A 5E Kindergarten Science Lesson:

Evidence-Based Reasoning about Bubbly Chemical Reactions

A supplement to "An Engineering Design Process for Early Childhood: Trying (Again) to Engineer an Egg Package"

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A note about content: *The primary purpose of this lesson for the kindergarteners was to engage students in the practice of evidence-based reasoning (NGSS Practice 7, Engaging in Argument from Evidence). Secondarily, we aimed to expose them to the concept of chemical reactions (not teach them this complex concept in depth). The concept of chemical reactions is typically taught in the later elementary and middle school years.*

Engage

To engage students in the lesson, we dropped an antacid tablet in about 50 ml of water in a clear plastic cup and asked students to describe what they observed. This was a "bubbly chemical reaction." (*Safety tip:* Do not let students handle medication!). We shared that bubbles like these are *one sign* that a chemical reaction has occurred. However, not every case in which bubbles form (e.g., boiling or Mentos in Coke) constitutes a chemical reaction.

Explore

To begin the exploration, we asked students to predict whether they would see a similar reaction if they placed one piece of chalk in 50 mL of water and another in 50 mL of vinegar; both liquids were in clear plastic cups. We asked students if they knew what vinegar was, and let them smell the vinegar. Students then dropped the chalk pieces into each liquid and made observations. They observed for about one minute and saw that bubbles formed continuously around the chalk in vinegar, but they did not form continuously on the chalk in water. We prompted students to describe their observations, asking, "What do you notice about the chalk in water? What about the chalk in vinegar?"

Explain

We prompted students to make an argument regarding in which liquid a chemical reaction occurred (i.e., the claim) and how they knew (i.e., the observational evidence). We asked, "Did the chalk have a chemical reaction with water? How do you know? Did the chalk have a chemical reaction with vinegar? How do you know?" Students verbally explained their claims and evidence to us.

Extend, Part 1

To extend this lesson, we asked students to predict what would happen if other materials—a wooden block, a plastic bead, an antacid tablet, about 5 mL of baking soda, and a piece of candy—were each placed in a cup of vinegar. Would these objects have a bubbly chemical

reaction like the chalk? (*Safety note:* Again, do not let students handle medication!) We gathered students around our carpeted area to test. Students were able to determine that the antacid tablet and baking soda had a chemical reaction in vinegar.

Note: An idea for enhancing this first extension: Have students predict whether the materials will have a chemical reaction with water. Allow students to test each object. The antacid tablet will have a chemical reaction, and the others will not.

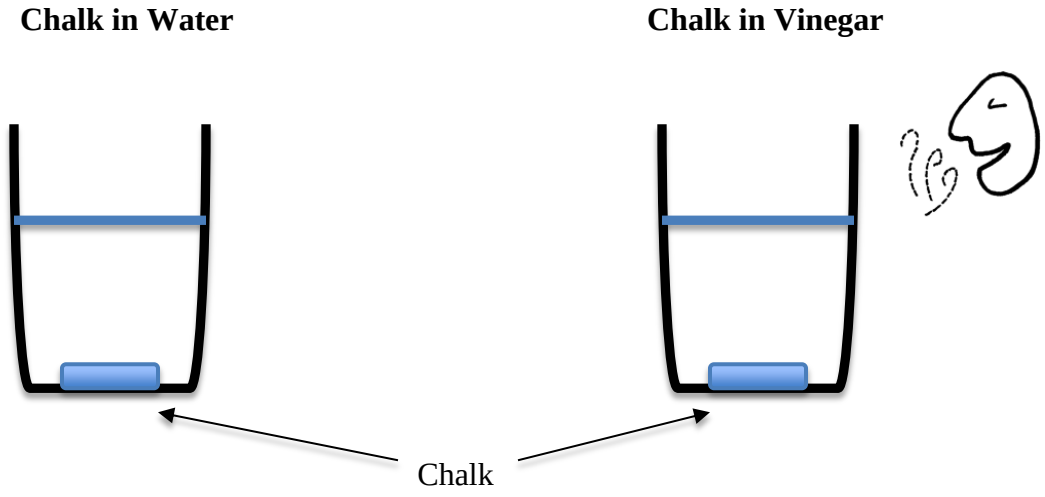
Extend, Part 2

To further extend the lesson, and to connect to the eggshell theme, we showed students a raw egg. (*Safety note:* Before this part of the activity, check to see whether any students have an egg allergy. In case there are students with unknown egg allergies, teachers should handle eggs, not students. If students handle the eggs, they should wash their hands.) We asked students to predict of the egg would have a chemical reaction in the vinegar. We placed an egg inside a 500 mL, clear cup filled with vinegar, and students noticed right away that bubbles formed on the egg. We continued to observe the egg throughout the week, with the students making observations for a few minutes each day. (*Tip:* Cover the egg completely, and on the second day, replace the old vinegar with new vinegar.) After about four days, the shell was *gone*, and what remained was a gelatinous, transparent egg. We asked the students whether a chemical reaction had occurred and how they knew this to be true.

Note: An idea for enhancing this extension: Have students compare the egg in vinegar to an egg in water for the same duration.

Evaluate

Our evaluations of student learning emphasized their evidence-based reasoning regarding bubbly chemical reactions for the chalk in vinegar (but not for the chalk in water) and egg in vinegar. Students drew and verbally explained their claims and evidence. For example, students would draw bubbles around the chalk in vinegar but not around the chalk in water. They drew on handouts that looked similar to this:



Students also created their own drawings of what the egg looked like right after being placed in the vinegar and once the egg shell was gone.

Material tip: We used white vinegar for our experiments. Because white vinegar looks like water but smells different, we used the symbol on the right to indicate all cups containing vinegar. We printed it onto stickers and then put the stickers on the clear cups.

***Common Core* Connections:** From their first predictions about chalk to this final explanation in the science lesson, students engaged in speaking, listening, and collaborative idea-generating processes inherent within the *Common Core State Standards (CCSS)*, in English language arts (ELA). This engagement continued in the read-aloud and design challenge.

Acknowledgment

The Engage, Explore, and Explain sections of this activity were adapted from an early child science lesson on chemical reactions by Cody Sandifer, Professor of Science Education in the Department of Physics, Astronomy, and Geosciences at Towson University.