynthesis’ a subunit of the lesson ‘Life Processes- 1’ taken from the science syllabus of class IX.

**Syntax of the Inquiry Training Model**

**Phase One.**  
**Confrontation with the problem.**  
Explain inquiry procedures

Present discrepant event.

**Example to Illustrate**  
(Chlorophyll is necessary for photosynthesis)

Teacher- Here is a puzzling situation for you to solve. I will present the puzzling situation. You have to solve the puzzle by asking questions. You should frame the questions in such a way that I will be able to answer in ‘yes’ or ‘no’. If a question is not answerable in yes or no, I will ask you to reframe the question. Do not ask any question starting with ‘what’, ‘which’ or ‘when’. Have you clearly understood the rules of the game? Students- ‘Yes’

Teacher- I have something to show you. Look carefully. I have two leaves in two petridishes before you. I have removed the color pigments of the leaves by boiling them in alcohol. Both the leaves have been washed with water as well. Now I will pour iodine solution on both of them to test for the starch content.
(After pouring the iodine solution) See one leaf has totally changed in to blue-black color. The other one has only partially changed its color to blue-black. Now tell me what is the puzzling situation?

Students: The second leaf has only partially turned blue-black. That means starch is present only in certain parts of the leaf.

Students: Have you taken both the leaves from the same plant?
Teacher: No

Students: Were both plants getting proper sunlight?
Teacher: Yes.

Students: Was the second leaf covered under the shadow of other leaves?
Teacher: No.

Students: Was the second plant well watered?
Teacher: Yes.

Students: Were the plants getting equal amount of carbon-dioxide?
Teacher: Yes.

Students: Was the second leaf too old i.e. about to fall?
Teacher: No.

Students: Was it too young?
Teacher: No.

Students: Was the second leaf healthy?
Teacher: Yes.

Students: Were both the leaves green?
Teacher: No.

Students: Was the second leaf partially green?
Teacher: Yes.

Students: Has only the green part of the leaf turned blue-black with iodine solution?
Teacher: Yes.

Phase Two.
Data gathering--------

Verification.

Verify the nature of the objects and conditions.

Verify the occurrence of the problem situation.

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Phase Three.
Data Gathering—Experimentation

Isolate relevant variables.

Hypothesize (and test) casual relationships.

Phase Four.
Organizing, Formulating and Explanation

Formulate rules or explanations.

Phase Five.
Analysis of the Inquiry Process

Analyze inquiry strategy and develop more effective ones.

(Students repeat the experiment. They bring the leaves of the two plants, one totally green and the other partially green, boil the two in alcohol and test with iodine solution. They get the same result once again.)

Students: - Is green color of the leaves due to chlorophyll?
Teacher: - yes.
Students: - Starch is present only in areas where chlorophyll is present.
Teacher: - yes.

Students: - It means that chlorophyll is essential for starch formation.
Teacher: - Very good. Now can you name the process in which starch formation takes place?
Students: - It is photosynthesis.
Teacher: - Very good. So, what conclusion have you derived out of this exercise?
Students: - Photosynthesis takes place only in those parts where chlorophyll is present. Or, Chlorophyll is essential for photosynthesis.

Teacher: - Very good. Let us now review the process we followed to arrive at the right conclusion. What did we do first?
Students: - You presented the problem and we found out the discrepancy in that problem.
Teacher: - Yes, what we did after that?
Students: - We asked fact-finding questions which be answered in 'yes' and 'no' by you.
Teacher: - What did you do when you had a guess?
Students: - We tested the guess by asking questions and experimenting.
Teacher: - How did you reach the conclusion?
Students: - we collected the facts one by one and gradually came to the conclusion.
Teacher: - did you like the game? Students: - Yes, of course.
Instructional and Nurturant Effects of Inquiry Training Model:

- Instructional
- Nurturant

Inquiry Training Model

- Tentative Nature of Knowledge
- Scientific Process
- Strategies for Creative Inquiry
- Spirit of Creativity
- Independence of Autonomy in Learning
- Tolerance to Ambiguity