Making Sense of Water

Where does water go and how does it move?

Teacher Materials

SCIENCE LITERACY

MOHSES
Modeling Hydrologic Systems in Elementary Science

NEBRASKA COLLABORATIVE FOR FOOD, ENERGY, & WATER EDUCATION

MoHSES: Modeling Hydrologic Systems in Elementary Science

Summary

The Modeling Hydrologic Systems in Elementary Science (MoHSES) project, supported by the National Science Foundation (DRL-1443223), involves five years of research and development to investigate 3rd-grade students' model-based reasoning about geospheric components of the hydrologic cycle (i.e., groundwater) and how elementary teachers scaffold students' model-based reasoning. Project activities were grounded in iterative adaptation and refinement of the Full Option Science System Water module, an 8-week elementary science unit, to better engage students in model-based reasoning about water. Grounded in empirical research, the revised unit provides substantial opportunities for elementary students to develop, use, reflect on, and revise models of the water cycle over the course of the unit. Classroom-based research has shown that the enhanced version of the unit developed through the MoHSES project better engages elementary students in scientific modeling and facilitates greater learning gains of NGSS-aligned 3-dimensional learning expectations. Want to learn more about the MoHSES project? More information can be found here.

Grade Level

3

Contents address the following Next Generation Science Standards

- 5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- MS-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

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Mapping MoHSES materials to the 3rd grade FOSS water unit

The MoHSES teaching materials provide adaptations to the 3rd grade Full Option Science System (FOSS) water unit to better engage students in model-based reasoning about water. MoHSES materials consist of both stand-alone supplemental lessons and embedded modeling lessons.

The following table provides a map of where all 8 MoHSES lessons fit within the FOSS water module.

Location	FOSS	MoHSES	Timing
Pre-Unit		Stand-alone modeling lesson	Before Unit
Investigation 1	Part 1		
	Part 2 (optional)		
	Part 3	Embedded modeling instruction	Within FOSS Lesson
Post-Investigation		Stand-alone modeling lesson	After Investigation 1
Investigation 3	Part 1		
	Part 2	Embedded modeling instruction	Within FOSS Lesson
	Part 3 (optional)		
	Part 4		
Post-Investigation		Stand-alone modeling lesson	After Investigation 3
Investigation 4	Part 1	Embedded modeling instruction	Within FOSS Lesson
	Part 2 (optional)		
	Part 3 (optional)		
	Part 4 (optional)		
Post-Investigation		Stand-alone modeling lesson	After Investigation 4
Post-Unit		Stand-alone modeling lesson	After Unit

Legend
MoHSES **stand-alone** modeling lesson = **Dark Grey**
FOSS + MoHSES **embedded** modeling instruction = **Light Grey**
FOSS investigations- **no adaptations** = **White**

Instructional modeling sequence

Scientific modeling can be completed using the following sequence of modeling practices. The instructional modeling sequence represents what students and teachers DO in the classroom. Typically, these actions produce usable artifacts to illustrate student thinking and learning. This general instructional cycle is grounded in past research and development work focused on scientific models and modeling in science classrooms (e.g., Abell & Roth, 1995; Coll, France & Taylor, 2005; Gilbert, 2004; Kahn, 2011; Lehrer & Schauble, 2006, 2010; Schwarz & White, 2005; Schwarz, Reiser, Davis, Kenyon, Acher, Fortus, Shwarz, Hug,& Krajcik, 2009; Stewart, Cartier, & Passmore, 2005)

1. Students **construct** an initial model that represents and explains phenomena
2. Students **use** their model to:
    a. make *predictions* about a phenomena
    b. *investigate* a phenomena
    c. *explain* a phenomena
    d. *communicate and justify* their explanations for phenomena
3. Students **evaluate** their models in light of empirical data and other model-based explanations
4. Students **revise** their model to better represent and explain phenomena

Facilitating classroom discussion using Talk Moves (TERC, 2012, p. 11)

One effective way to utilize student models is to leverage their discussions. The following are some strategies for teachers to use to deepen student discussions.

Goal: Students share, expand and clarify their own thinking

1. **Time to Think:**
   - Partner Talk
   - Writing as Think Time
   - Wait Time
2. **Say More:**
   - "Can you say more about that?"
   - "What do you mean by that?"
   - "Can you give an example?"
3. **So, Are You Saying…?:**
   - "So, let me see if I've got what you're saying. Are you saying…?" (always leaving space for the original student to agree or disagree and say more)

Goal: Students listen carefully to one another

4. **Who Can Rephrase or Repeat?**
   - "Who can repeat what Javon just said or put it into their own words?" (After a partner talk) "What did your partner say?"

Goal: Students deepen their reasoning

5. **Asking for Evidence or Reasoning:**
   - "Why do you think that?"
   - "What's your evidence?"
   - "How did you arrive at that conclusion?
   - " "Is there anything in the text that made you think that?"
6. **Challenge or Counterexample:**
   - "Does it always work that way?"
   - "How does that idea square with Sonia's example?"
   - "What if it had been a copper cube instead?"

Goal: Students think with others

7. **Agree/Disagree and Why?:**
   - "Do you agree/disagree? (And why?)"
   - "Are you saying the same thing as Jelya or something different, and if it's different, how is it different?"
   - "What do people think about what Vannia said?"
   - "Does anyone want to respond to that idea?"
8. **Add On:**
   - "Who can add onto the idea that Jamal is building?"
   - "Can anyone take that suggestion and push it a little further?"
9. **Explaining What Someone Else Means:**
   - "Who can explain what Aisha means when she says that?"
   - "Who thinks they could explain in their words why Simon came up with that answer?"
   - "Why do you think he said that?"

Investigation 1: Water Observations

Investigation Overview

Part	Physical Model	Target Explanation	Modeling Tasks	Modeling Practice	Epistemic Commitment	Optional Tasks
Pre-Unit Lesson and Pre-Test	Water running down a sloped pan with different materials on its surface	**Adult:** Water moves downhill due to gravity at varying speeds depending on surface material **Student:** The steeper slope makes it easier for gravity to work. Also, bigger water droplets have more area so there is less resistance and gravity can work easier.	Construct a model	Construct	all	
1. Looking at Water						
2. Surface Tension *optional						
3. Water on a Slope			Predict	Use	Generality	
			Investigate	Use	Evidence	
			Explain	Use	Mechanism	
4. Post-Investigation Lesson -CONSENSUS MODEL			Communicate and Justify	Use	Audience	
			Evaluate	Evaluate	all	**optional response worksheet: Water observations (where to place the tent).

*If you choose to do surface tension, we recommend the water droplet experiment but not the salt and soap portions of the lesson (FOSS 2nd ed steps 6 through 13; FOSS 3rd ed. Steps 8 through 12) of Investigation 1, Part 2.

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**If time runs short, please focus on completing the modeling pages and do not complete the OPTIONAL response worksheet.

Pre-Unit Modeling Lesson: Constructing Water Cycle Models

Stand-alone Modeling Lesson

Key Concepts

- Models are representations, not exact copies, of real-world phenomena
- Models can include many different kinds of elements
- The ways in which scientists use models (to predict and explain) is what makes a model 'scientific'

GUIDING THE INVESTIGATION

Use the following procedures to introduce students to scientific models **prior** to introducing Investigation 1: Water Observations of the FOSS water module.

Introduce models

1. **ELICITING STUDENTS' IDEAS ABOUT MODELS**
   Tell students that one of the ways scientists represent and share their ideas is my making models. Ask students to consider the following, and record in their notebooks.

   Below are listed things that students might do in a science class. Check off the things that are examples of using a model.
   ___*observing a bird's behavior at a bird feeder*
   ___*drawing a food chain*
   ___*going on a field trip to the Grand Canyon*
   ___*making a bridge out of toothpicks and testing how much weight it can hold*
   ___*doing an experiment to investigate growth*

   Explain your thinking. How did you decide whether something was a model OR NOT?

   After students have recorded their responses, have a whole class discussion about their ideas. Ask,

   - *Which of these examples are models? Why?*
   - *What is a model? What do models look like?*
   - *How do you think scientists use models?*

   Ask students to tell you what they know about models. On a large piece of paper or on a flip chart, make three columns for these 3 questions. Record students' ideas in the appropriate column. Emphasize that,

   - A model makes really complicated things in nature simpler so we can understand and study them

- Scientists construct, use, evaluate, and revise models to explain and make predictions about natural phenomena.
- People can create models with pictures, words, mathematical equations, and computer programs
- We can construct and use models in the classroom to help us understand water.
- We can use our models to share ideas and to make those ideas better. We can get new or different ideas from other people, and we can think through our own ideas when people ask us about our models.

2. CONSTRUCTING A SCIENTIFIC MODEL TO ANSWER THE DRIVING QUESTION

Remind students that they are studying water in this unit. Introduce the driving question. Ask,

- *Where does water go and how does it move?*

Tell students that scientists use models to study water and that they are going to begin to use scientific models to learn about water during the unit. Emphasize that certain things make a model a scientific model. Emphasize that that scientific models show,

- Important **parts** of something in real life
- **How** it works
- **Why** it works the way it does

Introduce and distribute the student resources packet.

Read to them the following description on **page 1** of the student packet:

Imagine that you are on the school playground after a huge rainstorm. There are many places where there is water. Some places have large puddles. There is also water in ditches and moving to the drains. You go out the next day and you see that some of that water is not there anymore. You also see some areas where the water is still in larger puddles. What happened to the water that is gone? Where did it go and how did it do that? Why is some of the water still on the ground? How did it move? On the next page in the big box draw a diagram of what you think happened and why. Include what you think happened to water above and below the ground.

Ask students to be like a scientist when they draw their model and answer the questions, they are trying to illustrate and explain where water goes (i.e., answer the question above). Encourage students to consider the following when drawing their models. CONSTRUCT

- Include what you think are the very most important things that happen to water
- Include what you think happens on top of and under the ground, in the sky, and in bodies of water
- Show why water goes where it does
- Use words and/or numbers to label parts of your model

Ask them to consider thinking about the model first in their head, how things in the picture change, and *why* things are happening (a mechanism). Encourage to think about what's happening underground, not just above ground. Remind them to also write responses to all the question on the student packet **page 3**.

3. **CREATING A CONSENSUS MODEL TO ANSWER THE DRIVING QUESTION**
   Display a blank screen on a SMARTBoard or projector screen. Tell students scientists often have different ideas and models and have to work together to agree on things. Ask students to think like scientists and share the most important parts of their models with other members of their groups. Share these ideas with the whole class. As students share ideas, add these ideas to the SMARTBoard image. As students contribute ideas, highlight and reinforce important concepts about the water cycle from the unit. These might include:
   - Rainfall
   - Evaporation
   - Condensation
   - Water flowing downhill on the ground
   - Water moving into and through the ground

Wrapping up the Pre-Unit Lesson

4. **MAKE WORD BANK ENTRIES**
   Add new words to the class word bank.
   Students may add words in the **Word Bank** section of their student packets on **page 4**

   - A **scientific model** is a representation, not an exact copy, of complicated things in nature that can have many different parts and that scientists use to explain and make predictions.

   - A **consensus model** is a scientific model that many scientists help construct and agree with. It is often the product of many disagreements that were worked out over time.

5. **MAKE CONTENT/INQUIRY ENTRIES**
   Add new concepts to the content/inquiry chart.

   - *What is a model?* [A model is a representation or something that has our ideas about, not an exact copy, of complicated things in nature]
   - *What do models look like?* [Models can be lots of different things and have lots of different parts, like pictures, words, and numbers]
   - *How do scientists use models?* [Scientists use models to explain and make predictions, that's what makes them 'scientific' models]

Investigation 1, Part 3: Water on a Slope

Embedded Modeling Instruction

GUIDING THE INVESTIGATION

Use the following procedures **during** Investigation 1, Part 3: Water on a Slope.

1a. REVISTING STUDENTS' WATER CYCLE MODELS USE/predict

Remind students of the models of the water cycle they drew at the beginning of the unit (**page 2** of the student resources packet). Ask students to review their playground models and to think about how their model applies to this experiment. Ask students to answer the following questions in their modeling notebooks:

- Does their model help you think about the following question: 'Does water move faster on a steep slope or gentle slope?' Why?
- Does your model help you make predictions about water on a slope? If so, do you predict water will move faster on a steep or gentle slope? Why?
- How would you figure out what happens to water on a slope? Where might you look? What might you need to know?
- Students should record their predictions in the packets on **page 5**

1b. PROPOSING AN INVESTIGATION

Ask students to consider how they would test their predictions. Encourage them to discuss possible ideas in their small groups. Consider asking students the following questions:

- How would you figure out what happens to water on a hill?
- Where might you look?
- What might you need to know?
- How would you design your experiment?
- Does your experiment include steeper and gradual slopes?
- What would your experiment tell you?
- Students should record their ideas about creating an investigation on **page 5 and 6**

11a. USING MODELS TO DESCRIBE WHAT HAPPENED USE/investigate

Discuss with students how their experiments relate to the real world. Ask students to think about what they observed in the experiment and answer the following question in their modeling notebooks:

- Did you observe water moving downhill faster on a steeper or gradual slope? How do you know?
- Does your water cycle model show water moving downhill like you observed in the experiment?
- If so, how does it show it? If not, why not?
- Students should record their observations on **page 7**

Investigation 1: Evaluating and Revising Water Cycle Models

Stand-alone Modeling Lesson

GUIDING THE INVESTIGATION

Use the following procedures **after** Investigation 1, Part 3: Water on a Slope.

1. CONSTRUCTING MODELS OF STUDENTS' EXPERIMENTS

Ask students to reflect on their original model of Water on the Playground and how they used them in the previous lesson to make predictions about and explain the movement of water on a slope (**page 5**).

Explain to students that they will now draw a model of their investigation itself on **page 8**. Students should focus their models on the important conceptual elements of the investigation. In particular, students' models should show that…

- Water moves downhill
- The slope of the surface impacts how fast water flows
- Gravity is a force that is responsible for water moving toward the Earths' surface

Remind students that certain things make a model a scientific model. Emphasize that scientific models show,

- Important **parts** of something in real life
- **How** it works
- **Why** it works the way it does

Discuss with students things to think about when drawing their models using different visual elements, etc. Ask them to consider thinking about the model first in their head, how things in the picture change, and *why* things are happening (a mechanism). Ask them to draw their model in PENCIL.

2. USING MODELS TO EXPLAIN WHAT HAPPENED USE/explain

Pose the questions and ask students to write an individual response in their modeling notebooks.

- Why does water move downhill?
- Why does water move downhill faster on a steeper slope?
- How does your model show 'why' water moves?
- Students should record their explanations about their diagrams on **page 9**

3. SHARING FINDINGS AND EXPLANATIONS USE/communicate and justify

Ask students to number off in their groups and assign partners across groups. Once students have paired up, allow each 2 minutes to use his/her model to share observations and explanations

Facilitate a whole-class discussion. Ask students to bring their modeling notebooks with them to a discussion space. Ask for a volunteer from one group to use their model to describe their explanation for why water moves downhill and does so faster as the slope is increased. Repeat this with a few more volunteers from different groups. Ask students to record key terms and ideas about each explanation. Encourage students to ask each other questions.

4. EVALUATING EXPLANATIONS AND MODELS EVALUATE

Ask students to individually complete **page 10** in their modeling portfolio. Before doing so, walk through the four questions with students so that they understand what they're being asked. Emphasize to students that they are to evaluate their water cycle model.

- How well does your model show how water moves downhill?
- How well does it show why it moves downhill?
- How well does it show your evidence from your observations (steeper slope) for how and why water moves downhill?
- How well does your model help you convince others that this is how and why water moves downhill?

Ask students to return to their ORIGINAL model and make any changes they think the original model needs in **RED** pencil.

5. CREATING A CONSENSUS MODEL TO ANSWER THE DRIVING QUESTION

Display the consensus model from Supplemental Lesson #1 on a SMARTBoard or projector screen. Remind students scientists often have different ideas and models and have to work together to agree on things. Ask students to think like scientists and share the most important parts of their models with the whole class. As students share ideas, add these ideas to the SMARTBoard image. As students contribute ideas, highlight and reinforce important concepts about the water cycle from the unit. These
might include:

- Rainfall
- Evaporation
- Condensation
- Water flowing downhill on the ground
- Water moving into and through the ground
- OPTIONAL: Response sheet on **page 12**.

Investigation 3: Water Vapor

Investigation Overview

Part	Physical Model	Target Explanation	Modeli
1. Evaporation	Plastic cups with water	**Adult:** Liquid water changes to water vapor when warmed and water vapor changes to liquid water when cooled. **Student:** Heat energy causes small parts of water to move to the air (water vapor). The more heat energy that is on the water, the faster this happens.	
2. Evaporation Locations			Predict Investig Explain
3. Surface area optional			
4. Condensation			
5. Post-Investigation Lesson -CONSENSUS MODEL			Commu Evaluat Revise r

**If time runs short, please focus on completing the modeling pages and do not complete the OPTIONAL response worksheets.

Legend
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FOSS + MoHSES **embedded** modeling instruction = **Light Grey**
FOSS investigations- **no adaptations** = **White**

Investigation 3, Part 2: Evaporation Locations

Embedded Modeling Instruction

GUIDING THE INVESTIGATION

Use the following procedures **during** Investigation 3, Part 2: Evaporation Locations.

8a. REVISTING STUDENTS' WATER CYCLE MODELS USE/predict

Remind students of the models about what happened to water on the playground they drew at the beginning of the unit. Ask students to review their models and to think about how their model applies to this experiment. Ask students to consider the following questions:

- Does your model help you think about the following question: 'What happens to the water inside the cups placed at different places in the room?' Why?
- Does your model help you make predictions about water? If so, what do you predict will happen to water when it is heated? Why?

Students should record their predictions on **page 13.**

8b. PROPOSING AN INVESTIGATION

Ask students to consider how they would test their predictions. Encourage them to discuss possible ideas in their small groups. Consider asking students the following questions:

- What causes water to evaporate?
- Where does water go when it evaporates?
- From where out on the playground do you think water evaporates?
- How would you design your experiment?
- Does your experiment include steeper and gradual slopes?
- What would your experiment tell you?
- Students should describe their proposed investigations on **page 13-14.**

9a. USING MODELS TO DESCRIBE WHAT HAPPENED USE/investigate

Discuss with students how their experiments relate to the real-world. Ask students to think about what they observed in the experiment and answer the following question in their modeling notebooks:

- Did you observe water evaporating?
- Does your playground model show water evaporating?
- If so, how does it show it? If not, why not?
- Students should record their observations on **page 14-15**

Investigation 3: Evaluating and Revising Water Cycle Models

Stand-alone Modeling Lesson

GUIDING THE INVESTIGATION

Use the following procedures **after** Investigation 3, Part 4: Condensation.

1. CONSTRUCTING MODELS OF STUDENTS' EXPERIMENTS

Ask students to reflect on their models and how they used them in the previous lesson to make predictions about and explain what happens to mixing of water samples at different temperatures (**see student page 13**). Explain to students that they will now draw a model of their experiment itself on **page 16** Students should focus their models on the important conceptual elements of the experiment. In particular, students' models should show that water evaporates, sometimes faster, sometimes slower, as temperature increases, water evaporates faster, and that heat is a form of energy that is transferred to the water. Remind students that certain things make a model a scientific model. Emphasize that that scientific models show,

- Important **parts** of something in real life
- **How** it works
- **Why** it works the way it does

Discuss **page 16** with students and things to think about when drawing their models, including using colors, different visual elements, etc. Ask them to consider thinking about the model first in their head, how things in the picture change, and *why* things are happening (a mechanism).

2. USING MODELS TO EXPLAIN WHAT HAPPENED USE/explain

Pose the questions and ask students to write an individual response in their modeling notebooks.

- Why does water evaporate?
- How does your model show 'why' water evaporates?
- Students should record their explanations on **page 17**

3. SHARING FINDINGS AND EXPLANATIONS USE/communicate and justify

Ask students to number off in their groups and assign partners across groups. Once students have paired up, allow each 2 minutes to use his/her model to share observations (**page 15**) and explanations (**page 17**) from the previous lesson.

Facilitate a whole-class discussion. Ask students to bring their modeling notebooks with them to a discussion space. Ask for a volunteer from one group to use their model to describe their explanation for why water evaporates and condenses. Repeat this with a few more volunteers from different groups. Ask students to record key terms and ideas about each explanation. Encourage students to ask each other questions.

4. EVALUATING EXPLANATIONS AND MODELS EVALUATE

Ask students to individually complete **page 18** in their modeling portfolio. Before doing so, walk through the four questions with students so that they understand what they are being asked. Emphasize to students that they are to evaluate their original playground model.

- How well does your model show how water evaporates and condenses?
- How well does it show why water evaporates and condenses?
- How well does it show your evidence for how and why water evaporates and condenses?
- How well does your model help you convince others that this is how and why water evaporates and condenses?

Ask students to return to their ORIGINAL model and make any changes they think the original model needs in **GREEN** pencil.

5. A CONSENSUS MODEL TO ANSWER THE DRIVING QUESTION

Display the consensus model from Investigation 2, Part 4 (Supplemental Lesson) on a SMARTBoard or projector screen. Remind students scientists often have different ideas and models and have to work together to agree on things. Ask students to think like scientists and share the most important parts of their models with the whole class. As students share ideas, add these ideas to the SMARTBoard image. As students contribute ideas, highlight and reinforce important concepts about the water cycle from the unit. These might include:

- Rainfall
- Evaporation
- Condensation
- Water flowing downhill on the ground
- Water moving into and through the ground
- OPTIONAL Response Sheet page 20 and 21

Investigation 4: Waterworks

Investigation Overview

Part	Physical Model	Target Explanation	Modeling Tasks	Modeling Practice	Epistemic Commitment	Optional Tasks
1. Water in Earth Materials	Samples of soil, sand, and/or gravel in containers (plastic cups, grad cylinder, ???) in which water in mixed	**Adult:** Water moves downward through Earth materials at different rates due to gravity and the composition of the Earth materials **Student:** Gravity pulls water down through Earth materials. But water moves at different speeds through Earth materials because soil is made of tiny particles and gravel is larger particles with spaces so water can move faster.	Predict	Use	Generality	
			Investigate	Use	Evidence	
			Explain	Use	Mechanism	
2. Waterwheels optional						
3. Water from home optional						
4. Choose your own investigation optional						
5. Post-Investigation Lesson			Communicate and Justify	Use	Audience	
			Evaluate	Evaluate	all	
			Revise model	Construct	all	
Post-Unit Lesson -CONSENSUS MODEL Post-Test			Revise	Revise	all	Optional response worksheet: Water in Earth materials

**If time runs short, please focus on completing the modeling pages and do not complete the OPTIONAL response worksheet

Legend
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Investigation 4, Part 1: Water in Earth Materials

Embedded Modeling Instruction

GUIDING THE INVESTIGATION

Use the following procedures **during** Investigation 4, Part 1: Water in Earth Materials.

3a. REVISTING STUDENTS' WATER CYCLE MODELS USE/predict

Remind students of the models of the water cycle they drew at the beginning of the unit. Ask students to review their water cycle models and to think about how their water cycle model applies to this experiment. Ask students to consider the following questions:

- Does their water cycle model help you think about the following question: 'What happens if you add water to Earth materials?' Why?
- Does your model help you make predictions about water in Earth materials? If so, what do you predict will happen? Why?

Students should record their predictions on **page 22**

3b. PROPOSING AN INVESTIGATION

Ask students to consider how they would test their predictions. Encourage them to discuss possible ideas in their small groups. Consider asking students the following questions:

- Where does water go when it reaches the ground?
- Do you think water moves underground?
- How would you design your experiment?
- Does your experiment include steeper and gradual slopes?
- What would your experiment tell you?
- Students should describe their proposed investigations on **page 23.**

7a. USING MODELS TO DESCRIBE WHAT HAPPENED USE/investigate

Discuss with students how their experiments relate to the real-world. Ask students to think about what they observed in the experiment and answer the following question in their modeling notebooks:

- Does your water cycle model show what happened when water was added to Earth materials?
- Does your playground model show what happens to water when it reaches the ground?
- If so, how does it show it? If not, why not?
- Students should record their observations on **page 24**

Investigation 4: Evaluating and Revising Water Cycle Models

Stand-alone Modeling Lesson

GUIDING THE INVESTIGATION

Use the following procedures **after** Investigation 4, Part 1: Water in Earth Materials.

1. CONSTRUCTING MODELS OF STUDENTS' EXPERIMENTS

Ask students to reflect on their original playground models and how they used them in the previous lesson to make predictions about and explain how water moves through soil. Explain to students that they will now draw a model of their experiment itself on **page 25**. Students should focus their models on the important conceptual elements of the experiment. In particular, students' models should show that water flows downward through Earth materials, sometimes faster, sometimes slower, as the size of the particles of Earth materials increases, water flows through it faster, and that gravity is the force that causes water to move downward through Earth materials. Remind students that certain things make a model a scientific model. Emphasize that scientific models show,

- Important **parts** of something in real life
- **How** it works
- **Why** it works the way it does

Discuss **page 25** with students and things to think about when drawing their models, including using colors, different visual elements, etc. Ask them to consider thinking about the model first in their head, how things in the picture change, and *why* things are happening (a mechanism).

2. USING MODELS TO EXPLAIN WHAT HAPPENED USE/explain

Pose the questions and ask students to write an individual response in their modeling notebooks.

- Where does water go when added to Earth materials?
- Why does soil soak up more water than other materials?
- How does your model show 'why' water evaporates and condenses?

Students should record their explanations on **page 26.**

3. SHARING FINDINGS AND EXPLANATIONS USE/communicate and justify

Ask students to number off in their groups and assign partners across groups. Once students have paired up, allow each 2 minutes to use his/her model to share observations and explanations (from the previous lesson.

Facilitate a whole-class discussion. Ask students to bring their modeling notebooks with them to a discussion space. Ask for a volunteer from one group to use their model to describe their explanation for why water samples of varying temperatures mix in ways they observed. Repeat this with a few more volunteers from different groups. Ask students to record key terms and ideas about each explanation. Encourage students to ask each other questions.

4. EVALUATING EXPLANATIONS AND MODELS EVALUATE

Ask students to individually complete **page 27** in their modeling portfolio. Before doing so, walk through the four questions with students so that they understand what they're being asked. Emphasize to students that they are to evaluate their water cycle model.

- How well does your model show how water mixes with Earth materials?
- How well does it show why water mixes with Earth materials?
- How well does it show your evidence for how and why water mixes with Earth materials?
- How well does your model help you convince others that this is how and why water mixes with Earth materials?

Ask students to return to their ORIGINAL model and make any changes they think the original model needs in **BLUE** pencil.

5. CREATING A CONSENSUS MODEL TO ANSWER THE DRIVING QUESTION

Display the consensus model from Investigation 3, Part 5 (Supplemental Lesson) on a SMARTBoard or projector screen. Remind students scientists often have different ideas and models and have to work together to agree on things. Ask students to think like scientists and share the most important parts of their models with the whole class. As students share ideas, add these ideas to the SMARTBoard image. As students contribute ideas, highlight and reinforce important concepts about the water cycle from the unit. These might include:

- Rainfall
- Evaporation
- Condensation
- Water flowing downhill on the ground
- Water moving into and through the ground
- OPTIONAL: New response sheet on **page 29**

Post-Unit Modeling Lesson: Revising Water Cycle Models

Stand-alone Modeling Lesson

Key Concepts

- Models are representations, not exact copies, of real-world phenomena
- Models can include many different kinds of elements
- The ways in which scientists use models (to predict and explain) is what makes a model 'scientific'

GUIDING THE INVESTIGATION

Use the following procedures **after** Investigation 4 of the FOSS water kit and the post-investigation lesson evaluating and revising students' water cycle models.

Reviewing and revising models

1. **REVISITING STUDENTS' IDEAS ABOUT MODELS**
   Remind students that earlier in the semester they recorded some ideas about models. They considered some examples that could be models and answered the following questions,

   - *Which of these examples are models? Why?*
   - *What is a model? What do models look like?*
   - *How do you think scientists use models?*

   As a class, revisit students' ideas from early in the unit. Record on the large piece of paper or on a flip chart any ideas that have changed during the semester. Again, as with Part 2B of Investigation 1, emphasize that,

   - A model makes really complicated things in nature simpler so we can understand and study them
   - Scientists construct, use, evaluate, and revise models to explain and make predictions about natural phenomena.
   - People can create models with pictures, words, mathematical equations, and computer programs
   - We can use models in the classroom to help us understand water

2. **REVISING A SCIENTIFIC MODEL TO ANSWER THE DRIVING QUESTION**
   Remind students that earlier in the Water unit, they constructed water cycle models to answer the question,

   - *Where does water go and how does it move?*

   Tell students that scientists often have to change their models when they discover new things about nature. Highlight some of the things students have learned about water during the Water unit. Tell students that they are going to have a chance to revise the models they originally constructed at the beginning of the unit to answer the question above.

Introduce the post-unit assessment on page 30-31. Ask students to review their first model, then draw a new model of the water cycle on the new worksheet. Remind students that certain things make a model a scientific model. Emphasize that that scientific models show,

- Important parts of something in real life
- How it works
- Why it works the way it does

Discuss with students things to think about when drawing their models, **including using colors, different visual elements, etc**. Ask them to consider thinking about the model first in their head, how things in the picture change, and *why* things are happening (a mechanism). Encourage to think about what is happening underground, not just above ground. Also, remind them to write written responses to the questions when they are finished.