Preparing for the Lesson

Mystery Box – Scientific Theories

Big Idea 3: The Role of Theories, Laws, Hypotheses, and Models
Benchmark: SC.6.N.3.2
Objective: The terms that describe examples of scientific knowledge, for example; "theory," "law," "hypothesis," and "model" have very specific meanings and functions within science.

Key Question:
Explain why a theory is accepted by the scientific community and how personal beliefs and religious views that are not based on scientific evidence are not part of learning science.

Background Information:

Scientific theories are evidence-based explanations based on related observations of experience or events. A scientific theory is based on a solid body of supporting evidence that has been tested and supported with multiple lines of evidence. Theories are widely accepted in the scientific community and can be used to make predictions. Theories can change if new evidence becomes available. New evidence may be made possible through new technological tools, techniques of analysis, new theoretical advances, or shifts in research emphasis that lead the scientific community to reconsider an existing explanation and revise it to fit new evidence that is available and accepted. Theories can also change when scientists view the same evidence differently, such as the example of Darwinian evolution and Lamarck's punctuated evolution in which the same evidence was looked at from a different perspective.

Examples of scientific theories include the germ theory of disease, the theory of biological evolution, plate tectonics theory, string theory, big bang theory, and kinetic molecular theory. These theories provide an explanation accepted by the scientific community for observed experiences. For example, plate tectonics explains the observed evidence for large-scale motions of the Earth's lithosphere. Student's and nonscientists adults often have definitions for the word theory that are quite different from the scientific meaning of the word.

Sometimes the words, hypothesis, theory, and law are inaccurately portrayed in science textbooks as an "evolution" of a scientific idea. There isn't a definite sequence or hierarchy for the development of scientific ideas – such as a hypothesis leads to a theory, which eventually becomes a law – because they represent different types of knowledge. It is possible to develop a law (observed behavior of nature) and not have the explanation (theory) for it, such as when Isaac Newton helped develop the law of gravity, but at the time he did not have an explanation for it.

Law and theory are two different key elements of the nature of scientific knowledge. Laws are generalizations, principles, or patterns in nature derived from scientific facts that often describe how the natural world behaves under certain conditions. Laws describe relationship among observable experience. Some laws are expressed mathematically. Examples of scientific laws include Newton's laws of motion, universal law of gravitation, Boyle's law, and Mendel's laws. A law describes an experience or event but it does not explain it, like a theory does. A theory is not a "law in waiting." Theories do not eventually become laws. A theory is a well established explanation. Laws describe ***what***, and theories explain ***why***.

Teaching Tips: (If you are concerned about time constraints, you can introduce the lab in the last 5 minutes of the previous day.)

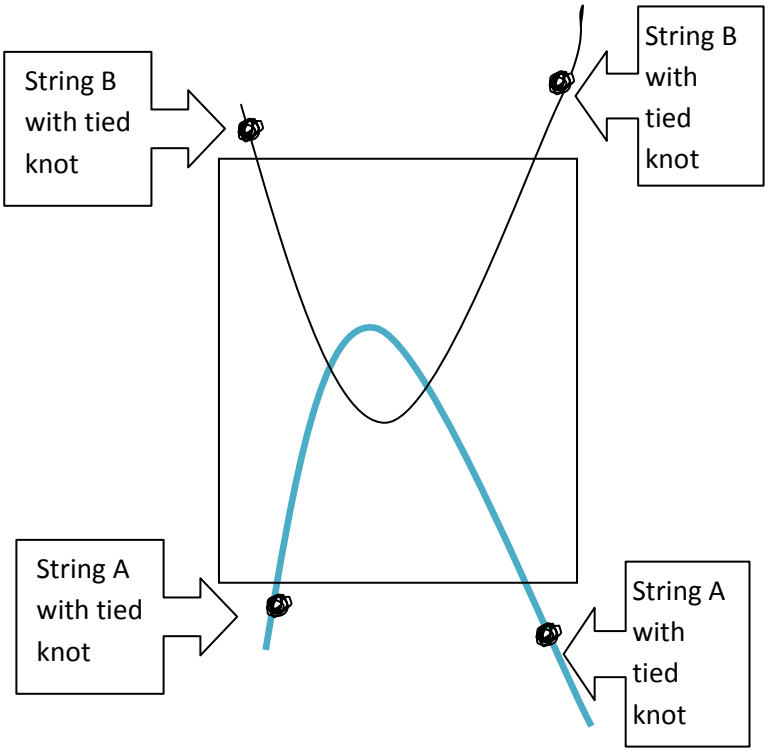
- Prepare the mystery boxes in advance of this lesson. You will need time to gather materials and construct.

To construct Mystery Boxes –

1. Use shoe boxes, cereal boxes or any other boxes where you can seal up the ends or top.
2. Poke or cut four holes – two at the top and two at the bottom.
3. Measure string to flow through the inside of the box so that it has at least an inch or two outside of the box.

Timeframe:
Approx. 2 50-minute class periods

4. Tie the end in a knot so it will not fall through the box but has enough room for students to pull on the string.
5. Optional – You may cover with paper or paint boxes all one color.
6. Please ensure that the students cannot look at the string through the holes. Please see diagram for reference.



Safety Precautions:
- It is essential to review all safety precautions with your students before beginning the lab.
- Do the activity in a clean area that is free of chemical residues and other hazardous substances.

STEP 1 - ENGAGE:	**Materials**
Is it a Theory – Assessment Probe – Have students evaluate and describe the meaning of a theory as applied in science.	• Page Keeley *Uncovering Student Ideas in Science* Volume 3, page 84
STEP 2 - EXPLORE:	
Students will complete student lab sheet. **1.** Have students make observation and record them in their journal. They are not to touch the mystery box at this point. **2.** The students make predictions about what would happen when they manipulate the box. They are to write down the predictions in their journal. **3.** Students will now test their predictions by pulling on various strings and recording their results.	

4. Students will then compare with team mates / classmates and devise "A String Theory". **5.** You may elaborate at this point and have them switch boxes. You may also set up various string combinations in various boxes. **6.** Students compare "A String Theory" with those of their classmates and devise "A String Law" if applicable.	
STEP 3 - EXPLAIN:	
1. Display the mystery box – Set a mystery box in front of each group of students. Groups may include 2 – 4 students. **2.** Have students write down their physical observations of the box. Example, it is rectangular, it's about 8 inches long and two inches wide, it has four strings hanging out, two at the top and two at the bottom….etc. **3.** Point out to the students that up until now they have made observations. **4.** Have the students start to manipulate the box. This is starting the experimentation. In science we manipulate things that we observe to gain further understanding. **5.** Have the students write down predictions of what they think will happen during this stage. For example, grab the short string directly across from the long string, they believe the string straight across will move. Most students will simply predict that the short string you pull will slide out of the box and will lengthen while the long string protruding goes in and becomes shorter. **6.** Have students come up with a general statement that accurately describes the behavior of the strings when pulled. Example – The amount of pulled string lengthens is directly proportional to the amount the long string shortens. (You can use a ruler to verify this.) **7.** Have students agree upon a class "String" theory.	• Mystery Box constructed. • Ruler. • Paper/Journal • Pencil or Pen
STEP 4 - ELABORATE:	
1. After students have about 20 minutes to develop their string theory have them share their ideas with the rest of the class. Student will come up with a variety of creative explanations and more than one could possibly work. Have students diagram their explanations and discuss the results of the class. **2.** You may elaborate at this point and have them switch boxes. You may also set up various string combinations in various boxes. **3.** Students compare "A String Theory" with those of their classmates and devise "A String Law" in applicable.	
STEP 5 - EVALUATE:	
Have students record in their science journal or lab sheet (teacher preference) draw and explain their ideas of how the mystery box works. Have them write a reflection upon the lesson relating to the Nature of Science.	

Name_____
Date_____
Class Period_____

ENGAGE	**Mystery Box**
	Key Question: Explain why a theory is accepted by the scientific community and how personal beliefs and religious views that are not based on scientific evidence are not part of learning science?
	Student Predictions/Ideas: Answer the Key Question.
EXPLORE	**Safety Precautions:** • Follow all classroom/lab safety procedures that you have been taught.
	Materials: • Prepared Mystery Box • Pencil and Paper • Ruler
	Procedure: **1.** Each group receives one mystery box. **2.** Make and record visual observations of the mystery box. **3.** Make and record predictions of what will happen as you test the strings. **4.** Record your observations based upon your data and evidence. **5.** As a group devise a theory of Mystery Box Strings. **6.** Record, draw and diagram your "1st and "2nd Theory of Mystery Box Strings.
	Observations & Data: **1.** Record you observations by only **LOOKING** at the mystery box – diagram what you see.

Name_____
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2. Record your predictions of what you believe will happen when you manipulate your mystery box strings. You may include diagrams in your predictions. Be specific using complete sentences.

3. Record your observations of the manipulations of the strings in the mystery box.

Name_____
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EXPLAIN

Data Analysis:

1. Based upon your observations, devise two general statements that describe the behavior of the tube strings. Label these statements, "1st Theory of Mystery Box Strings" and "2nd Theory of Mystery Box Strings".

2. What is a scientific theory and how is it different from a scientific law?

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	Explanation of Key Question Based on Evidence: Scientific laws and theories can change as new **evidence** comes to light. Use the Web sites www.answers.com or http://en.wikipedia.org or http://school.eb.com/ to research scientific laws and theories. Describe three laws or theories that have changed since they were first developed.
ELABORATE	**Reflection:** Write a reflection essay on "1st Theory of Mystery Box Strings" and "2nd Theory of Mystery Box Strings". Please Include: Your group's official theories. What is the meaning of theory? Why is it important to understand the difference between a scientific law and a scientific theory? How you know that a theory is not a law? Why are personal beliefs and religious views that are not based on scientific evidence not part of learning science?