System in a Bottle

By Jennifer Munoz

NGSS: 5-LS21 Connections to DCIs in Fifth Grade—5-ESS2-A, 5-PS1-A

Connections to CCSS: Language Arts—RI, 5.7, SL. 5.5

EP&Cs: Students should be developing an understanding—

**Principle III Concept A:** Natural systems proceed through cycles and processes that are required for their functioning.

**Principle III Concept C:** Human practices can alter the cycles and processes that operate within natural systems.

**Principle IV Concept A:** The effects of human activities on natural systems are directly related to the quantities of resources consumed and to the quantity and characteristics of the resulting byproducts.

**Principle IV Concept B:** The byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral or detrimental in their effect.

**Summary**

Students collect 2-liter bottles and build their own bottle ecosystems which become the source of phenomenon used for collecting evidence, making causal explanations, and modelling using a *Developing and Using Models* graphic organizer.

**Overview of the Formative Assessment Process in This Resource**

Clarifying Intended Learning

- **Learning Goal:** Students will create a diagram model of the bottle ecosystem focused on predicting or explaining the natural world. Students evaluate the merits and limitations of the model.
- **Success Criteria:**
  - Ask questions about how matter moves through their ecosystem relating to particles and make sense of their phenomena.
  - Identify the phenomena, define the boundaries of the system.
  - Draw and label the components and identify the relationships between the components.
o Explain their thinking, make a claim and engage in argument based upon evidence.

Elicit Evidence:
Build ecosystem prototype—Bottle Biology TerrAqua Column
Graphic Organizer Developing and Using Models
Partner and Science Talk

Interpret Evidence

**Evidence Statements (observable student actions)**
Using the Graphic Organizer, students are able to:

1. Identify components of the model that includes the idea that matter is made of particles too small to be seen. In the model, students identify the relevant components for the phenomenon, including:
   a. Bulk matter (macroscopic observable matter; e.g. water)
   b. Particles of matter that are too small to be seen. (e.g. air)

2. Identify relationships between components including relationships between the components above (see #1).

3. Support claims that include the idea that plants acquire the materials they need for growth chiefly from air and water.

4. Identify scientific evidence that support the claim, including evidence of:
   a. Plant growth over time.
   b. The weight of soil and water over time within a closed system with a plant indicating:
      i. Soil does not provide most of the material for plant growth (e.g., changes in weight of solid and plant in the bottle over time)
      ii. Plants’ inability to grow without water over time.
      iii. Plants’ inability to grow without air.
      iv. Air is matter.

5. Students use reasoning to connect the evidence to support the claim with argumentation. Students are able to describe their chain of reasoning using their evidence from above (see #4).
**Act on Evidence**

Students can share out their thinking and reasoning with the whole group. Teacher can document thinking and facilitate a science talk by note taking, allowing students to lead their own discussion as a whole group. Students might need to revisit earth’s systems to reinforce their explanations about interactions between the atmosphere and biosphere. Examples of this include modeling the phenomena of dust moving across the Atlantic Ocean from North Africa and settling in the rainforests of South America. This cycling of matter is critical for moving matter between the atmosphere and biosphere, providing essential nutrients for the trees that grow in the rainforest.

Students can also revisit and apply their understanding of decomposers, photosynthesis and matter used by animals for growth and repair.

**Feedback**

Help Students to get started by asking key questions:

- What do we think is providing the energy for the system in the bottle?
- What evidence shows that energy is present? Is matter moving through the system?
- What forms of matter (states of matter) are present?
- Can you see evidence of matter (such as water) moving between states of matter?

Press Further

- What will your experiment tell us about ecosystems?
- How can you apply your model to predict how an ecosystem works?

Follow-up

- Can you say more about ecosystems?
- Do you all agree? Why?
- What makes you think that?
- Who can share their thinking with the whole group?
- What questions do you want to ask an ecologist?

**Instructional Moves**

Eliciting Evidence from students requires that teachers honor all ideas. At this point in the lesson, students are encouraged to share ideas and thinking. It is the role of the teacher to move between tables of students and interact with students. The following instructional moves are encouraged (adapted from *Ambitious Science Teaching*):

1. Listen first- move from group to group to listen to student ideas.
2. Press and Point- ask questions that either probe thinking or redirect them to reason further.
3. Follow up- “What do you mean?” or “tell me more.”

4. Include everyone- ask follow-ups of all group members such as “do you agree?” or “want to add on?”

5. Prepare for later share-out- ask “are you comfortable sharing that with the whole group?” and “get ready to share with the whole group shortly.”

Pose the leaving question- prepare groups to continue discussion by leaving a final question before you move on to the next group.

**Instructional Task Description**

**Differentiation**

*For English Language Learners*

Visuals are used throughout to support ELL students. Give ELL students time to verbally collaborate with other students during completion of the graphic organizer. Provide ELL students with sentence frames so they can explain their answer in writing. For example: “water moves from the soil to _________. We observed plant growth ________ which confirms_________.” “If the system does not have air or water, then ________________.”

*For Students with Disabilities*

Provide students with partners to assist in building the prototype. Provide students with sentence frames so they can explain their answer in either verbal or written format. For example: “I see that water, sun and ________ are needed for the system to ___________.”

*For Other General Education Students*

The lesson can be adapted to challenge student thinking and you can extend the lesson by further exploring other “Wonder statements” created by students. Give Actionable Feedback to the students. It may require a conversation about sources of error in building the prototypes. What will happen when the plant dies? Will the water disappear? How does this model help us understand other earth systems? How can we build a different system?

**Additional Comments and Considerations from the Author(s)**

Recommended Educator: Reading

- *Ambitious Science Teaching* (2018) by Mark Windschitl, Jessica Thompson, And Melissa Braaten
- *Talk Science Primer* by Sarah Michaels and Cathy O’Connor
  https://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf

- *Science Practices Continuum – Students’ Performance*

- *Science Practices Continuum – Supervision*

- *Instructional Strategies – Developing and Using Models*

**Student Materials and Additional Resources Links**

*Science and Engineering Practices Graphic Organizers:*  
https://thewonderofscience.com/documents

*Bottle Biology Project Guide:* http://bottlebiology.org/

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