In this section of Resonance, *we invite readers to pose questions likely to be raised in a classroom situation. We may suggest strategies for dealing with them, or invite responses, or both. "Classroom" is equally a forum for raising broader issues and sharing personal experiences and viewpoints on matters related to teaching and learning science.*

! How Stimulating Ideas Can Generate An Attitude of Inquiry

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Discrepant events are phenomena that occur or run contrary to our natural line of reasoning. In this article we highlight how such phenomena can be used to promote inquiry-oriented science learning in the classroom.

Introduction

The organisation of scientific information depends on the ways humans comprehend and classify knowledge. Accordingly, four major types of scientific knowledge are generally recognised: organisational knowledge, relational or interactional knowledge, inferential knowledge, and applied knowledge.

Many important aspects of the way we live can be, and are, affected by science and technology. Our attitudes, beliefs, ethics, and practices are equally affected by scientific knowledge. Science, as it is applied, benefits from advances made in technology; and technology, in the modern sense, To be successful in reaching all types of students the science teacher must possess a great reservoir of stimulating ideas to generate an attitude of inquiry.

depends on scientific discovery. When such knowledge is taught to science students in a graded manner according to their degree of curiosity and receptivity, it could well motivate them to become contributing scientists. Some of the important requirements to achieving this include curiosity, an inherent interest to understand the natural world, an inquiring mind, and the determination to work long hours. To be successful in reaching all types of students – highly motivated, self-starters, slow, bored, truant, or plain disinterested students – the science teacher must possess a great reservoir of stimulating ideas to generate an attitude of inquiry. And, discrepant events work best. The ideas generated might come from hands-on examples and/or minds-on examples, based on natural discrepant events. In the hands-on examples, activities are designed around those discrepant events that students can manipulate and gain experimental knowledge from. The minds-on examples serve to consistently stimulate the mind of both the self-starter student and the bored/disinterested student to develop an attitude of inquiry.

Motivation in the Classroom

What, exactly, is a discrepant event? A discrepant event is a phenomenon that occurs or runs contrary to our natural line of reasoning. There are many scientific phenomena in the natural world that are often classified as anomalies and shrouded with ambiguity and uncertainty. In the students' (and, ours, too) daily life, learning science concepts often involves confronting natural discrepant events. For instance, we presented the following set of statements to undergraduate science students asking them to mark the statements as true or false.

- A gaseous white ring around the moon more often than not foretells precipitation.
- That the moon appears larger on the horizon than when overhead is an illusion.
- When meteorites hit the Earth they are extremely cold – not hot.

- During a tornado, windows tend to blow outward – not inward.
- Humans can skate on ice because ice is slippery until very low temperatures are reached.

Most students evaluated each statement as false. When we told them each statement was true, lengthy and heated discussions followed among the students. We succeeded in getting them involved, very interested in the inquiry, and very willing to discuss and share ideas. When the students are intrigued by the observed discrepancy in the discrepant event (see *Table 1* for some additional examples), they will be motivated to resolve the conflict between their own interpretation (assuming that it is non-scientific) of the event and the observed discrepancy. Some students may be dogmatically 'deep-seated' in their views. But, they will quickly realize that the new experience requires a depth of understanding of the problem as well as an evaluation of the validity of their knowledge of science concepts and principles.

In the disinterested students, both the curiosity and latent talent are awakened from their deep slumber with activities that captivate their senses, sustain motivation and imagination, and promote a deep desire to learn more.

This is an excellent opportunity for teachers. They could guide the student towards successful learning and testing of hypotheses through carefully designed experiments. To reduce the likelihood of learners quitting the learning experience, we recommend that the teacher: identify perceptions; provide new encounters which are motivating and allow for first-hand exploration; ascertain which existing ideas students are linking to and the aspects of the encounter they focus on; challenge incorrect or inappropriately reasoned ideas; recognise when students are playing guessing games ('false accommodation'); provide opportunities for students to practice applying new ideas; and, if necessary, provide them with remedial assistance.

Helping Students Overcome Misconceptions

Why is using discrepant events in instruction a viable pedagogical method? First, drawing students' attention to

Table 1. Examples of Discrepant Events.

Phenomenon, Event, Question, or Statement	Probable Student Response	Conceptual Discrepancy	Scientific concept or Principle Illustrated by Conceptual Discrepancy
The electric eel (Electrophorus electricus) is a true eel.	True	False. The electric eel is a freshwater fish and grows to a length of 2 to 4 metres. Researching the animal's ability to produce electricity will yield interesting information for further study.	More closely related to the carp and catfish than to eels, the electric eel is capable of delivering an electric shock of 500 volts when alarmed; a lower range of 60 to 100 volts is used for navigation. The animal is not a true eel because it has to surface very often to obtain oxygen from the air for respiration.
Amber is a mineral and a gem of great value.	True	False. Amber is not a mineral but can be a gem. As for its value, there is nothing great about it. However, some interesting properties and applications of amber are widely known.	Amber is a hard, translucent, yellowish-brown resin of fossil pine trees. Considered to be a good electric insulator, amber is also known to have the property of preserving the fossil remains of prehistoric insects. The insects were probably caught in the sticky resin, trapped, unable to escape, and died. The translucence of amber makes the study of trapped insects, and also preserved specimens of ancient plant leaves and parts, crystal-clear and fascinating in their original form.

conceptual discrepancies provokes them to display their natural curiosity about how the natural world works. This initial inquiry motivates them to become involved in learning activities and to develop logic-based explanations for the cause of such events. Particularly in the disinterested students, both the curiosity and latent talent are awakened from their deep slumber with activities that captivate their senses, sustain motivation and imagination, and promote a deep desire to learn more.

Second, surfacing, identifying and classifying students' misconceptions are made very easy. As a result we could then use appropriate examples to help students overcome their misconceptions.

While teaching some new concepts or principles might prove a daunting task, correcting a misconception could be much more difficult. Understanding how students respond, when their current beliefs about the physical world conflict with information presented during science instruction, is critical for two reasons. First, encountering contradictory information is a very common occurrence in learning science. Second, students typically resist giving up or modifying their pre-instructional beliefs (especially, irrational ones).

Understanding how students respond, when their current beliefs about the physical world conflict with information presented during science instruction, is critical.

In recent times, deep processing and reflective theory change have been suggested in science education research literature, as avenues through which teachers could help students overcome misconceptions. Deep processing involves fostering personal involvement in the discrepant data issue, and ensuring that students justify their reasoning. Reflective theory change encourages students to reflect on their pre-instructional beliefs and change their incorrect theory in light of scientific reasoning.

We present here a few guidelines for science teachers keen on helping students deal with discrepant events and overcome misconceptions in their learning of science.

A. Influence Prior Knowledge

- Reduce the degree of entrenchment ('deep-seatedness') of students' prior theories;

Even though examples of discrepant events cannot be developed for every topic or scientific principle, teachers should remember that the event is used as an incentive to student involvement.

- assist students in constructing appropriate rational categories (ontological categories: the class of beliefs about the fundamental categories and properties of the world); faulty ontological beliefs include, for instance, (most) children's notion that the largest fish is the blue whale. In essence, they do not seem to acknowledge the fact that the whale is a mammal and not a fish;
- foster appropriate epistemological commitments (beliefs that are relatively immune to change because they are used to support ideas in many different subdomains); and,
- assist students as they build their fundamental knowledge.

B. Introduce the Alternative Theory

- Introduce a plausible alternative theory;
- ensure that the anomalous data (discrepant data) is credible; and,
- ensure that such an alternative theory is easily comprehensible to the audience.

C. Introduce the Anomalous Data

- Ensure that the anomalous data is credible and familiar;
- avoid using any ambiguous data; and,
- when necessary, encourage the use of multiple lines of information (data).

D. Influence Processing Strategies

Encourage students to pursue deep processing of available information when they are being presented with the anomalous data. (To ensure 'deep processing' of information, we recommend the use of appropriate thinking and reasoning skills — skills that are consistent with the development of scientific and logical reasoning strategies.)

Concluding Remarks

Our intention in this article was to highlight the heuristic value of using discrepant events as an avenue to promoting inquiry-oriented learning in the science classroom. Even though it is obvious that examples of discrepant events cannot be developed for every topic or scientific principle, teachers should remember that the event is used as an incentive to student involvement.

We hope science teachers will enjoy using discrepant event examples in the classroom. Teachers could go a step further by motivating students to work with their peers to research discrepant events that appeal to their curiosity, develop practical skills of report writing and present the information to the public.

In closing, we particularly welcome both teachers and students to share with us their discrepant event examples. Let us know what works for you, particularly if and when you modify our suggestions. For those of you already using discrepant events, we would enjoy learning of your ideas. Please share them with us.

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Suggested Reading

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If readers wish to acquire any of the above references, please contact the first author.