IDS 101

MYSTERY BOXES

Have you ever wondered how scientists know what makes up the Earth's core? After all, no one has ever taken a sample from the center of the Earth. What about the stars? How do we know, for example, that the sun contains large amounts of helium? How do we know that all matter is composed of atoms? Until recently no one had ever seen an atom, yet students have been learning about atoms and molecules for well over one hundred years. All of this information is possible because scientists are able to draw conclusions from observations and data that can be collected in the lab or in the field. Even though we can't observe these things directly, there is evidence- strong evidence- that they exist.

In today's activity you are going to get an introduction to the concept of indirect evidence by trying to gather information about the contents of a sealed box. It's not unlike trying to figure out what your parents got you for your birthday. You'll be surprised to see how much you can find out about an object without actually seeing it. Hopefully you'll begin to appreciate and understand the processes that scientists use to understand the world around them.

Directions:

1. Find two partners and choose a box from the cart. Record the number on the next page. Begin examining the box to try and learn about its contents. Do not open the box! The objective of this exercise is not to *identify* the contents of the box. Rather, you are trying to find out the *characteristics* of the item (or items) inside the box.

   On the next page are some questions to get you started thinking about what's in your box. For each question, be sure to write down both what you think ***and why you think it***. This can be difficult. Try to focus on what it is that leads you to a particular conclusion.
2. Once you have finished working with your box, trade boxes with another group that is finished. Don't compare notes at this point. Just swap boxes. Repeat the investigative process with this new box and record your results as before. Don't worry if you don't have enough time for the second box. It's more important to do a thorough job on one box than to complete two of them.

OK, so what's in the box!

I bet you'd like to know, right? Is this realistic? Do scientists investigating natural phenomena ever get to "open the box"? Sometimes yes, sometimes no. As we mentioned earlier, no one has traveled to the center of the Earth and it's unlikely that anyone ever will. Scientists studying the earth's core never get to open their box. They have to be confident that their experimental evidence is completely reliable. That's part of what make science so exciting! If we wanted to be completely realistic we'd never tell you what's in the boxes. But that would be frustrating, and we don't want to frustrate you on your first day. We'll revisit the boxes later this week, and at that time we'll reveal what's in the boxes.

Name_____

In the space below, write down everything you can figure out about the object or objects in your box. For each item, write down both what you know and how you know it. For example, if you write down that the object is glass, you must also say why you think so.

Tips: Start by thinking about the size and shape of the object. What is it made of? What other characteristics can you come up with? Avoid vague terms like big or heavy. It can also be useful to state what the object is not. What can you rule out based on your observations? Be specific, and quantify your observations whenever possible.

Box Number:

I think that the object(s) in the box…… Because……

What is your confidence level in your results/conclusions? What are you most sure of? Least?

Name: _____

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Homework:

Complete this section at home and bring it with you to class tomorrow.

Observation vs. Inference

Beginning students frequently confuse observation with inference. What's the difference? Perhaps you've heard the expression, "Where there's smoke, there's fire." Is that necessarily true? Maybe, maybe not. If you're driving home from school and see black smoke in the air, you might conclude that there's a fire nearby, and you'd probably be right. But that is an inference, not an observation. Did you see the fire? If not, then you inferred, rather than observed that there was a fire.

- What are some other possible explanations?

Don't get the idea that inferences are bad things. Science is based upon making conclusions and inferences from observed data. But, if you mistakenly confuse an inference with an observation, you won't be open to the possibility that other explanations might be possible. Good scientists are open minded and creative when looking at data.

- Using the results from your first box, go back over your results and try to separate the observations from the inferences. **On a separate sheet of paper**, write down all of your observations in one column, and all of your inferences or conclusions in another. Think of observations as those things that you detected using your five senses. Everything else is inferred. For example, suppose you decide that the object in the box is round. Is that an observation or an inference? Did you see the object? If you did, then you broke the rules by opening the box! So you didn't see it, right? OK - so why do you think it's round? What observations led you to infer, or conclude, that the object is round?