How to apply the Scientific Method without asking students to list the steps again!

by Dr. Pam Foster, Carlisle High School, Carlisle, PA--PA OBTA 2010
(fosterp@carlisleschools.org)

<u>Lesson 1</u>: Lego Activity--to stress the importance of procedure in experimentation and to correctly follow it. Otherwise, time, effort, and materials could be wasted.

<u>Lego Inquiry Activity</u>: "Can Your Procedure Be Replicated?"

<u>Procedure</u>:

1. Remove the 6 Lego blocks from the baggie provided. Assemble the 6 blocks into an unusual structure.
2. <u>On the backside of this paper</u>, write the directions for your 6-block structure as to how to assemble your 6 blocks into your unusual structure so that <u>another student will replicate it exactly without seeing it</u>.
3. On a separate 1/2 sheet of paper, draw a sketch of your 6-block structure. Disassemble your structure into the 6 blocks and place them back into the baggie. Do not lose any pieces!
4. Now find a student to exchange bags of blocks and directions with. Do <u>not</u> show him/her your drawing until you are ready to check accuracy. You will try to duplicate his/her 6-block structure using only his/her written directions, and he/she will try to duplicate your 6-block structure using only your written directions.
5. When each of you believe that you have duplicated the other's structure, show the 6-block structure to him/her. Compare each replicated and original structure by checking your partner's drawing of the structure. Determine if the directions were written correctly and followed. Identify which parts of the directions were clear and accurate, and which were unclear or misleading. Completely answer the questions below and be prepared to discuss them when asked.

<u>Post-Activity Questions</u>:

1. Did you exactly replicate your partner's 6-block structure? Why or why not? Explain.

2. Did your partner exactly replicate your 6-block structure? Why or why not? Explain.

3. If applicable, how could you have written better directions if your partner did not exactly replicate your structure?

4. Why is it important that scientists write procedures that can be replicated? Explain why and also provide 2 examples in the "real world," (Ex: putting together a tricycle from a kit).

Lesson 2: Demonstration to emphasize open-mindedness in the approach to scientific investigation using a sieve (idea taken from Bob Tierney many years ago)

Preparation beforehand:

Buy a kitchen sieve (as used to strain blueberries or whatever) and coat it with several layers of clear nail polish or so that water will no longer flow through it. Cut a circular piece of clear Saran Wrap to fit the bottom of the sieve.

Materials:

Sieve with holes blocked; circular piece of Sarah Wrap inside on sieve's bottom
Beaker half full of water

Demonstration:

1. Show students the sieve and ask what it is and what it is used for.
2. Show them the beaker half full of a "clear liquid." Don't tell them that it is water yet.
3. Ask them to "hypothesize" what might happen if you were to pour some of the clear liquid from the beaker into the sieve. Listen and repeat their several hypotheses. Ask students to raise their hands to vote for whatever hypothesis that they agree with as you state each one.
4. Tell them that it is now time to conduct the experiment to determine which hypothesis is correct. Go to a student who believed that the clear liquid would not go through the sieve and hold the sieve above his/her head. Slowly pour some of the liquid into the sieve. (You can kid around about hoping that he/she is correct so that the liquid does not fall onto his/her head! The water should not go through the sieve!)
5. Ask students to rethink how to explain what they just observed and what other hypotheses they could offer: "The clear liquid is not water, but a thick liquid." "The holes in the sieve are too small and water can't go through the holes of the sieve." (Not so since a molecule of water is only 3 atoms!) "The sieve's holes are clogged with something." Etc. If you want, you can now tell students that the liquid is water.
6. Dump the water in the sieve back into the beaker. Stare at the bottom of the sieve and shockingly state that no wonder the liquid did not go through the sieve! Someone "messed" with your sieve and placed a piece of plastic on its bottom, thus blocking the flow of water! Remove this circular piece of Saran Wrap, show it to them, and disgustingly place it on a tabletop!
7. Ask students to provide more hypotheses and to vote again by raising their hands for whichever hypothesis that they want to support.
8. Time to experiment again. Go to another student and slowly pour some of the liquid from the beaker into the sieve. (It should not go through the sieve!)
9. Ask students to again try to hypothesize what they just observed and what explanations they can verbalize.
10. Tell students not to repeat your demonstration at home with a "bratty" sibling! Leave this demo. to the experts! *However, finally explain what you did to the sieve (layers of clear nail polish!), but emphasize the importance of conducting experiments with an open mind.* Perhaps provide some examples of how some scientists tried to sway the results of their experimentation with preformed ideas/opinions. Have fun acting this whole scenario out with your students. They will definitely be engaged!

<u>Lesson 3</u>: Termite Inquiry Lab. Students observe live termite workers and try to hypothesize reasons for their behavior. [Eventually, students will determine that the termites followed the "scent" (similar to pheromones) made by the PaperMate Extend red ink pen.] Go to this web page for more explanation about required materials, etc.:

http://www.uky.edu/Ag/Entomology/ythfacts/resourc/tcherpln/termtrails.htm

<u>Termite Inquiry Lab:</u>
<u>A Hands-On Discovery Activity</u>

<u>Objectives:</u>

1. Students will observe the behavior of termites and draw conclusions about their behavior.
2. Students will record data concerning termite behavior.
3. Students will analyze data, discuss it with others, and write a summary.
4. Students will recognize basic components of the scientific method (such as hypothesis, variables, conclusion, etc.).

<u>Purpose</u>: This activity is to review the scientific method of inquiry. You will work as a lab table group. Your goal is to observe the movement and behavior of a <u>live</u> “worker termite” that is following a trail on paper inside a container.

<u>Background Information</u>: Termites are small, usually pale-colored insects. They are social insects that live in colonies in the ground or rotting wood. Their food consists primarily of wood or other vegetable material. The workers are sterile (not capable of reproduction) and lack compound eyes. They do the main work of the colony by collecting food, feeding the queen, soldiers, and young as well as constructing galleries. Many species cause considerable damage to buildings, furniture, utility poles, fence posts, and other materials. Wood fibers made up of cellulose (a very complex, difficult to digest carbohydrate) are not actually digested by the termite, but by the tiny, numerous protists living inside of its digestive system. This is an interesting example of symbiosis between two different species of organisms called “mutualism.” However, termites are important decomposers who help to break down dead trees and other plant materials into nutrients useful to plants. The ones given to you today have been purchased from a biological supply company. <u>The termite is not to be harmed in any way</u>. It is fragile! Use a camel hair paintbrush to “block” (not touch) the termite.

<u>Hypothesis</u>: State what you believe the termite will do once it is placed in the container with the PaperMate X-tend red ballpoint ink trail: “I believe that the termite will ____.”

<u>Procedure</u>:

1. On a piece of plain white paper cut to the size of the container, use the **PaperMate Xtend red ballpoint ink pen** to draw a simple design using continuous lines (such as an oval or square). The lines must be drawn heavily and well spaced. Place this paper on the bottom of the container with the ink side up.

2. A live worker termite will be placed in your container by Dr. Foster. Observe how it moves inside the container. Record your observations in the chart provided.
3. Hypothesize as to the reason(s) why the termite moves in this way.
4. To continue questioning and exploring the termite behavior, create several new "trails" using other writing utensils in the plastic cup to test your hypothesis. Also experiment with different trail designs. Try maybe a design with a sharp angle on one side of the continuous line. What happens then? Think about how you will "defend" your conclusion when asked by other lab groups and/or by Dr. Foster.

<u>Data</u>:

	Utensil used to draw trail?	Does termite follow it? (Yes or No)	Hypothesis for termite behavior?
trial 1	**PaperMate Xtend red ink pen**		
trial 2			
trial 3			
trial 4			
trial 5			
trial 6			

<u>Control</u>: What was the "control" (that part of the experiment under normal conditions) in this experiment?

<u>Variables</u>: Please list the variables (factors that were changed during this experiment):

<u>Hypothesis proven or disproven</u>: Was your "original" hypothesis proven to hold true or was it disproven by your observations? Explain.

<u>Conclusion</u> (about termite behavior)**:**

Pam Foster
Carlisle High School
623 West Penn St.
Carlisle, PA 17013
(717) 240-6800, extension 26127