HEURISTIC METHOD

RISK PERCEPTION

RISK ASSESSMENT

RISK MANAGEMENT

Name: ________________________.


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Subject: TEACHING OF SCIENCE.
Heuristic Method

One of the most important aspects of the problem solving approach to children’s development in scientific thinking is the teacher’s attitude. His approach should be teaching science with a question mark instead of with an exclamation point. The acceptance of and the quest for unique solutions for the problem that the class is investigating should be a guiding principle in the teacher’s approach to his programme of science.

In Heuristic method (The word ‘Heuristic’ means to discover), the student be put in the place of an independent discoverer. Thus no help or guidance is provided by the teacher in this method. In this method the teacher sets a problem for the students and then stands aside while they discover the answer.

In words of Professor Armstrong, "Heuristic methods of teaching are methods 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".

The method requires the student to solve a number of problems experimentally.

To almost every one — especially children — experiments and science are synonymous. Once an idea occurs to a scientist he immediately thinks in terms of ways of trying out his ideas to see if he is correct. Trying to confirm or disprove some thing, or simply to test an idea, is the backbone of the experiment. Experiments start with questions in order to find answers, solve problems and clarify ideas or just to see what happens. Experimenting should be part of the elementary school science programme as an aid to helping children find solutions to science problems as well as for helping them to develop appreciation for one of the basic tools of science.

Objectives:

By this heuristic method a student
- can solve a problem by using his scientific attitude
- explains his activities to be done
- demonstrates the experiments
- illustrates the results of the experiments
- acquires the knowledge about the new concepts
- thinks independently
- collects and analyses the data for information.
Procedure / Method:

Teacher should give the work sheets (Information Sheets) to each student to solve the problems written or depicted in it. Students themselves solve the problems given in the work sheet through the appropriate experiments. The experiments can be done with the help of hints given in the work sheet or with the guide lines provided by the teachers.

In this method, it is not mandatory that the student must carry out the experiments instantly. Teachers should give appropriate help or guidelines to the students whenever felt necessary.

The students have to do the experiments as detailed in the work sheet and record the events or effects occurred during the experimentation.

The recorded information during and at the end of experiments must be analyzed for final results. This the final stage of this method. In this method the child behaves like a research scholar and discovers the truth.

Hence, the heuristic method is a method which can give adequate training for discovery and experimentation or research. This method prefers the discovery and practice than knowing the concepts.

Procedure of the Method

The method requires the students to solve a number of problems experimentally. Each student is required to discover everything for himself and is to be told nothing. The students are led to discover facts with the help of experiments, apparatus and books. In this method the child behaves like a research scholar.

In the stage managed heuristic method, a problem sheet with minimum instructions is given to the student and he is required to perform the experiments concerning the problem in hand. He must follow the instructions, and enter in his note book an account of what he has done and results arrived at. He must also put down his conclusion as to the bearing which the result has on the problem in hand.

In this way he is led to reason from observation. Essentially therefore, the heuristic method is intended to provide a training in method. Knowledge is a secondary consideration altogether. The method is formative rather than informational.

The procedures and skills in science problem solving can only be developed in class rooms where searching is encouraged, creative thinking is respected, and where it is safe to investigate, try out ideas.
Teachers Attitudes & Responsibility in Heuristic Method

Teachers must develop sensitiveness to children and to the meanings of their behaviour. Teachers should be ready to accept any suggestion for the solution of problems regardless of how irrelevant it may seem to him, for this is really the true spirit of scientific problem solving. By testing various ideas, it can be shown to the child that perhaps his suggestion was not in accord with the information available. It can then be shown that this failure gets as much closer to the correct solution by eliminating one possibility from many offered by the problem.

- In this method, teacher should avoid the temptation to tell the right answer to save time.
- The teacher should be convinced that road to scientific thinking takes time.
- Children should never be exposed to ridicule for their suggestions of possible answers otherwise they will show a strong tendency to stop suggestions.
- For success of this method, a teacher should act like a guide and should provide only that much guidance as is rightly needed by the student.
- He should be sympathetic and courteous and should be capable enough to plan and devise problems for investigation by pupils.
- He should be capable of good supervision and be able to train the pupils in a way that he himself becomes dispensable.

Steps in Heuristic Method
The following steps are followed in the heuristic method:

Planning -
- Creating of Objectives
- Identification of Problem
- Arriving for appropriate solutions for the problem

Execution -
- Perceiving and observing for accurate results
- Recording of the results observed

Conclusion -
- Formulation of hypothesis
- Identification / Arriving the accurate solution.

As an adjective, heuristic (pronounced hyu-RIS-tik and from the Greek "heuriskein" meaning "to discover") pertains to the process of gaining knowledge or some desired result by intelligent guesswork rather than by following some pre-established formula. (Heuristic can be contrasted with algorithmic.)

As a noun, a heuristic is a specific rule-of-thumb or argument derived from experience. The application of heuristic knowledge to a problem is sometimes known as heuristics.

Example - 1:
Using this Heuristic method the student-teacher can teach the lesson `Acids, Bases and Salts` as illustrated below:

Acids, Bases and Salts
Sources - properties and types of acids;
Sources - properties and types of bases;
Sources - types and properties of salts;
Phase 1: Role of Teacher – Preparation of Information Sheets

The above mentioned unit can be taught and the students can understand the unit by this heuristic method. Preparation of the Information sheet (Work sheet) should be done by the Teacher. For the above mentioned topic the problems should be depicted as follows:

Information Sheet:

- What are the acidic foods / compounds?
- Mention the name of the acid present in the Milk?
- Which fruit bears Maleic acid?
- Is there acids available in inorganic compounds?
- Name the acid present in lemon.

Problem: Teacher can give the following notes for the question What are the acidic foods / compounds?

Note: The Acidity of a food or compound is ensured by its sour taste. The blue litmus paper can be used to find the acidity of a compound.

Phase 2: Students’ Role – Experimentation

The students who select the Information sheet (work sheet of above mentioned topic) should do the experiments described in it for the answers / results / solution:

Experimenting:

The sour tasted compounds and food components are known as Acidic in nature. Students can know the acidity of the compounds through taste (the non toxic, non-corrosive, weak solutions of the compound or food samples must be used). The substances such as vinegar, Lemonade, tamarind solution, are acidic in nature.

The acidity of substances can be affirmed through the litmus test. In order to conduct the litmus test the following are kept ready.

Aim: To affirm the acidity of the given substance through litmus test.

Apparatus and Reagents required: Sample substances (ex. Tamarind, etc.), water, Glass beakers or test tubes and Blue litmus paper.

Procedure: In a beaker or test tube, the sample substances must be soaked and dissolved with sufficient amount of water. Then a blue litmus paper is inserted in the solution at the beaker or test tube for a few seconds.

Observation: Observe the color change in the litmus paper.

Result: If the blue litmus turns red the solution is affirmed as acidic other wise non-acidic in nature.
By following the instructions and guidelines of the teacher the students acquire the solution for the problem depicted in the Information sheet (work sheet). Likewise, the students can solve the other problems in the information sheet (with the help or guidelines from the teacher whenever necessary).

Example -2: Germination of Seeds.

The lesson germination can be taught effectively with this approach. The factors, period of germination can be easily known by the students themselves through the experimentation. The seeds and other equipments for this experimentation are widely available. The environment and equipments can easily procured by the students themselves. Students also show their interests in experiments and results. The following steps and method can be used to conduct the experiment which can motivate the students in their learning experiences.

Phase 1: Role of Teacher – Preparation of Information Sheets

**Problem:** How do the seeds germinate?
What are the factors of seed germination?

**Note:** The germination of the seed requires good seed, red soil, water, sunlight, air.

**Recording the Changes / events:**
The blue litmus turns red in color when it is exposed into the sample (tamarind or vinegar) solution.
The Acids change the color of the Blue litmus in to red
This change must be noted by the student.

**Conclusion:**
From the observation and findings the students can derive the inference; the substance (Tamarind solution) is acidic in nature.
Phase 2: Students’ Role – Experimentation

The student who proposed to solve the problem given in the information sheet on seed germination has to collect the information or guidelines from the teacher and gather the seeds and other necessary tools and equipments. He should conduct the experiments as follows.

Experimenting:

**Aim:** To identify the factors of seed germination.

**Apparatus and Reagents required:** Bean seeds of good quality, a defective seed, Glass beakers, red soil.

**Procedure:** Take five glass beakers (100 ml) and label them as 1, 2, 3, 4 and 5. Fill the red soil up to ¾ level of each beaker except the last one. Leave the fifth beaker without red soil. Plant the bean seeds of good quality in the first three beakers. Plant a defective bean seed in the fourth beaker. Place a good seed in the beaker without soil.

Keep the beakers numbered 1 and 4 in the place where the sun light is available outside.

Keep the beakers numbered 2 and 3 within the shelf or almirah where there is no light.

Keep the beaker number 5 outside where the sunlight is available.

**Observation and maintenance:** Students has to look out the seed growth with proper care and observe the changes happening with the seeds. This can be done with the help of guidelines / instruction from the teacher also.

Students has to water the seeds at the beakers numbered 1, 3, 4 and 5 for five to six days regularly during morning time. No watering to the beaker 2.

After five or six days students has to observe the change in the seeds placed in the beakers.

If necessary, information given about the seed germination at the text books can be compared and arrive the final conclusion.

**Recording the changes:**

Each and every seed is observed for the changes happened. The changes need be recorded:

<table>
<thead>
<tr>
<th>Beaker No.</th>
<th>Changes on the seed effected on 5th day</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Seed germinates shows full growth.</td>
<td>This good quality seed in this beaker has sufficient amount air, soil, water and sunlight.</td>
</tr>
<tr>
<td>2</td>
<td>Seed had dried. Not germinated.</td>
<td>This good quality seed needs water to grow hence it dried.</td>
</tr>
<tr>
<td>3</td>
<td>Seed had grown and not germinated.</td>
<td>This good quality seed needs shows a little growth but no germination is effected. Because it need sunlight.</td>
</tr>
<tr>
<td>4</td>
<td>Seed had not grown and germinated.</td>
<td>This seed is a defective one. So it has no germination.</td>
</tr>
<tr>
<td>5</td>
<td>Seed is perished and not germinated.</td>
<td>This good quality seed needs soil to cater itself. so that it perished. It loses its germination capability.</td>
</tr>
</tbody>
</table>

**Result:** The factor of seed germination are healthy seed, red soil or garden soil (soil with essential nutrients), air, sunlight and water.
With the experiments and the results of observation, the students learnt that the seeds require healthy and the sufficient air, water, sunlight and soil with essential nutrients. The experiments can be done by the students themselves give ample curiosity and scientific attitude for them.
Example -2: Reflection of Light.

From the lesson Light, the unit comprising the Light reflection and Laws of reflection of light and proof for the laws can be illustrated through this method. The experiments on plane mirror can be conducted by the students and the laws can be understood practically by them.

Phase 1: Role of Teacher – Preparation of Information Sheets

Problem: What is reflection?
What are the laws of reflection?

Note: Plane mirror reflects almost all of light which falls on it through the same medium it has traveled.

Phase 2: Students’ Role – Selection of Information sheet

The students who opts this information sheet will be given the guidelines. The laws of reflection are stated as follows:

- The incident ray, the reflected ray and the normal to the reflection surface at the point of the incidence lie in the same plane.
- The angle which the incident ray makes with the normal is equal to the angle which the reflected ray makes to the same normal. (i.e. the angle of reflection is equal to the angle of incidence)

In order to define and prove the reflection and laws of reflection the experiment need be conducted by the student with the following tools or equipments: Drawing board, Plane mirror, Pins and white paper etc.,

Experimenting:

Aim: To explain the phenomenon reflection and prove the Laws of reflection using plane mirror.

Apparatus and equipment or tools required: Drawing board, Plane mirror of size 12 cm x 3 cm, Pins and white paper.

Procedure: To view an image of a pencil or pin in a mirror, you must sight along a line at the image location. As you sight at the image, light travels to your eye along the path shown in the diagram. This shows that the light reflects off the mirror in such a manner that the angle of incidence is equal to the angle of reflection. It just so happens that the light which travels along the line of sight to your eye follows the law of reflection.
Place a sheet of white cardboard perpendicular to the reflecting surface of plain mirror, and we send a pencil of light to the surface of the mirror so that it just skims along the surface of cardboard. Pencil which strikes the surface of the mirror is called the *incident pencil* and the pencil which is reflected by the surface is called the *reflected pencil*. Results of the experiment are shown in the following diagram.

This experiment leads us to the conclusion that when light is reflected from a plane specular surface, the incident ray, the normal (the perpendicular to the surface at the point of contact), and the reflected ray all lie in the same plane. This statement is called the first law of reflection. Now we can measure the angles between the normal and two rays by placing a white plastic protractor instead of the cardboard. We can repeat measurements for different angles of incidence but conclusion will be always the same: the angle of reflection \( r \) is equal to the angle of incidence \( i \). This statement is called the second law of reflection.

In the diagram, the ray of light approaching the mirror is known as the *incident ray* (labeled \( I \) in the diagram). The ray of light which leaves the mirror is known as the *reflected ray* (labeled \( R \) in the diagram). At the point of incidence where the ray strikes the mirror, a line can be drawn perpendicular to the surface of the mirror. This line is known as a *normal line* (labeled \( N \) in the diagram). The normal line divides the angle between the incident ray and the reflected ray into two equal angles. The angle between the incident ray and the normal is known as the *angle of incidence*. The angle between the reflected ray and the normal is known as the *angle of reflection*. (These two angles are labeled with the Greek letter \( \theta \).)
accompanied by a subscript; read as "theta-i" for angle of incidence and "theta-r" for angle of reflection.) The law of reflection states that when a ray of light reflects off a surface, the angle of incidence is equal to the angle of reflection.

Recording the Changes: The experiments will be conducted as per the instruction of the teacher and the result are recorded as in the following table.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Angle of Incidence</th>
<th>Angle of Reflection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>60</td>
<td></td>
</tr>
</tbody>
</table>

Conclusion: By the results obtained the students understand the laws of reflection.

Merits of Heuristic Method

This method of teaching science has the following merits:

- It develops the habit of enquiry and investigation among students.
- It develops habit of self learning and self direction.
- It develops scientific attitudes among students by making them truthful and honest for they learn how to arrive at decisions by actual experimentations.
- It is psychologically sound system of learning as it is based on the maximum, "learning by doing"
- It develops in the student a habit of diligence.
- In this method most of the work is done in school and so the teacher has no worry to assign on check home task.
- It provides scope for individual attention to be paid by the establishing cordial relations between the teacher and the taught.
Limitations of Heuristic Method

Main limitations of this method are as under:

- It is a long and time consuming method and so it becomes difficult to cover the prescribed syllabus in time.
- It pre-supposes a very small class and a gifted teacher and the method is too technical and scientific to be handled by an average teacher.
- The method expects of the teacher a great efficiency and hard experience and training.
- There is a tendency on the part of the teacher to emphasize those branches and parts of the subject which lend themselves to the subject which do not involve measurement and quantitative work and are therefore not so suitable.
- It is not suitable for beginners. In the early stages, the students need enough guidance which if not given, may greatly disappoint them and it is possible that the child may develop distaste for studies.
- In this method too much stress is placed on practical work which may lead a student to form a wrong idea of the nature of science as a whole.
- They grow up in the belief that science is some thing to be done in the laboratory, forgetting that laboratories were made for science and not science for laboratories.
- The gradation of problems is a difficult task which requires sufficient skill and training.
- The succession of exercises is rarely planned to fit into a general scheme for building up the subject completely.
- Sometimes experiments are performed merely for sake of doing them.
Learning by this method, pupils leave school with little or no scientific appreciation of their physical environment.

The romance of modern scientific discovery and invention remains out of picture for them and the humanizing influence of the subject have been kept away from them.

Evaluation of learning through heuristic method can be quite tedious.

Presently enough teachers are not available for implementing learning by heuristic method.

This method cannot be successfully applied in primary classes but this method can be given a trial in secondary classes particularly in higher secondary classes. However, in the absence of gifted teachers, well equipped laboratories and libraries and other limitations this method has not been given a trial in our schools. Even if these limitations are removed this method may not prove much useful under the existing circumstances and prevailing rules and regulations. Though not recommending the use of heuristic method for teaching of science it may be suggested that at least a heuristic approach prevails for teaching of science in our schools. By heuristic approach we mean that students be not spoon fed or be given a dictation rather they be given opportunities to investigate, to think and work independently along with traditional way of teaching.

The application of heuristic knowledge to a problem is sometimes known as heuristics. The term seems to have two usages:

1) Describing an approach to learning by trying without necessarily having an organized hypothesis or way of proving that the results proved or disproved the hypothesis. That is, "trial-by-error" learning.

2) Pertaining to the use of the general knowledge gained by experience, sometimes expressed as "using a rule-of-thumb." (However, heuristic knowledge can be applied to complex as well as simple everyday problems. Human chess players use a heuristic approach.)