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# The Use of Discrepant Events in Teaching and Learning Science

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## What is a Discrepant Event?

A discrepant event is a phenomenon which has a surprising and paradoxical outcome that is not what the observer would normally expect. Consider for example, the potato which when put into two containers of identical looking liquids, remains suspended in one but sinks in the other. Or the case of the knitting needle that is pierced right through a full-blown balloon without bursting it. This kind of occurrence which runs counter to one's intuition, tends to evoke a strong feeling of "wanting to know more about how it works", and a consequent need to solve the discrepancy in one's mind. It challenges the observer to find answers to the seemingly illogical results of the event to resolve the conceptual conflict that arises.

## Why use Discrepant Events?

In teaching a science concept or principle, it is important for the teacher to arouse the students' curiosity. The use of discrepant events is one method which can capitalize on students' curiosity as the discrepancy itself piques students' interest and compels them to seek a solution to the "mystery". When students are strongly motivated, conditions are favourable for learning.

The use of discrepant events in Science has its base in Festinger's (1957) Theory of Cognitive Dissonance. According to this theory, the existence of cognitive dissonance or inconsistency creates a psychological discomfort that will motivate a person to reduce the dissonance and actively seek consonance or mental equilibrium. In the case of discrepant events, the incongruity between what is physically observed to occur and what students think should occur upsets their intellectual equilibrium and impels them to change their existing

intellectual scheme. In their search for information which will logically explain the occurrence, students are involved in the process of inquiry and problem-solving which are so essential in scientific investigations.

## **Use of Discrepant Events in Promoting the Processes of Science**

How can the discrepant event be used in a Science lesson? Although not every conceivable topic or scientific principle lends itself to the use of discrepant events, many Science investigations, especially at the upper primary and secondary level, have the potential for the unexpected. Wherever possible, the teacher can consciously plan experiments or demonstrations which cause the students to experience cognitive dissonance. The students are then asked to predict what will happen, observe if anything unexpected has occurred and explain the phenomenon or event being investigated.

Friedl (1986) outlines three general steps that may be used when utilizing discrepant events.

### **1. Set up the Discrepant Event**

The teacher creates a situation with a paradox or discrepancy that students attempt to solve. This could be a perplexing problem or a demonstration by the teacher where the students then try to reproduce the event themselves.

### **2. Involve Students in Solving the Discrepancy**

Ask the students to write predictions stating what they think will happen before carrying out the activity. They then make their observations, noting down anything unexpected, with the teacher guiding them by asking appropriate questions that will lead them to the scientific cause of the discrepancy. Writing down their discoveries helps students to organize their thoughts and internalize what they are learning. From their observations, students formulate testable hypotheses and design further experiments to test them.

Invite students for possible explanations for the discrepancy between what they thought would happen and what actually happened.

Students could work individually or discuss in pairs or groups. In attempting to resolve the discrepancy, students will be engaged in science inquiry and practising the science processes of predicting, observing, questioning, recording data, interpreting data, hypothesizing and inferring which are so very much advocated by Science programmes.

### 3. **Resolve Questions Posed by the Event and relate them to the body of Scientific Knowledge**

By their own direct experiences, students will find the answers to many of the questions posed by the discrepant event. They would have a vested interest in the outcome, and even if they are unsuccessful in finding the answers, the teacher's explanation will not be so abstract as they would have been involved with the event. It is important for the teacher to bring closure to a discrepant event and guide students to a conclusion, so as not to generate confusion, or even frustration, in their living with the unexplained.

### **Some Activity Ideas**

Wherever possible, simple daily life materials which are familiar to students can be used when carrying out activities employing discrepant events. When the concept underlying the event is placed in context and related to everyday experiences that the learner can identify with, it will become more meaningful to him or her.

The following are some examples of discrepant events.

#### 1. **The Two Pepsis** (adapted from Halpin & Swab, 1990)

Concept : Density, mass-volume relationship, sinking and floating

Materials : Regular Pepsi, Diet Pepsi, container of water.

Procedure : • Place 2 cans, a Regular Pepsi and a Diet Pepsi, into a container of water. One floats while the other sinks.

- Students hypothesize why the cans behave differently and design procedures to test their hypotheses. Some typical student responses may include differences in packaging, mass, volume, density, degree of carbonation or chemical constituents.
- Discussion may also tie the physical phenomenon investigated to how biological organisms such as fishes, birds and sea-weeds use the principle of density as an adaptation to life.

Explanation : The Regular Pepsi sinks but the Diet Pepsi floats. This is due to the difference in the density of the two liquids because of the difference in the mass of sugar and aspartame in Nutrasweet, the artificial sweetener in the Diet Pepsi.

## 2. **The Confused Waters** (adapted from Ruck et al, 1991)

Concept : Convection currents

Materials : 4 glass jars, food colouring (blue, yellow), 2 index cards.

- Procedure :
- Fill two jars with cold water and the other two with warm water. (Do not tell students the temperature differences.)
  - Add a few drops of food colouring to the jars as follows:
    - C<sub>1</sub> – cold water, blue colouring
    - C<sub>2</sub> – cold water, yellow colouring
    - W<sub>1</sub> – warm water, blue colouring
    - W<sub>2</sub> – warm water, yellow colouring
  - Cover the blue jars with index cards. Invert them so that the one with cold water (C<sub>1</sub>) is on top of the yellow jar with warm water (W<sub>1</sub>), and the one with warm water (W<sub>2</sub>) is on top of the yellow jar with cold water (C<sub>2</sub>).
  - Students predict what will happen when the cards are removed.

- The blue water from the first set-up flows into the yellow to produce a column of green. In the second set-up, the colours remain separated and there is no mixing.

Explanation : The less dense warm water (W) in the first set-up rises and the cold water (C) sinks, setting up convection currents. In the second set-up the warm water is above the cold water and no convection currents occur.

### 3. **Blue Bottle** (adapted from Wright, 1981)

Concept : Oxidation-reduction reaction

Materials : 250 ml. flask with rubber stopper (or bottle with screw-cap), 4 g glucose, 120 ml. distilled water, 2 g sodium hydroxide, 3 drops methylene blue.

Procedure :

- Dissolve all the above chemicals in the flask.
- Students observe the colour of the solution as the flask is shaken vigorously and then left to stand. Repeat this several times.
- The mixture turns blue when shaken but becomes clear upon settling.

Explanation : Methylene blue is reduced to a colourless compound by an alkaline solution of a reducing sugar. On shaking, oxygen dissolves in the solution and the methylene blue is oxidized to a blue colour. Upon standing, it is reduced again.

### 4. **Turn Water into Wine, Milk and Beer** (adapted from Liem, T., 1987)

Concept : pH, precipitation, reaction of carbonates

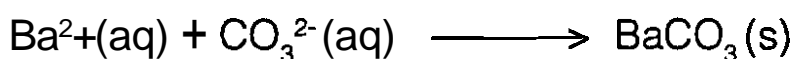
Materials : 20% sodium carbonate, saturated sodium bicarbonate, phenolphthalein, saturated barium chloride solution, dilute hydrochloric acid (2M), bromothymol blue, 4 beakers.

Procedure :

- Fill beaker 1 with 50 ml. of water. Add 10 ml. sodium bicarbonate and 30 ml. sodium carbonate solution. This gives a pH of 10.

- Add 5 drops of phenolphthalein to beaker 2.
- To beaker 3, add 20 ml. barium chloride.
- Add 100 ml. dilute hydrochloric acid and a few drops of bromothymol blue to beaker 4. (Perform the above steps before demonstrating the following to the students).
- Pour the colourless "water" from beaker 1 into beaker 2 forming red "wine".
- Pour the contents from beaker 2 into beaker 3 (shaking to swirl the mixture) to form "milk".
- Pour the "milk" into beaker 4 and watch it turn into "beer".

Explanation : The red colour in beaker 2 is caused by the phenolphthalein which changes colour in the basic sodium bicarbonate–sodium carbonate solution. The white precipitate in the "milk" is barium carbonate.



Pouring this suspension into the acid in beaker 4 produces carbon dioxide gas forming a foam like in beer. The bromothymol blue gives it a yellow colour at that particular pH.

Further examples of discrepant events can be found in the references listed below. As you can see, although science is not magic, it can bring magic into the classroom.

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