

“The Genie in a Bottle” – An Open-Ended Inquiry

Warning: Genies have been known to be mischievous; work with a partner to be safe!

Materials:

Clear plastic soda or water bottles (several per group)
Wooden matches
Source of water

Preliminary Procedure:

- 1) Remove labels from bottles.
- 2) Rinse bottles thoroughly with cold water – Hint: Cap the bottle and shake it to be sure it is completely rinsed.
- 3) After rinsing, empty the bottle and cap it tightly.
- 4) Working with a partner, one student should remove the cap from the bottle. The other student should carefully light a match and drop it into the bottle. The cap should be replaced immediately and the bottle shaken slightly to prevent the hot match head from melting a hole in the plastic.
- 5) Squeeze the bottle and observe what happens.
- 6) Have your partner record your observations.
- 7) Release the bottle and observe what happens.
- 8) Record your observations.
- 9) Steps 5 through 8 may be repeated if desired.

Experimental Procedure:

- 1) Formulate one or more hypotheses to explain the cause of any phenomena that you observed. Be sure to record your hypotheses.
- 2) Design one or more experiments to test your hypothesis or hypotheses.
- 3) Using whatever materials you choose, carry out the experiments that you designed in Step 2.
- 4) Be sure to accurately record the results of your experiments, paying particular attention to which variables were manipulated and what the results were.
- 5) Re-evaluate your hypothesis or hypotheses in light of the results of your experiments. Should you reject or modify your hypothesis/hypotheses?
- 6) Design and conduct another round of experiments if you feel it is necessary.
- 7) Remember to record your results (See Step 4 above.).
- 8) Write a statement that expresses whatever you have concluded regarding the “Genie in the Bottle.
- 9) Evaluate the validity of your original and revised hypotheses and the effectiveness of your experiments in testing these hypotheses.

“Genie in a Bottle” Instructor’s Notes

Pre-service Earth Science Teachers

In doing the “Genie in a Bottle” with pre-service secondary teachers, we generally discuss the results in class immediately after completing the activity. I use this as a model of open-ended inquiry and we discuss the advantages and disadvantages of the method. I always point out to the students that this activity, more commonly known as the “Cloud in a Bottle,” is typically conducted as a show-and-tell demo rather than having students do it and think about it.

We also discuss how the activity could be used in the context of the curriculum. In a recent discussion, the students decided that you could almost teach all of the meteorology-related Performance Indicators in the New York State Physical Setting: Earth Science Core Curriculum with this activity as a foundation (Example: Demonstrate adiabatic cooling more graphically by taking the squeezed bottle and slowly releasing the pressure as you raise the bottle over your head.). It was a great deal of fun watching them brainstorm an entire unit based on such a simple experience.

Pre-service Elementary Teachers

I have also used this activity with great success with pre-service elementary teachers. Owing to the fact that these students have much less experience with the content, they tend to come up with some very creative (though not necessarily scientifically productive) hypotheses and experiments! Generally, they vary the amount of water, the temperature of the water, the number of matches, try it without water, try it without matches, etc.

With some classes, nearly half of the students believe that it is the smoke from the matches, rather than water droplets that is appearing and disappearing. Although they are puzzled by how smoke can disappear and reappear, it is fairly unusual for these students reject the smoke hypothesis. It is for this reason that I use the ambiguous and engaging title of “Genie in a Bottle” rather than the more typical “Cloud in a Bottle.” I don’t want to bias the students in advance and I want to allow them the freedom to explore all variables.

Many students recognize that the “genie” is a cloud or fog, but can’t quite figure out why it forms and why it disappears upon squeezing. In reading the student reports, it is a fairly common occurrence to have students report the appearance of the “genie” with pressure – the exact opposite of what they observed. I have not yet been able to determine if this is the result of sloppiness in recording observations or a genuine misconception.

For the pre-service elementary teachers, I ask them to formally write up the lab and submit it during the following class (generally two days later). I am less interested in what they put in their reports than I am in having them continue to think about their experiments outside of class and what their results may mean. When we discuss the “genie” in the following class, the students are literally squirming in their seats to find out what was actually happening inside those bottles! They are fully engaged and then some!

After hearing brief oral reports from each group on the results of their experiments and their conclusions, I repeat the experiment and explain to them the actual cause of the appearance of the “genie” and what variables are at work. During some semesters, I have had students comment to me in subsequent weeks that they no longer look at clouds the same way.