Using a Thinking Tube

Introduction to Problem-solving – the Thinking Tube Investigation (60 min)

Background

The Thinking Tube activity is not related to any specific area of science. Rather, the purpose is to introduce the idea of open-ended problem solving. The idea of open-ended problem solving is new to most of the students in the class. Most are more familiar with a lecture approach to learning science and this new environment for learning science can be frightening and frustrating to the students. This simple example is a good way to break them into the methods to be used in the class and acts as a foundational point which can be referred back to throughout the class as they encounter problems that are more complex.

You as the instructor are in charge of the tube itself. Students are not allowed to manipulate it. In a way, this is like a scientist who can only observe phenomena happen away from themselves and are not able to interact with the object of their study. The idea is for the students to make observations and collect data about the phenomena (in this case the silver box) and to develop a model which will explain what they are able to observe.

Beginning the Problem

As you begin with the students, explain some of the background and how this exemplifies some of the methods we are going to be using this semester. Ask a volunteer to record some observations on the white board and then introduce the thinking tube.

Explain the thinking tube is like "our world" and that we need to make observations about what we see. Explain that they cannot touch the tube, but that they can ask you to do anything to the box except open it.

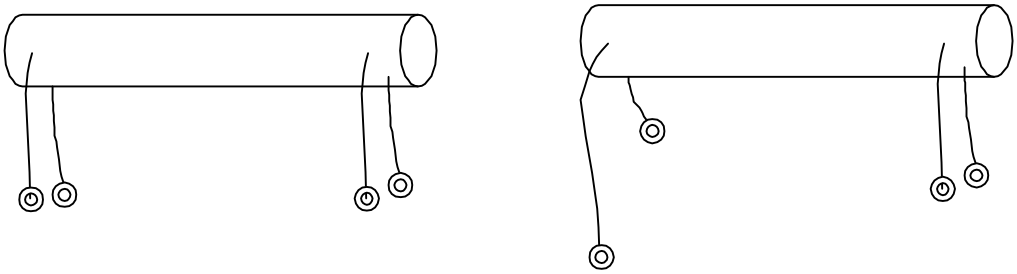
As you are manipulating the tube, you want to create as much of a discrepant event as possible. Some of this is done by using a small slight of hand. When you pull on strings, you can create visual problems for the students by pinching your finger over one of the holes at the other end of the tube from which you are pulling. This will cause the strings to do things which will confound the students.

Have the students make as many observations as they can. You may wish to have a ruler with you to allow you to measure strings as you are asked. Past student observations have included some of the following:

Color(s)
Shape
Diameter
shiny
hollow
strings move
movement associated with the pulling of various strings

Creating Models
After they have made their observations have them get in groups of three and use their observations to attempt to build a model which explains the things they can see (i.e. how does the tube work). Ask them to attempt to build two models which might explain the phenomena. Pass out paper to each group of students and have them divide it in half, with each half devoted to one of the models.

Each model the students construct should show the thinking tube in three modes: with the strings of equal length and with the strings at two different positions.



As students work on their models, circulate around the classroom and query students about their models. Your questioning strategies should make the students think about their model and if it predicts and explains the observations they have made. There may be levels of frustration, but be encouraging.

Presentation
After students have had sufficient time to develop at least one model and potentially two models of how the thinking tube works, have each group present their model. The key to the presentation is not you as an instructor critiquing the student models (and they will look your direction for support and acknowledgement that it is right), but for the class as a whole to critique the model and to determine if the model predicts and explains the data that was collected earlier.

Ask the students which model was correct. The key here is that they will respond that they do not know because they cannot see inside the tube. This shows the tentative nature of science. We cannot always know the answer, but make models based on the information that we have available to us. This leads into a short discussion on the tentative nature of science.

Nature of Science
What we really want the students to come away with from this activity is that science is not about always knowing the right answer, but seeing how we know something. We often teach science as something which is absolute, when in fact scientists do not see it that way. Demonstrate this by drawing a line on the board which shows a continuum between relativism and absolute truth.

Relativism Absolute Truth

Students need to learn to be critical of relativism – that is that any answer goes, but at the same time, they need to be wary of ascribing absolute truth to things in science. We are really somewhere in the middle of this continuum between these two extremes. Models, like the one we constructed for the thinking tube are science's way of describing nature, but this could change if something new is observed which does not fit the current model of understanding. This is why science is tentative, but not relative and not absolute truth.

Wrapping it Up

As the class wraps up query the students about opening the tube. Should we open it? Why? Why not? Explore different reasons for opening vs. not opening the box.

You should feel comfortable admitting to students that scientists take advantages of whatever opportunities they have to learn about the world and thus, in this particular example, a scientist might indeed open the tube to satisfy his or her own curiosity. Nevertheless you should conclude with the fact that we will <u>not</u> be opening the tube (in fact, none of us as instructors even know what the inside of the tube looks like!), because we want to draw home a moral about the nature of science in general: namely, the nature of the phenomenon often prevents a scientist from "opening the tube" and as such the scientist must rely upon <u>indirect</u> inferences from its behavior (as we have done today in attempting to evaluate the various models being considered), rather than directly seeing the mechanism in question. You should also draw attention to the fact that there is always a level of uncertainty that we must deal with in science. This is important to understand. Science is not about certain facts, but how we know what we know.