Puddles Mini-Unit Overview

Phenomenon & Anchoring Question

Tell students about a time you saw a puddle and what happened when you returned a few hours later. Then ask students to consider: *Where did the puddle come from? Where did it go?*

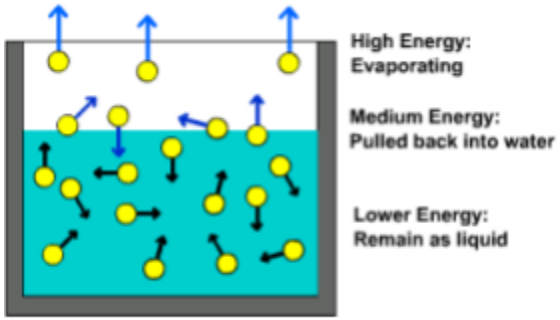
Photo of puddles on a grassy field with a dirt road. Rain absorbs into the ground until it becomes supersaturated

Teacher Content Knowledge

This mini-unit helps students explain an everyday phenomenon so students can draw on their personal experiences to think about how puddles change – what happens when it rains, when it's sunny, etc. – and how water moves or changes. You will likely hear students talk or see them draw pieces of ideas presented below. The most important thing is that you and your students are seeking to make sense of what's happening to the puddle together; this brief adult-level explanation may help you see productive beginnings of science ideas in students' ideas and will probably raise further questions or ideas to pursue with students or other teachers.

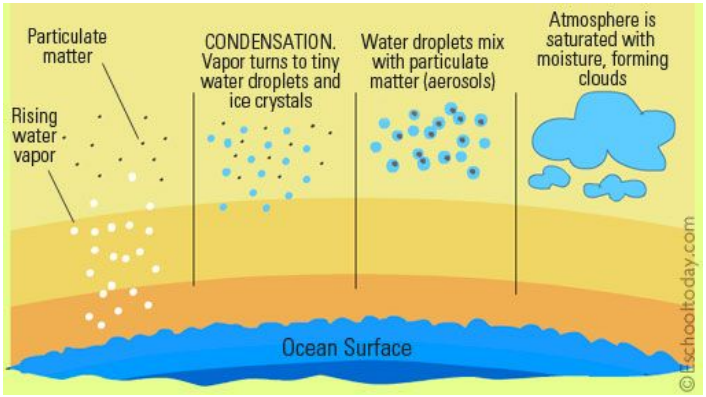
Where does a puddle come from? Why don't I always see puddles when it rains? Puddles can form when it rains, but not always. Whether or not a puddle forms depends on two factors: (1) the rate at which the rain falls, and (2) the rate at which the water runs off or soaks into the surface. We see puddles form when rain is falling heavily and quickly. Too much water overwhelms natural and manmade drainage. But puddles may not form if there is adequate drainage for the amount of rain. Puddle formation is one example of the science principle that matter is conserved – matter (in this case, water) cannot be created out of nothing nor disappear out of existence. So rain water that's falling has to go somewhere – running off, soaking in, or staying put and forming puddles.

Where does the puddle go? What is evaporation, and how does it happen? One reason the puddle goes away is that water evaporates – changing from a liquid to a gas. Liquid water is made up of millions of water molecules that are close together and attract each other. When heat energy is added (like from the sun, or from the stove), water molecules move faster and break away from each other, moving into the air. Water vapor (gaseous water) is made up of the same water molecules that were in the liquid water, but they are much farther apart and moving faster. Thus, water does not disappear; it changes forms from liquid to gas. Matter is conserved! Remember: Water is water is water. Whether it's ice (solid water), liquid (water) or gas (water vapor) it is still the same water molecules (H_20). Adding or removing heat energy from the system causes water to change observable forms from solid to liquid to gas and back when heat is removed. *[Note: A factor affecting evaporation is humidity – how much vapor is present, and how much more can move into the air. Also, the shape of the puddle can affect evaporation speed -- a shallow puddle with more surface area makes it easier for water molecules to "break away" and evaporates more quickly than a deep puddle with less surface area.]*



Water vapor is made of water. Energy (from sun, from warm pavement) moves water molecules in the puddle faster and faster until some are moving fast enough to break the hydrogen bond between molecule and zoom away!
For more information about energy and evaporation visit:
http://www.chem4kids.com/files/matter_evap.html

So, once water gets enough energy to evaporate into the air, then what happens? Water molecules in the air will slow down as they rise into the colder levels of the atmosphere. When there is dust, dirt, or smoke, these water molecules bump into each other and coalesce or condense together. Eventually, this forms a cloud. As more and more water molecules stick together, the cloud gets heavier and eventually it will rain. Understanding evaporation and condensation is a little tricky since it looks like the water "disappeared" or was "invisible" which is why the activities selected for this mini-unit are intended to help trap this water to help make that more visible to students and how heat energy plays a role (more heat energy = more evaporation; less heat energy = cooling/condensation).



Mini-Unit Overview

This sequence of lessons will take 6-8 sessions, 30-45 minutes each. Plan on 3 weeks if you have science time 2-3 times per week. This mini-unit may take your students more time than indicated. Be responsive to your students' needs. This mini-unit only focuses on how water evaporates but the longer version of this unit also includes lessons for students to learn about how water goes down moving into/through soils and how plants use puddle water.

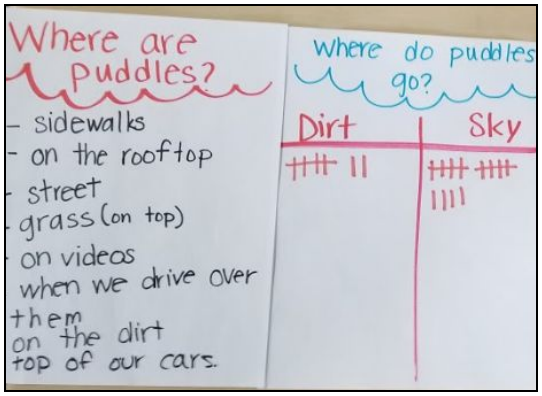
*** = Materials provided in the mini-kit. Please rinse and return all materials.**

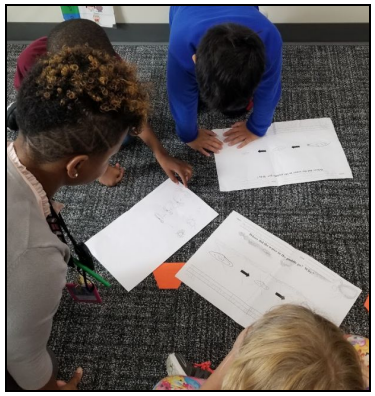
	Purpose	Questions/Prompts in this Lesson	Next Generation Science Standards (NGSS)	Materials
1	**Introduce phenomenon; Elicit students' ideas on an explanatory model** *1 day*	Where/when have you seen puddles form? Where do puddles come from? What makes puddles bigger? smaller? Why do puddles go away? How can you show that in a model? What text features can you add to the model so other scientists can understand your ideas?	**SEP: Developing and Using Models** *Scientists use models to represent their current understanding of a system (or parts of a system) under study, to aid in the development of questions and explanations, and to communicate ideas to others.* **DCI: ESS2.D Weather and Climate** *People measure weather conditions to describe and record the weather to notice patterns over time* **CCC:** Cause & Effect *Analyze patterns and consider what might be causing these patterns to occur*	Teacher Guide GoogleDoc Slide Guide GoogleSlides Model Scaffold per student (GoogleDoc or PDF) Colored pencils, crayons, pencils
2	**Compare ideas; Create a class model; Ask Questions** *1 day*	How can we show water moving/changing in a model? How do we show temperature (warm/hot) in the model? How can color, arrows, and size show ideas in pictures? What ideas do many of us think are important?	**SEP: Developing and Using Models** **SEP: Asking Questions** **DCI: ESS2.D Weather and Climate** *People measure weather conditions to describe & record weather to notice patterns over time* **CCC:** Cause & Effect *Analyze patterns and consider what might be causing these patterns to occur*	Teacher Guide GoogleDoc Slide Guide GoogleSlides Chart or butcher paper Markers *Sticky notes (optional)*
3	**Covered vs. uncovered puddle** *Introduce the idea of evaporation and that water changes forms* *2 days*	What do you observe? Where did the water go? What makes the water go into the air? How can we make evaporation happen faster?	**SEP: Obtain and communicate information** *Read grade-appropriate texts and use media to obtain scientific information to determine patterns in the natural world.* **DCI: PS1.A Structure and properties of matter** *Different kinds of matter exist and many of them can be either solid or liquid (or gas), depending on temperature.* **CCC:** Patterns *Data are represented to facilitate pattern recognition which can then be used as a tool in seeking an underlying explanation for what causes the pattern*	Teacher Guide GoogleDoc Slide Guide (GoogleSlides) Student sheet (GoogleDoc) *Per experimental set-up/group:* 2 plastic plates* 1 clear plastic cups* 1 cup measuring cup* 1 pipette* water and paper towels
4	**Compare a physical model to the real world system** *(water cycle in-a-bottle)* *1-2 days*	What's happening on the cold cup? What do you notice about where droplets form? If the warm water in the bottom is like the ocean heated by the Sun, what does the ice in the cup at the top represent in the real world? What about the of water that fall down? What could we change to make this physical model better represent the real world? Why would you add___?	**SEP: Developing and Using Models** *Represent and explain phenomena with multiple types of models .Discuss the limitations and precision of a model as the representation of a system.* **DCI: PS1.B Chemical Reactions** *Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not.* **CCC:** Systems and System Models *Systems in the natural and designed world have parts that work together. System models are developed to represent these parts to study and better understand how these parts interact during natural and designed processes.*	Teacher Guide GoogleDoc Slide Guide (Link) Student sheet (GoogleDoc) *Per experimental set-up/group:* 1 clear plastic cup* 1 ice cube tray* (need 6 ice cubes) 1 cup measuring cup* 1 two-liter clear plastic bottle sharp scissors (for adult-use only) warm tap water
5	**Update and revise puddle modes** *1-2 days*	What have we done and learned so far? What was your favorite part of thinking about puddles? How can you show that idea in a picture? What are some different ways to use arrows to show your idea?	**SEP: Constructing Explanations** **DCI: ESS2.D Weather and Climate** *People measure weather conditions to describe and record the weather to notice patterns over time* **CCC:** Cause & Effect *Analyze patterns and consider what might be causing these patterns to occur*	Teacher Guide GoogleDoc Slide Guide (Link) Model Scaffold pr student (GoogleDoc or PDF) *Optional: Chart or butcher paper, w/ markers*

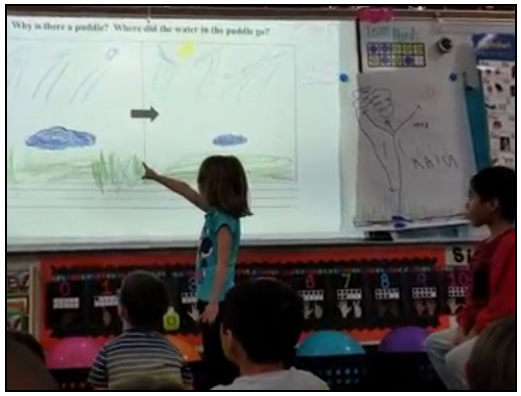
Lesson Photos

Photos from lesson 1

Introduce phenomenon, elicit students' initial ideas, share ideas, from K-2 classrooms. After some initial talk about where students find puddles, students worked independently on their models. Then compared ideas in pairs or groups. Finally, some students shared some ideas about the role of the sun, why the puddle changed size, or how puddles are different on grass or concrete.

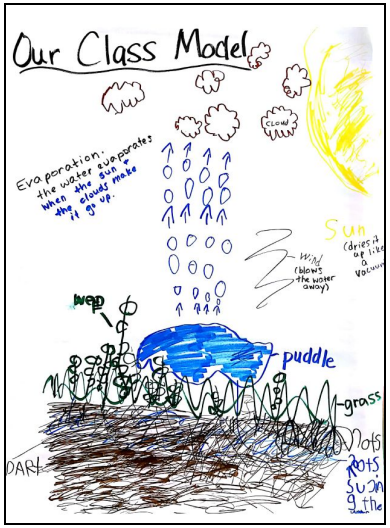


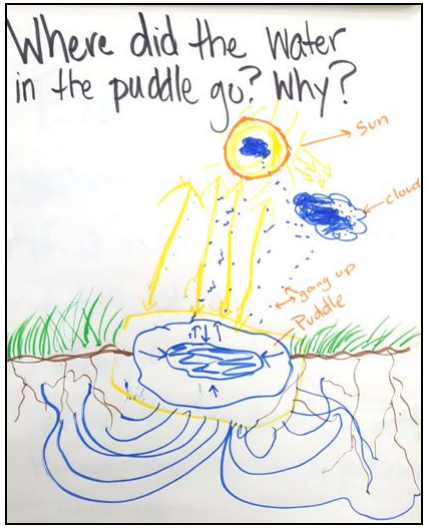


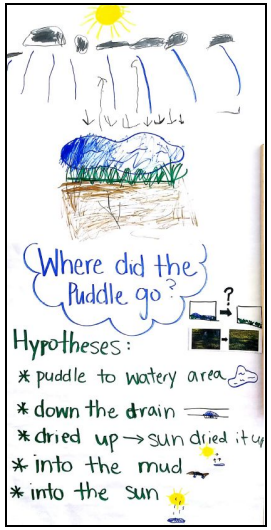


Photos from lesson 2

Class models and questions from K-2 classrooms: Notice the mix of teacher and student writing. If at least 3 agreed, then the student came up or the teacher added it to the model.

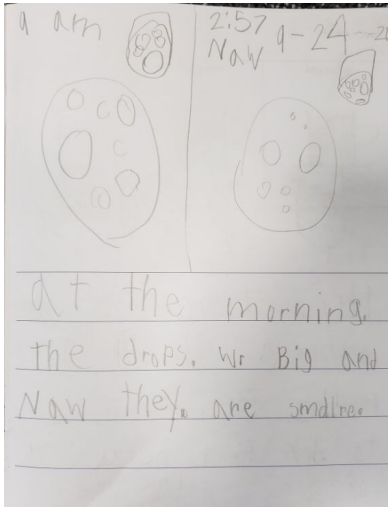


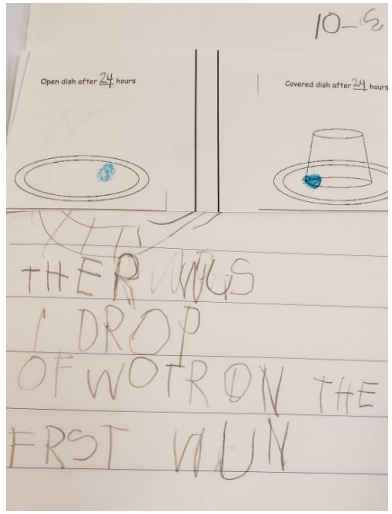




Photos from lesson 3

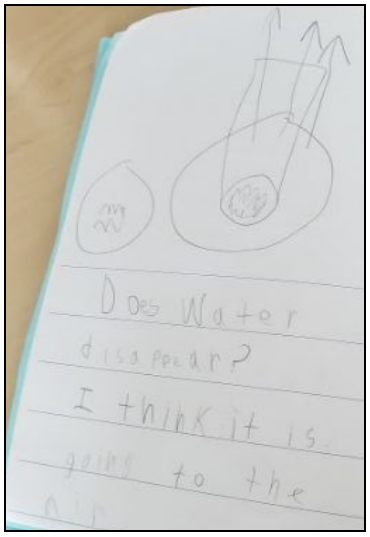
Evaporation: The covered dish has water inside and some droplets on the sides. The uncovered dish has a dried up spot but no liquid water left. This was left overnight or over several hours to fully evaporate. Students draw, talk, and write about their observations. Some students may say that the "air took the water away" (evaporation). If students say "it disappeared" ask about what happened under the cup ("it got trapped")





Help students model their ideas. What does this sound like? See the brief teacher-student exchange below. This happened while the teacher circulated the room as students were each observing and drawing/writing about their investigation. Press students to make sense of observations by asking for a comparison. Keep in mind the big science idea of conservation to help students recognize that the water doesn't disappear. The next lesson (4) helps with this, too, so it's okay if students are still skeptical that the water doesn't disappear.

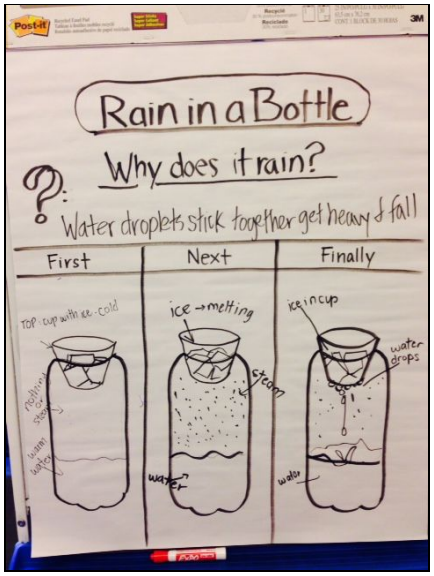
Teacher	**What do you notice?**
Student	The water disappeared *(pointing to plate)*
Teacher	**What about here?** *(pointing to the cup)*
Student	The water got... trapped.
Teacher	**So if that water got trapped here** *(pointing at cup)***, what happened to this water?** *(pointing to plate)*
Student	It went away...it got out. But here *(cup)* it still goes up.
Teacher	**How could you draw that in your notebook?**
Student	I could draw...arrows...going up?
Teacher	**That sounds like a plan. Showing the idea of water going up using arrows.** *(Moves on to another student)*

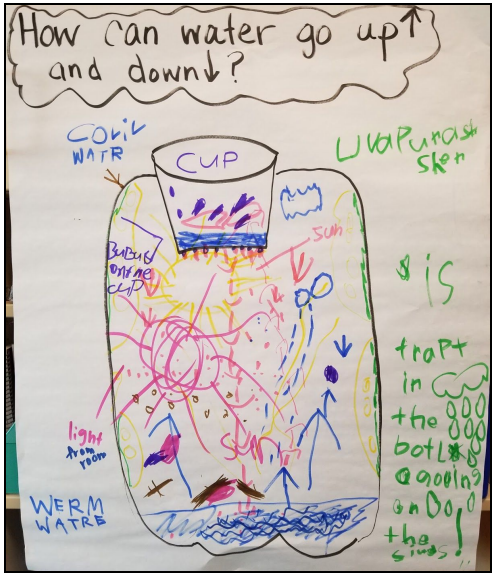


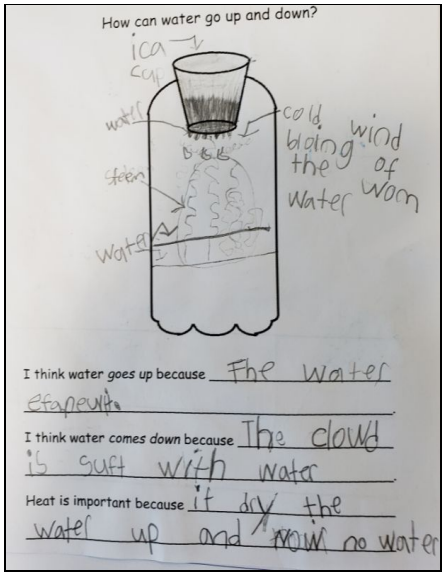
Does water disappear?
I think it is going to the air.

Photos from lesson 4

Class models and student models from the water cycle in-a-bottle physical model. How is this model like the real world? How is it not? How does this help us explain where the water goes? What is the role of temperature (hot/cold) in this science story?







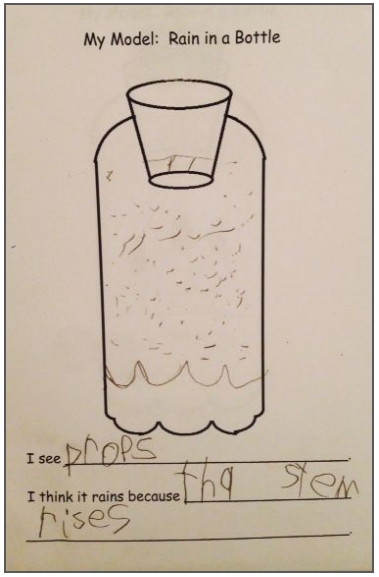
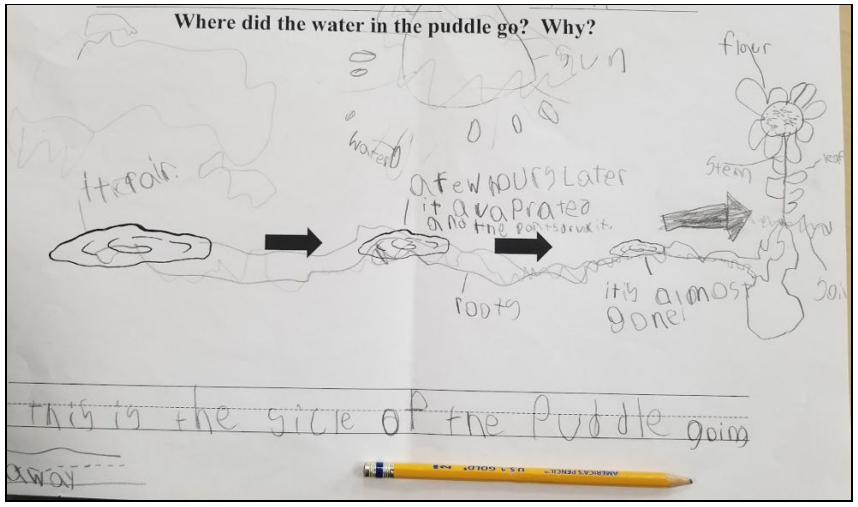


Photo from lesson 5

Students use information from lessons 3 and 4 to see if they can create more elaborated models to explain where the puddle goes. For lessons 3 and 4, focus students on coming up with symbols they can use to show that water changes to explain where puddles come from and where they go.



Student wrote: "It rains" ""a few hours later it avaprated (evaporated) and the pants (plants) druk (drunk) it." "it is almost gone" "This is the sicle (cycle) of the puddle going away."

The student talked about evidence but did not add it in writing. A next step might be providing a checklist and/or sentence starters so the student remembers to include it.

Also, the lack of student writing is likely due tothe page layout. Next time, the teacher will add more space for writing on the paper itself (as student started to add an additional line).