

A Model of Matter, Part 1 Revisited: Student Responses

We're interrupting the regularly scheduled emails to bring you some breaking news. At the end of *A Model of Matter: Part 1*, we wondered how students would reply to the following:

Draw a diagram and explain how water disappears from a puddle.

- What happens?
- Where does the water go?
- Why?

We've recently received many student responses from grades 2 and 3, and we thank the following teachers for taking the time to question their students and to share this very interesting data.



Michele DeGuire	Gr. 2	Watervliet
Carol DiLallo	Gr. 2	Burnt Hills-Ballston Lake
Maria Geene	Gr. 2	Watervliet
Paula Evwaraye	Gr. 3	Schenectady
Cindy Hopkins	Gr. 3	Burnt Hills-Ballston Lake
Tim Keegan	Gr. 3	Schenectady
Kathy Terpening	Gr. 3	Watervliet

Some were written answers, some were diagrams, and some were a combination of the two.

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We noticed some very interesting things when we examined the responses. Those cited below occurred often enough for us to consider them significant. There were several encouraging signs from the elementary grades:

- Use of the word “evaporation” to explain the puddle disappearance.
- Explanation of evaporation as part of a larger process, the water cycle.
- Statement that heat is needed for evaporation.
- Identification of liquid water in a puddle turning into a gas.
- Use of diagrams to further explanations.
- Use of a scientific format for the explanation: “This is what happens (*statement*) because (*explanation*)...”
- Use of complete answers. Check out this response (spelling corrected): “It evaporated because of the sun. The sun’s heat turned the water into a gas. The water’s gas is in the air. The air has moisture.” This young student seems to have a clear initial understanding of both the evaporation process and water’s phases.

Young children base scientific explanations both on their daily observations and on the few years of science education they’ve received in school. Trying to merge these takes time and often leads to some misunderstandings. We observed a few of these:

- Misunderstanding the word “condensation;” that it is part of the process of evaporation of the puddle.
- Confusing the state of a cloud: is it water vapor (no) or condensed water droplets (yes)?
- Misunderstanding where the water goes immediately as it evaporates: into the clouds (no), into the sky (no), into the air (yes).
- Equating melting with evaporating.

At the K-3 elementary level we did not see anything about our model of matter (tiny particles in motion), which is essential to the process of evaporation. However, we did not expect to see it at this level since it is not specifically included within the New York State Elementary Science Core Curriculum.

Of course, this interesting data leads to new questions...

- One line of inquiry to use with students is to investigate exactly what they mean when they use technical terms such as “**evaporation**” and “**condensation**.” It’s very likely that they learned this vocabulary in school, therefore, teachers know what they *want* students to understand about the concepts. But do our expectations match their reality? For instance, if a student states that, “the puddles **evaporate** into the air,” we can accept this as technically correct. However, does the student have the same definition of “**evaporation**” as we do? From the student’s statement, we can’t know for sure. Probing an answer, especially when it contains a technical term, will inform us if a student really understands a concept or merely has memorized a term.
- Some responses completely avoided the issue of evaporation. Several students indicated that the puddle water goes into sewers. Others wrote about the water soaking into the ground and perhaps watering plants. These responses elicited further questions:
 1. Was our question not clear enough for students of this age? Did ambiguity guide students away from evaporation, focusing instead on other topics? Certainly, some puddle water does run into sewers, and some does soak into the ground. Should the question be re-written to accentuate a puddle on a flat-surfaced driveway?
 2. Were the students who focused on watering plants in the midst of studying plants? Were they so engrossed in botanical life that they assumed a science question must apply to that unit?
 3. Were some students confused by the question and, feeling the need to present some work, came up with an explanation that fit their understanding?

We suspect that none of these is *the* right answer; it is a combination of all, plus, perhaps, others.

4. With extended response questions becoming more important on high stakes test, how can we help students become better scientific writers?

This could be a whole book in itself, but we do have some suggestions:

- Students must be aware of their *audience* when writing. They should not be writing for their classroom teacher; it’s too likely that students will assume some common knowledge and leave out essential information. Instead, writers should address an audience unfamiliar with what has been going on in the classroom.
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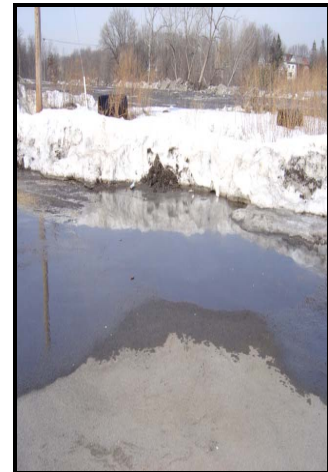
- Students need to answer the full question; in science the *why* is just important as the *process* involved.
- Diagrams are helpful, but they are open to interpretation. Text should be included to provide clarification.
- Students should avoid including *too* much information. For instance, it's not necessary to discuss *everything* they know about water (such as how it helps a seed germinate) to answer the puddle question. Extraneous material can lead to questions about student understanding of a specific, identified topic.

We're grateful to have had the opportunity to examine student responses. This connection between professional development theory and classroom practice is vital, both to the success of the CRSEP project, and, ultimately, (and most importantly) our students' success in science.

Coming up Next week, we'll return to our regularly scheduled email. We left off with a *Model of Matter: Part 3*. We were discussion evaporation rate of a puddle. It ended with this task

Original puddle had a length of 1 m and a depth of 25 cm

What if we *decrease* the length to 50 cm but keep the volume of water the same?



What if we *increase* the length to 200 cm but keep the volume of water the same?

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Consider asking your students to compare the rate of evaporation of the original puddle to the others and send their responses to crsep@schenectady.k12.ny.us

- How does our model of matter (tiny particles in motion) help us to explain this?

What do the New York State standards say?

In the Elementary Core Curriculum, Standard 3, The Physical Setting,

Major Understanding states:

- 3.1a Matter takes up space and has mass. Two objects cannot occupy the same place at the same time.
- 3.1c Objects have properties that can be observed, described and/or measured: length, width, volume, size, shape, mass or weight, temperature, flexibility, reflectiveness of light.
- 3.1f Objects and/or materials can be sorted or classified according to their properties.
- 3.2b Temperature can affect the state of matter of a substance.
- 3.2c Changes in the properties or materials of objects can be observed and described.

In the Intermediate Core Curriculum, Standard 3, The Physical Setting,

Major Understanding states:

- 3.1a Substances have characteristic properties. Some of these properties include color, odor, phase at room temperature, density, solubility, heat and electrical conductivity, hardness, and boiling and freezing points.
- 3.1d the motion of particles helps to explain the phases (states) of matter as well as changes from one phase to another. The phase in which matter exists depends on the attractive forces among particles.
- 3.3b Atoms and molecules are perpetually in motion. The greater the temperature, the greater the motion.
- 3.3a All matter is made up of atoms. Atoms are far too small to see with a light microscope.
- 3.3c Atoms may join together in well-defined molecules or may be arranged in regular geometric patterns.

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