RESPeCT Summer Institute Professional Development Leader Guide (PDLG)

Grade Level	2	**Day**	4	**STeLLA Strategy**	STL Strategy 6: Use and Apply New Science Ideas	**Subject Matter Focus**	Properties of Matter

Focus Questions

- Why is it necessary to engage students in using and applying new science ideas in a variety of ways and contexts?
- How will the Student Thinking Lens strategies help you teach the Properties of Matter lessons?
- How can we use mathematics to understand the size of molecules that make up everyday objects?
- What is matter made of, and how can it change?

Main Learning Goals

Participants will understand the following:

- In order to develop meaningful understandings of science ideas, students need multiple opportunities to try using and applying new science ideas in a variety of ways and contexts.
- Large numbers greater than 10,000 are hard to relate to as counting numbers. Place value can help us develop numerical literacy by thinking of large numbers as smaller numbers of medium-sized groups (e.g., 10,000 is 10 groups of 1,000 each).
- To attach meaning to a large number, such as the number of molecules in a single drop of water, we can try to understand progressively larger groups of a model of the unit being counted. For example, if we use Lego bricks to model molecules as in the lessons, then creating models of progressively larger groups of such groupings can help us understand larger numbers. This understanding can help us comprehend how small water molecules really are.
- Matter is made up of atoms and molecules. Changes in matter can be explained as physical changes in the arrangement and movement of molecules or as chemical changes in which the atoms that make up substances rearrange to form new substances or molecules.

Preparation

Daily Setup Tasks

- Check that video clips are correctly linked to PowerPoint (PPT) slides.
- Set up PowerPoint.
- Make sure video clips play correctly with good sound.
- Arrange furniture and food.
- Arrange participant materials.
- Put up posters and charts.

Planning and Preparation Tasks

- Study the PDLG, PowerPoint slides (PPTs), video clips, and handouts. Make changes to PPTs if needed.

Materials

Posters and Charts

- STeLLA Framework and Strategies poster
- Day-4 Agenda (chart)
- Day-4 Focus Questions (chart)
- Norms for Working Together (chart)
- Effective Science Teaching chart (from day 1)
- Strategy charts from days 1–2 (STL strategies 1–5)
- Chart of STL strategies highlighted in Properties of Matter lesson plans (see PPT slide 24 for model)
- Parking Lot poster

Handouts in RESPeCT PD Binder Front Pocket

- Z-fold summary chart: Student Thinking Lens Strategies

Videos

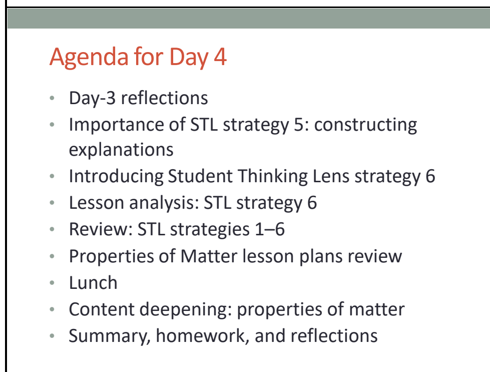
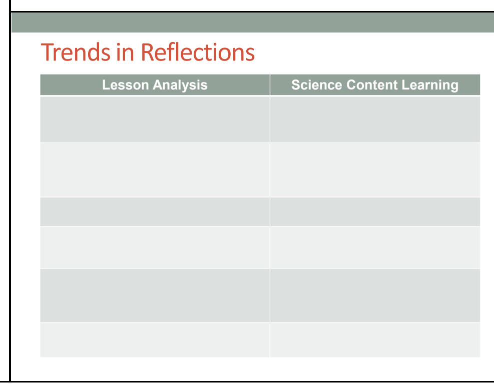
- Hershberger video clip, *Introducing the CER* (on companion DVD for Zembal -Saul book *What's Your Evidence?*)
- Video Clip 4.1: Fowler classroom (use and apply, strategy 6); 4.1_mspcp_gr.2_matter _ fowler_L6_c10–c11
  Video Clip 4.2: Fowler classroom (use and apply, strategy 6); 4.2_mspcp_gr.2_matter _fowler_L6_c12–c14

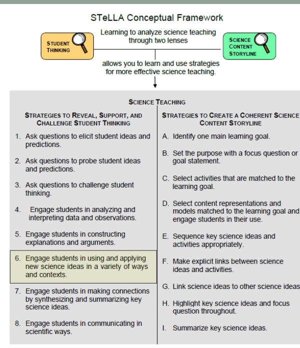
• Review the reflections from day 3 and create a summary slide.
• Watch video clips and anticipate participant responses.
• Prepare charts for the day's agenda and focus questions.
• Using PPT slide 24 as a model, prepare a chart of the STL strategies highlighted in the Properties of Matter lesson plans.
• For content deepening:
    • Assemble enough zip-seal plastic bags of Lego bricks (10 red, 2 × 4"; 20 white, 2 × 2" per bag) so that each pair of participants will have one bag.
	Handouts in RESPeCT PD Binder, Day 4
	• 4.1 Importance of Engaging Students in Constructing Scientific Explanations (task sheet)
	• 4.2 Student Work from Zembal-Saul Book *What's Your Evidence?*
	• 4.3 Benefits of Engaging Students in Constructing Scientific Explanations
	• 4.4 Transcript for Video Clip 4.1
	• 4.5 Transcript for Video Clip 4.2
	• 4.6 Identifying Student Thinking Lens Strategies
	• 4.7 Daily Reflections—Day 4
	
	PD Leader Masters, Days 1–4
	• PD Leader Master: Identifying Student Thinking Lens Strategies (Answer Key)
	
	Supplies
	• Science notebooks
	• Chart paper and markers
	• Lesson materials kit
	• For content deepening:
	    • At least 5 zip-seal, plastic bags of Lego bricks (10 red, 2 × 4"; 20 white, 2 × 2" per bag) (1 bag per pair)
	    • 1 meter stick (per pair)
	    • Sheets of blank, letter-sized paper (for comic strips)
	
	PD Resources
	• STeLLA strategies booklet
	• RESPeCT PD program binder
	• RESPeCT lesson plans binder
	
	Resources in Lesson Plans Binder
	Resources section:
	• Properties of Matter Content Background Document
	• Common Student Ideas about Properties of Matter	

DAY 4 SESSION OUTLINE

Time	Activities	Purpose
8:00–8:15 15 min	**Getting Started: Housekeeping, Agenda, Day-3 Reflections, Focus Questions**	• Build community by sharing participants' reflections from day 3. • Set the stage for a day of learning.
8:15–8:50 35 min	**Importance of STL Strategy 5: Constructing Explanations**	• Develop an appreciation for the multiple ways in which engaging students in constructing scientific explanations can have an impact on student learning within and beyond science.
8:50–9:10 20 min	**Introducing Student Thinking Lens (STL) Strategy 6**	• Develop an initial understanding of the purpose and key features of strategy 6: Engage students in using and applying new science ideas in a variety of ways and contexts.
9:10–10:10 60 min	**Lesson Analysis: STL Strategy 6**	• Use lesson analysis of classroom videos to better understand strategy 6. • Deepen science-content knowledge of the properties of matter through lesson analysis.
10:10–10:55 45 min (Includes 10-min break)	**Review: STL Strategies 1–6**	• Review and deepen understandings of key similarities and differences among STL strategies 1–6.
10:55–12:00 65 min	**Properties of Matter Lesson Plans Review**	• Understand why the Properties of Matter lesson plans are so scripted and how they should be used before and during the lessons. • Understand the conceptual flow within and across the Properties of Matter lessons. • Understand the focus question, main learning goal, and main activity in each lesson. • Understand how STL strategies 1–6 are embedded in the lessons.
12:00–12:45 45 min	**LUNCH**	
12:45–3:15 150 min (Includes 10-min break)	**Math Content Deepening: Properties of Matter**	• Develop participants' numerical literacy by using place value and treating large numbers as smaller numbers of medium-sized groups. • Develop participants' understandings and appreciation of the small scale of a water molecule and the vast number of molecules in a single drop of water. • Explore factors, such as the diffraction limit, that explain why individual water molecules are too small to see.
3:15–3:30 15 min	**Wrap-Up: Summary, Homework, and Reflections**	• Summarize and reflect on key ideas from today's learning and preview the transition to the Science Content Storyline Lens (SCSL) strategies.

DAY 4

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
8:00–8:15 15 min **Getting Started** Slides 1–5	**Purpose** • Build community by sharing participants' reflections from day 3. • Set the stage for a day of learning. **What Participants Do** • Review the day's agenda. • Discuss the reflections from day 3. • Read today's focus questions. **Posters and Charts** • STeLLA Framework and Strategies poster • Day-4 Agenda (chart) • Day-4 Focus Questions (chart)		**Display Slide 1.** RESPeCT PD Program (5 min) a. Take care of any housekeeping issues.
			**Display Slide 2.** Agenda for Day 4 (3 min) a. Talk through the agenda for the day.
			**Display Slide 3.** Trends in Reflections (5 min) a. Invite participants to look at your feedback on their reflections from day 3 and offer reactions, comments, or follow-up questions.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Today's Focus Questions • Why is it necessary to engage students in using and applying new science ideas in a variety of ways and contexts? • How will the Student Thinking Lens strategies help you teach the Properties of Matter lessons? • How can we use mathematics to understand the size of molecules that make up everyday objects? • What is matter made of, and how can it change?	**Display Slide 4.** Today's Focus Questions (1 min) a. Introduce the focus questions that will guide today's work. b. "Like STeLLA strategies 4 and 5, the goal of strategy 6 is to move student thinking forward toward deeper understandings of science ideas."
			**Display Slide 5.** STeLLA Conceptual Framework (1 min) a. Draw participants' attention to the new strategy highlighted on the slide. b. "Strategy 6 is the third STL strategy that is a type of activity designed to move student thinking forward."
8:15–8:50 35 min **Importance of STL Strategy 5: Constructing Explanations** Slides 6–7	**Purpose** • Develop an appreciation for the multiple ways in which engaging students in constructing scientific explanations can have an impact on student learning within and beyond science. **Content** • Engaging students in constructing scientific explanations helps them develop meaningful understandings of science ideas and how scientists work.	**The Importance of Engaging Students in Constructing Scientific Explanations** Read handout 4.1 and your group-specific handout. Then complete the assigned task: **Group 1:** Analyze a student explanation (handout 4.2). **Group 2:** Summarize benefits for students of constructing scientific explanations (handout 4.3). **Group 3:** Summarize the benefits for teachers of engaging students in constructing scientific explanations (handout 4.3).	**Display Slide 6.** The Importance of Engaging Students in Constructing Scientific Explanations (25 min) **Note:** If you need some time to catch up on day-3 activities, you can skip this slide. However, this activity is beneficial for reviewing strategy 5 (constructing explanations) and helping participants understand why explanation building is such important work in science and beyond. **Timing note:** For this segment, allot 5 minutes for reading, 10 minutes to prepare for a group share-out, and 10 minutes for the share-out. a. Divide participants into three groups or pairs. Assign

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	What Participants Do • Review jigsaw-strategy readings about the importance of scientific explanations and examine a sample of student work. • Share key ideas about constructing scientific explanations. • Watch and discuss a lesson video in which the teacher explicitly teaches 3rd graders how to construct explanations that include a claim, evidence, and reasoning that connects to science ideas. **Posters and Charts** • STeLLA Framework and Strategies poster • Strategy charts from days 1–3 (STL strategies 1–5) **Videos** • Hershberger video clip, *Introducing the CER* **Handouts in PD Binder** • 4.1 Importance of Engaging Students in Constructing Scientific Explanations (task sheet) • 4.2 Student Work from Zembal-Saul Book *What's Your Evidence?* • 4.3 Benefits of Engaging Students in Constructing Scientific Explanations **PD Resources** • STeLLA strategies booklet		each group a number (1, 2, 3). b. Direct participants to three handouts: 1. Importance of Engaging Students in Constructing Scientific Explanations (handout 4.1 in PD program binder) (This handout describes what groups are to do with the following two handouts.) 2. Student Work from Zembal-Saul Book *What's Your Evidence*? (handout 4.2 in PD binder) (Group 1's task is linked to this handout.) 3. Benefits of Engaging Students in Constructing Scientific Explanations (handout 4.3 in PD binder) (Tasks for Groups 2 and 3 are linked to this handout.) c. After participants have read the designated handouts for their groups and completed their assigned tasks, invite them to share out.
		The CERA Framework for Constructing Scientific Explanations • Next, we'll watch video clip of a 3rd-grade teacher instructing students how to construct scientific explanations. • Think about ideas this clip gives you for helping your students learn to construct scientific explanations by making a claim, supporting it with evidence and reasoning, and considering alternative explanations and strategies (CERA). Link to *Introducing the CER* video clip.	**Display Slide 7.** The CERA Framework for Constructing Scientific Explanations (10 min) **Note:** This activity is optional but powerful. a. "Let's watch how one 3rd-grade teacher taught her students to construct scientific explanations. This is the teacher whose student writing Group 1 just read about. The class in this video clip has been studying simple machines (such as pulleys and levers)." b. "We're not going to analyze this video clip in terms of STeLLA strategies. Instead, think about ideas this clip gives you as to how you might introduce your students to the CERA framework for constructing scientific explanations, which involves making a claim, supporting it with evidence and reasoning, and considering alternative explanations and strategies." c. After watching the clip, discuss participants'

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			reactions and any ideas it gave them about how they might help their students learn to construct strong scientific explanations. **Note:** Make sure participants are aware that in addition to using the CERA framework as a tool for teaching students how to develop scientific explanations and arguments (STeLLA strategy 5) in the classroom, they will be using the same framework for videocase-based lesson analysis of their science teaching in RESPeCT study groups throughout the school year.
8:50–9:10 20 min **Introducing Student Thinking Lens (STL) Strategy 6** Slide 8	**Purpose** • Develop an initial understanding of the purpose and key features of strategy 6: Engage students in using and applying new science ideas in a variety of ways and contexts. **Content** • After students encounter new science ideas, they need opportunities to practice them and see their usefulness in explaining a variety of phenomena. Activities that challenge students to use and apply new ideas give them the time and space to really make sense of the concepts. **What Participants Do** • Make and discuss charts highlighting the purpose and key features of strategy 6. **Supplies** • Chart paper and markers **PD Resources**	Introducing STL Strategy 6 Engage students in using and applying new science ideas in a variety of ways and contexts. 1. What are the purpose and key features of this strategy? 2. Why do you think use-and-apply questions or activities are often shortchanged in science teaching?	**Display Slide 8.** Introducing STL Strategy 6 (20 min) a. **Small groups (10 min):** Divide participants into two groups to make charts highlighting the purpose and key features of strategy 6: Engage students in using and applying new science ideas in a variety of ways and contexts. Encourage participants to refer to the STeLLA strategies booklet and STL Z-fold summary chart for this activity. b. **Whole group (10 min):** Have groups present their charts in a whole-group share-out and compare them. Ask participants, “What differences and similarities do you notice when you compare your charts with those of other groups?” **Key ideas:** • Strategy 6 is a time for “strategic telling” and making sure students are using science ideas accurately. • A use-and-apply question or activity is introduced *after* students have experienced/encountered a new science idea. It provides an opportunity for students to use and apply the idea in a new context or novel way and/or link two or more science ideas together. • A common misconception is that use-and-apply questions or activities *assess* student learning. Teachers often talk about asking these kinds of

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	• STeLLA strategies booklet • STL Z-fold summary chart (front pocket of PD binder)		questions on tests. However, according to research findings published in *How People Learn* (National Academy of Sciences, 2000), *application* is part of the learning process, or developing a conceptual framework. If application is treated like assessment, students may encounter a use-and-apply question on a test without ever having had the opportunity to practice this way of thinking as part of their learning.
9:10–10:10 60 min **Lesson Analysis: STL Strategy 6** Slides 9–14	**Purpose** • Use lesson analysis of classroom videos to better understand strategy 6. • Deepen science-content knowledge of the properties of matter through lesson analysis. **Content** • Strategy 6 involves engaging students in using and applying new science ideas in a variety of ways and contexts. **What Participants Do** • Watch a classroom video clip to identify strategy 6 and analyze student thinking that is revealed and challenged from using this strategy. • Check their understandings of strategy 6 by taking a quick multiple-choice quiz. **Videos** • Video Clip 4.1, Fowler classroom **Handouts in PD Binder** • 4.4 Transcript for Video Clip 4.1	Lesson Analysis: Focus Question 1 Why is it necessary to engage students in using and applying new science ideas in a variety of ways and contexts?	**Display Slide 9.** Lesson Analysis: Focus Question 1 (Less than 1 min) a. Highlight the focus question that will guide the lesson analysis work during this phase.
		Lesson Analysis: **Review** Lesson Context Read the lesson context for this video clip at the top of the transcript (handout 4.4 in your PD program binder).	**Display Slide 10.** Lesson Analysis: Review Lesson Context (2 min) a. "Read the lesson context at the top of the video transcript (handout 4.4 in your PD program binders)." b. Make sure participants understand the science content and activity that are the focus of this video clip. **Note:** Refer to the content background document as needed throughout the lesson analysis.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process

	PD Resources
	• STeLLA strategies booklet
	Resources in Lesson Plans Binder
	Resources section:
	• Content background document
		Lesson Analysis: **Identify** Strategy 6
		1. What makes this a **use-and-apply** task? (Focus on task.)
		2. What do you notice about the types of questions the teacher asks during the clip?
		Link to video clip: 4.1_mspcp_gr.2_matter_fowler_L6_c10-c11
			Display Slide 11. Lesson Analysis: Identify Strategy 6 (25 min)
			a. "As you watch the video, think about what makes the activity in this clip a use-and-apply task. What science ideas should students be using and applying in each scenario? Also notice what kinds of questions the teacher asks."
			b. Show the video clip.
			c. **Individuals:** "Think about the questions on the slide and mark the transcript as you identify the use of strategy 6."
			d. **Whole group:** Discuss participants' responses to the questions.
			Ideal observations:
			• The activity in the clip is a use-and-apply task because it doesn't introduce any new science ideas or practices. Instead, students use what they've learned about changes in matter (especially phase changes) to come up with examples in everyday life. Then they identify the type of change in each example and explain the cause.
			• In this activity, students need to understand and use the following science ideas:
			  • Matter can change from a liquid to a solid and from a solid to a liquid.
			  • Heat causes matter to change from a solid to a liquid.
			  • Removing heat (cooling) causes matter to change from a liquid to a solid.
			  • Sometimes changes in matter result in new substances being formed (like the gas in the "fizzies" example).
			• During a use-and-apply task, the teacher should ask many probe and challenge questions.
			  • The teacher should use probe questions to determine whether students are using science

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process

			ideas accurately.
			• The teacher should use challenge questions that are open ended enough to reveal whether students understand the science ideas. Challenge questions should push students to move their thinking forward, elaborate on their answers, and connect their thinking with the science ideas.
			
			Examples:
			• **Probe questions:** See comment below about weaker challenge questions.
			• **Strong challenge questions:**
			  • **Video segment 00:00:00:** "I want you to think about a time that you either saw a liquid turn into a solid [or] a solid turn into a liquid or maybe a gas outside of our classroom."
			  • **Segment 00:00:45:** "[Anyone] have any ideas of why there's still ice hanging out over there?"
			  • **Segment 00:01:34:** "Jilissa, where have you seen changes in matter outside of our classroom?"
			  • **Segment 00:04:14:** "And how is that a change in matter?"
			• **Weaker challenge questions:** The following challenge questions are weaker because they prompt only one-word responses from students. Some participants might consider them probe questions, but since the teacher is trying to get students to extend their thinking and use science ideas they've learned, they qualify as challenge questions.
			  • **Video segment 00:00:21:** "What do you think caused the snow to melt?"
			  • **Segment 00:00:25:** "And what does the Sun provide?"
			  • **Segment 00:00:52:** "So what does the shade stop [from] happening?"
			  • **Segment 00:01:02:** "And then that stops what from happening?"
			  • **Segment 00:02:17:** "What did it create,

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			though?” • **Segment 00:02:36:** “What kind of matter are bubbles?” • **Segment 00:03:44:** “And what type of matter is hail?” • **Leading questions:** Possibly at video segment 00:01:20 (“’Cause it’s missing …?”). At segment 00:03:50, the teacher rephrases a question to make it easier for students to answer (i.e., from “What type of matter is hail?” to “Is it a liquid, a gas …?”).
		Lesson Analysis: **Analyze** Strategy 6 and **Reflect** **Analyze:** • What student thinking is revealed by engaging students in using and applying new science ideas? By providing a claim, evidence, and reasoning? **Reflect:** • What did you learn about strategy 6 from watching and analyzing this video clip?	**Display Slide 12.** Lesson Analysis: Analyze Strategy 6 and Reflect (25 min) a. **Individuals:** “For the analysis questions on the slide, study the video transcript and come up with a claim, evidence, and reasoning to support your claim.” b. **Whole-group share-out:** As participants share their claims, evidence, and reasoning, encourage them to challenge one another by asking questions, disagreeing, and suggesting improvements or alternative explanations and arguments. (Refer to the norms at the heart of the RESPeCT program.) **Note:** You may also want to ask participants whether they noticed in the transcript any missed opportunities for engaging students in using and applying new science ideas. c. **Reflect (1 min):** Give participants time to think about the reflection question on the slide. d. **Whole-group discussion:** Discuss the reflection question as a group. Make sure participants note specifically what they learned about strategy 6 from watching and analyzing this video clip. **Student thinking revealed in this clip:** • In the clip, students recognize that heat can cause changes in matter. The first example is the Sun

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			causing snow to melt (video segment 00:00:24). Another student adds onto this idea by explaining that shady areas still have snow/ice because they don't get as much heat (segment 00:00:56). • Jilissa gives an example of a soda exploding when her sibling put a mint candy in the drink (segment 00:01:41). Although the teacher originally asked students about phase changes, at segment 00:01:34, she changes the question to a broader one about "changes in matter." So Jilissa's example is appropriate even though it illustrates a chemical change rather than a physical (phase) change. (This is never made explicit in the clip.) When the teacher asks what type of matter is formed as a result of this change, Jilissa struggles with the question, but another student identifies the new substance as air/gas (segment 00:02:41). The teacher helps students link this back to the baking-soda and vinegar lesson. (segment 00:02:08) • Students offer good examples of phase changes at segments 00:00:18 (snow melting) and 00:03:06 (rain turning into hail). The teacher links science ideas in this use-and-apply task by asking students to identify the type of matter, how it's changing, and what is causing the change. • At segment 00:04:06, Ava gives an example of an apple-tree flower turning into an apple or an apple tree. This example isn't related to the lesson goals but illustrates the rich experiences students have with the subject matter. The teacher links to the ideas about phase changes by pointing out that although the size and shape of the solid matter changes, this isn't an example of a phase change because the matter is a solid before and after the change.

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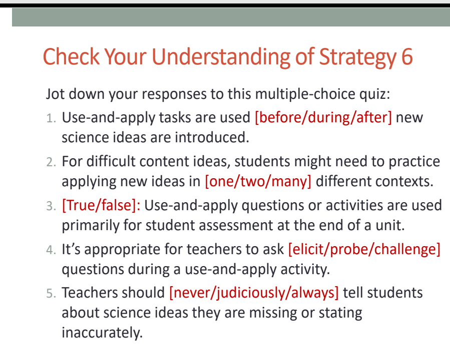
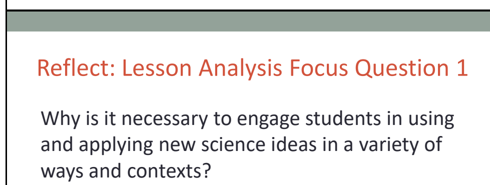
			**Display Slide 13.** Check Your Understanding of Strategy 6 (5 min) **Note:** This activity is optional if time is running short. a. "To check your understanding of STL strategy 6, jot down your responses to this multiple-choice quiz." b. Have participants discuss their answers either in pairs or as a group. (If time is short, just read the answers aloud.) **Answer key:** 1. After 2. Many 3. False 4. Challenge (and probe) 5. Judiciously (defined as "good or discriminating judgment; wise, sensible, or well advised")
			**Display Slide 14.** Reflect: Lesson Analysis Focus Question 1 (3 min) a. **Individuals (1 min):** "Think for a moment about how you would answer the focus question on this slide." b. **Whole-group share-out (2 min):** Have a few participants share their ideas.

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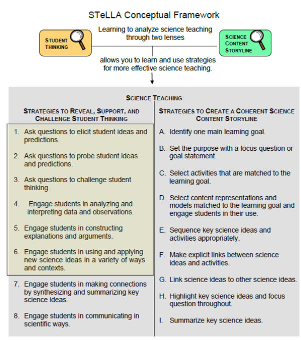
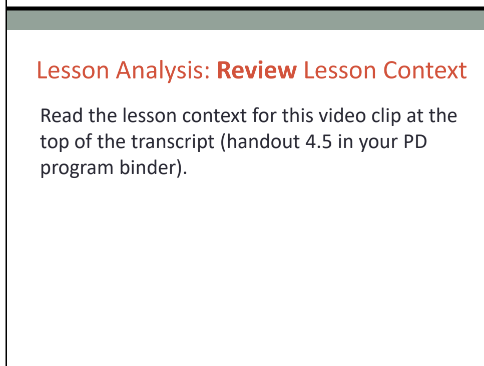
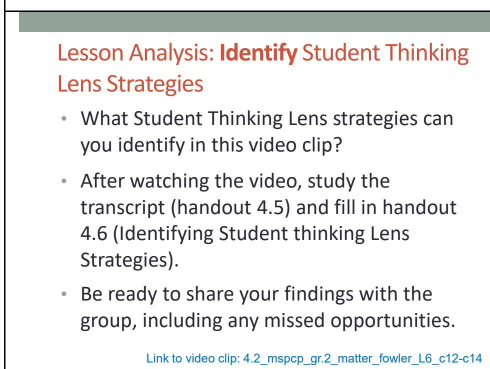
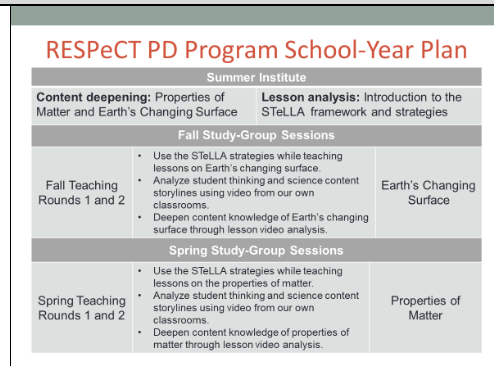
10:10–10:55 45 min (Includes 10-min break) **Review: STL Strategies 1–6** Slides 15–19	**Purpose** • Review and deepen understandings of key similarities and differences among STL strategies 1–6. **Content** • STL strategies 1–6 reveal, support, and challenge student thinking. **What Participants Do** • Study the Summary of STeLLA Student Thinking Lens Strategies chart in the STeLLA strategies booklet. • Discuss patterns, similarities, and differences among STL strategies 1–6. • Watch a classroom video clip and identify any STL strategies used during the lesson. Discuss observations and missed opportunities. **Posters and Charts** • Strategy charts from days 1–3 (STL strategies 1–5) **Videos** • Video Clip 4.2, Fowler classroom **Handouts in PD Binder** • 4.5 Transcript for Video Clip 4.2 • 4.6 Identifying Student Thinking Lens Strategies **PD Leader Masters** • PD Leader Master: Identifying Student Thinking Lens Strategies (Answer Key)	Lesson Analysis: Focus Question 2 How will the Student Thinking Lens strategies help you teach the Properties of Matter lessons?	**Display Slide 15.** Lesson Analysis: Focus Question 2 (Less than 1 min) a. **Transition:** "Now we'll shift our attention to the second lesson analysis focus question and spend some time summarizing what we've learned so far about Student Thinking Lens strategies 1–6. Then we'll review the Properties of Matter lesson plans and highlight how these strategies are used in the lessons you'll start teaching in January."
			**Display Slide 16.** STeLLA Conceptual Framework (Less than 1 min) a. "These are the Student Thinking Lens strategies we've explored so far. You'll get practice using them as you teach the lessons on the properties of matter and Earth's changing surface."
		Review: Student Thinking Lens Strategies Review the STL summary chart in the STeLLA strategies booklet and discuss these questions: 1. What pattern(s) do you see in this arrangement (organization) of the STL strategies? 2. How does this arrangement (organization) highlight the differences and similarities among the Student Thinking Lens strategies?	**Display Slide 17.** Review: Student Thinking Lens Strategies (3 min) a. **Individuals:** Have participants review STL strategies 1–6 on the summary chart in the strategies booklet (Summary of STeLLA Student Thinking Lens Strategies). b. **Whole group:** Discuss the questions on the slide. **Key ideas:** • Strategies 1–3 are types of questions, and strategies 4–6 are activities designed to move

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	PD Resources • STeLLA strategies booklet		student thinking forward toward more-scientific understandings. • Some strategies are used at any time during the lesson (e.g., probe questions); others are used at specific times (e.g., elicit questions used *before* students have been introduced to new science ideas; use-and-apply activities used *after* students have been introduced to new science ideas). • Each strategy has its own specific purpose(s), but the strategies are closely connected to one another. That is, these strategies aren't used in isolation; they're complementary.
			**Display Slide 18.** Lesson Analysis: Review Lesson Context (1 min) a. "Read the lesson context at the top of the video transcript (handout 4.5 in your PD program binders)." b. Make sure participants understand the science content and activity that are the focus of this video clip.
			**Display Slide 19.** Lesson Analysis: Identify Student Thinking Lens Strategies (30 min) **Note:** If absolutely necessary, you can skip this video analysis. a. Orient participants to handout 4.6, Identifying Student Thinking Lens Strategies. b. Make sure participants understand the context of the video clip (from the transcript). c. Show the video clip. d. **Individuals:** "Study the video transcript and complete handout 4.6, Identifying Student Thinking

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			Lens Strategies.” e. **Whole group:** “What STL strategies did you identify in the video transcript? Did you spot any missed opportunities?” **Note:** • See PD Leader Master: Identifying Student Thinking Lens Strategies (Answer Key) for suggested answers to this analysis. Keep in mind that these are just suggestions. Don’t expect the group to come up with exactly the same responses. The important thing is to make sure participants understand the strategies and are using that knowledge to make appropriate decisions.
10:45–10:55 10 min	**BREAK**		
10:55–12:00 65 min **Properties of Matter Lesson Plans Review** Slides 20–24	**Purpose** • Understand why the Properties of Matter lesson plans are so scripted and how they should be used before and during the lessons. • Understand the conceptual flow within and across the Properties of Matter lessons. • Understand the focus question, main learning goal, and main activity in each lesson. • Understand how STL strategies 1–6 are embedded in the lessons. **Content** • All lessons are designed to support the science content storyline within and across lessons. Each lesson contains a focus question, a main learning goal, and an activity.		**Display Slide 20.** RESPeCT PD Program School-Year Plan (1 min) a. “Before we share our reports about each of the Properties of Matter lesson plans and how they support you in practicing these Student Thinking Lens strategies, let’s review the plan for the school year.” b. “In the fall you’ll teach the **Earth’s Changing Surface** lessons, and we’ll meet in our study group to analyze video clips and student work from these lessons. This analysis will help us deepen our understandings of the STeLLA strategies, the science content, the lesson plans, and our students’ thinking and learning.” c. “Starting in January, you’ll teach the **Properties of Matter** lessons, and we’ll meet in our study group to analyze video clips and student work from these lessons. Do you have any questions?”

<table>
<tr><th>PD Model: Time/Phase</th><th>Purpose, Content, and What Participants Do</th><th>Slides</th><th>Process</th></tr>
<tr><td rowspan="3"></td><td rowspan="3">

- The Student Thinking Lens strategies work together across lessons according to the following pattern:
  - Elicit and probe strategies are very important in lesson 1.
  - Probe and challenge strategies are used throughout all the lessons.
  - Strategies 4 and 5 are highlighted in the middle lessons.
  - Strategy 6 is highlighted toward the end of the lesson, after students encounter new science ideas but before final unit assessments.

What Participants Do

- Review the plans for school-year study groups.
- Listen to the PD leaders describe the lesson plans for the study groups and how they should be used/adapted.
- Present a summary of an assigned lesson plan to help their peers understand the lesson.
- Raise questions and concerns about the lesson plans and make suggestions.

Supplies

- Chart paper and markers

PD Resources

- RESPeCT lesson plans binder

</td><td></td><td>

d. **Important reminder:** “Remember that we’re analyzing video clips of our own classroom teaching to help us all learn, not to evaluate and critique one another. Everyone is learning to use both new strategies and new lesson plans, so it’s predictable that our first attempts at teaching these lessons will have rough spots. We need to appreciate and acknowledge the courage each of us is demonstrating in sharing our initial efforts to teach these lessons. Please be assured that our analyses of the videos will focus on the strategies, the science content, and most importantly, how students are making sense of the lessons. We’re not going to focus on rough spots or management problems. We’re here to support one another and to learn and grow as science teachers.”

</td></tr>
<tr><td>

The RESPeCT Lesson Plans as a Study Tool: Part 1

The RESPeCT lesson plans are **study tools** designed to support your learning and for our study group to analyze.

This has two implications.

1. These lessons don’t represent a complete unit. You may need to add lessons to help your students achieve all the learning goals, and …

</td><td>

Display Slide 21. The RESPeCT Lesson Plans as a Study Tool: Part 1 (2 min)

a. Read through the information on this slide.

b. Elicit and respond to any comments or questions from participants.

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<tr><td>

The RESPeCT Lesson Plans as a Study Tool: Part 2

2. As a study tool, the lesson plans are highly scripted to model how they might be implemented.
   a. Study this script in your lesson planning.
   b. Adapt the plans and PowerPoint slides to make them work for you and your students (but don’t add or drop main activities).
   c. You don’t have to be tied to the script as you teach! Using the slides as a guide can help free you from the script.

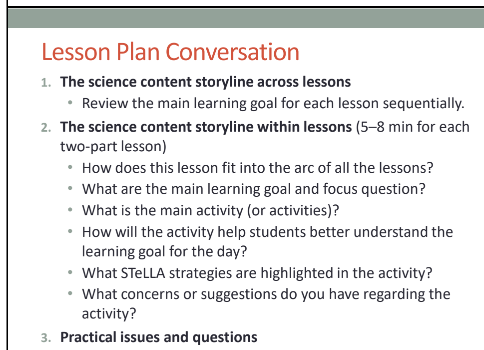
</td><td>

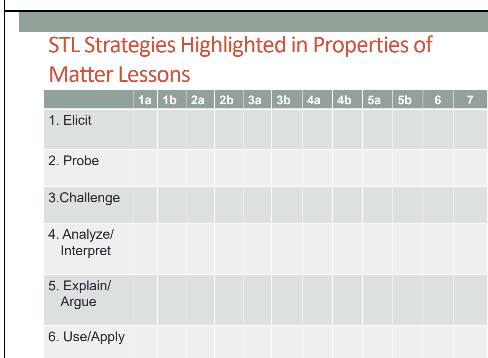
Display Slide 22. The RESPeCT Lesson Plans as a Study Tool: Part 2 (2 min)

a. Read through the information on this slide.

b. Elicit and respond to any comments or questions from participants.

</td></tr>
</table>

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 23.** Lesson Plan Conversation (60 min in conjunction with next slide). a. For step 1 on the slide, have participants describe the main learning goal for their assigned two-part lesson (parts A and B) and how it connects to the lessons that precede and follow it. (5 min) **Note:** The Properties of Matter unit has five two-part lessons and two additional extension lessons (lessons 6 and 7) that can be treated as one 2-part lesson. b. For steps 2 and 3, have participants report on their assigned two-part lesson. **Note:** Rather than walking through every step in the lesson plan, participants should present the *big picture* using the questions in step 2 on the slide. They should bring up details only when they have some concern, question, or suggestion about a modification. c. As participants give their reports, mark on a chart the Student Thinking Lens strategies that are highlighted in each lesson. (Use the chart on the next slide as a model.) **Note:** Encourage participants to pick just one or two Student Thinking Lens strategies that are highlighted in the lesson. (Several strategies may be used in a lesson.) d. Highlight the following ideal pattern and how the STL strategies work together across lessons: • Elicit and probe strategies are very important in lesson 1. • Probe and challenge strategies are used throughout all the lessons. • Strategies 4 and 5 are highlighted in the middle

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			lessons. • Strategy 6 is highlighted toward the end of a lesson, after students encounter new science ideas but before final unit assessments. **Timing note: Make sure you limit the time allotted for each lesson** so you can get through them all. For example, if you have 6 two-part lessons, you'll have approximately 8 minutes for each lesson (4 minutes for part A, and 4 minutes for part B). If your lesson series has more than 6 two-part lessons, you'll have to decrease the time for each lesson.
			**Display Slide 24.** STL Strategies Highlighted in the Properties of Matter Lessons a. Use this slide in conjunction with the previous slide.
12:00–12:45 45 min	**LUNCH**		

<table>
<tr><th>PD Model: Time/Phase</th><th>Purpose, Content, and What Participants Do</th><th>Slides</th><th>Process</th></tr>
<tr>
<td rowspan="3">12:45–3:15

150 min (Includes 10-min break)

Math Content Deepening: Properties of Matter

Slides 25–49</td>
<td rowspan="3">Purpose
• Develop participants' numerical literacy by using place value and treating large numbers as smaller numbers of medium-sized groups.
• Develop participants' understandings and appreciation of the small scale of a water molecule and the vast number of molecules in a single drop of water.
• Explore factors, such as the diffraction limit, that explain why individual water molecules are too small to see.

Content
• Matter is made up of atoms and molecules.
• Changes in matter can be explained as physical changes in the arrangement and movement of molecules or as chemical changes in which the atoms that make up substances rearrange to form new substances or molecules.
• Large numbers greater than 10,000 are hard to relate to as counting numbers. Using place value facilitates developing numerical literacy by representing large numbers as smaller numbers of medium-sized groups (e.g., 10,000 is 10 groups of 1,000 each).
• Water molecules are impossible to see because they're smaller than a size threshold called the diffraction limit.
• Creating models of progressively larger groups can help us attach</td>
<td>PROPERTIES OF MATTER
MATH CONTENT DEEPENING
Grade 2</td>
<td>Display Slide 25. Math Content Deepening: Properties of Matter (Less than 1 min)

a. "Let's dig into our content deepening work for today."
Note: Refer to the Properties of Matter Content Background Document and Common Student Ideas about Properties of Matter as needed throughout this phase.</td>
</tr>
<tr>
<td>Content Deepening Focus Questions
• How can we use mathematics to understand the size of molecules that make up everyday objects?
• What is matter made of, and how can it change?</td>
<td>Display Slide 26. Today's Focus Questions (Less than 1 min)

a. Introduce today's content deepening focus questions.
b. Point out that the second focus question and the unit central questions are the same.
c. "Let's begin by exploring the first question."</td>
</tr>
<tr>
<td>Warm-Up: Assigning Meaning to Numbers
<table>
<tr><th>Number</th><th>Meaning/ Example</th><th>Number</th><th>Meaning/ Example</th></tr>
<tr><td>7</td><td></td><td>33,000,000</td><td></td></tr>
<tr><td>24</td><td></td><td>350,000,000</td><td></td></tr>
<tr><td>100</td><td></td><td>7,000,000,000</td><td></td></tr>
<tr><td>5,280</td><td></td><td>88,990,000,000</td><td></td></tr>
<tr><td>22,000</td><td></td><td>512,000,000,000</td><td></td></tr>
<tr><td>151,348</td><td></td><td>1,200,000,000,000</td><td></td></tr>
<tr><td>7,800,000</td><td></td><td>16,770,000,000,000</td><td></td></tr>
</table></td>
<td>Display Slide 27. Warm-Up: Assigning Meaning to Numbers (7 min)

a. "As a warm-up, let's test our sense of numbers. Listed on the slide are some numbers you might encounter in everyday life, in problem solving, in measurements, in politics, in the news, you name it."
b. Turn and Talk: "Pair up with an elbow partner and try to think of real-world meanings that could be attached to each of these numbers. For example, you might attach the meaning "days in a week" to the number 7. In 5 minutes, we'll share out as a group."</td>
</tr>
</table>

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process

Purpose, Content, and What Participants Do (continued)

meaning to large numbers and better understand how small water molecules are.

What Participants Do

- Use everyday experiences to assign possible meanings to various numbers that become progressively larger and more difficult to comprehend.
- Explore how scientists use metric units for measurement and enumeration and how this relates to small scales and place value.
- Compare the size of a water molecule with other types of matter.
- Consider the size of a water molecule compared to other types of matter.
- Discover how the diffraction limit makes it impossible to see individual water molecules.
- Use Lego molecules to construct mental models of progressively larger groups in order to visualize the phenomenally large number of molecules in a single drop of water.
- Synthesize their understandings of matter and how it changes by creating a comic strip illustrating key science ideas.

Supplies

- Science notebooks
- Chart paper and markers
- Lesson materials kit
- 5 Ziploc bags of Lego bricks (10 red and 20 white per bag) (1 bag per pair)

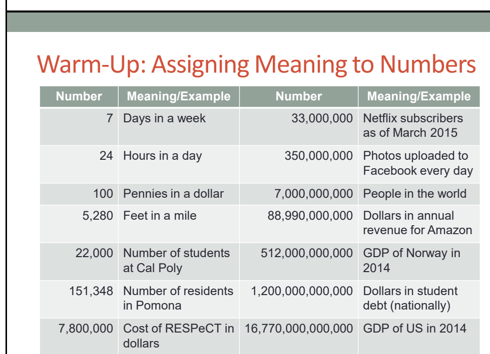
Process (continued)

c. As pairs are working on the task, circulate around the room. If participants are struggling to assign meanings to any of the numbers, ask elicit, probe, and challenge questions to stimulate their thinking. If they're really stuck, you can suggest they think about populations or amounts of money.

Note: Most people can easily attach meanings to numbers below 10,000, but larger numbers are often outside of everyday experience.

d. **Whole-group share-out:** Invite participants to share the meanings they assigned to each number on the table. It isn't necessary to record participants' responses on chart paper, since examples will be displayed on the next slide. Simply emphasize that this activity illustrates how difficult it can be to assign meaning to large numbers.

Slides



Number	Meaning/Example	Number	Meaning/Example
7	Days in a week	33,000,000	Netflix subscribers as of March 2015
24	Hours in a day	350,000,000	Photos uploaded to Facebook every day
100	Pennies in a dollar	7,000,000,000	People in the world
5,280	Feet in a mile	88,990,000,000	Dollars in annual revenue for Amazon
22,000	Number of students at Cal Poly	512,000,000,000	GDP of Norway in 2014
151,348	Number of residents in Pomona	1,200,000,000,000	Dollars in student debt (nationally)
7,800,000	Cost of RESPeCT in dollars	16,770,000,000,000	GDP of US in 2014

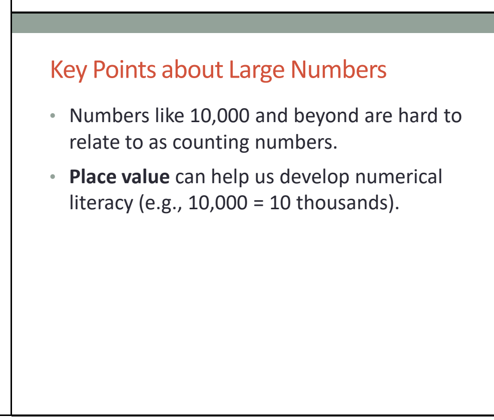
Process

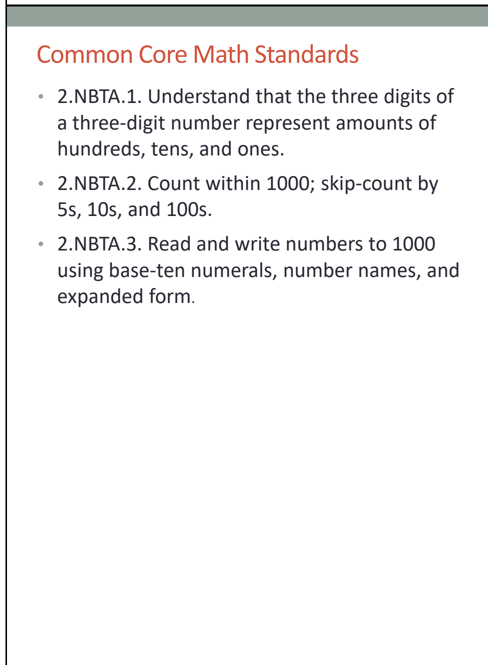
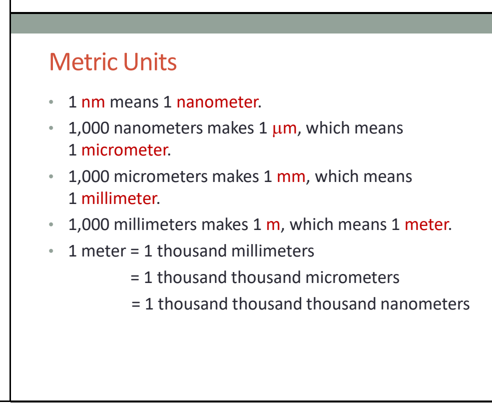
Display Slide 28. Warm-Up: Assigning Meaning to Numbers (5 min)

a. "The authors of the RESPeCT program compiled the examples on this slide. Let's review the meaning attached to each number."

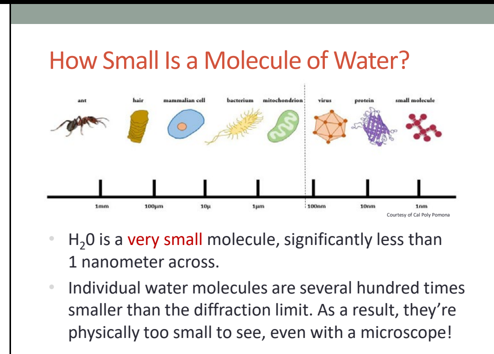
b. Read through the meanings on the slide and highlight some of the amazing figures.

Note: The number of photos uploaded to Facebook per day is not an exaggeration. In fact, the figure may be much higher now. In 2015, Facebook reached 1 billion users worldwide, and many people are using the social-networking platform on multiple

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	• 1 meter stick (per pair) • Sheets of blank, letter-sized paper (for comic strips) **PD Resources** • RESPeCT lesson plans binder **Resources in Lesson Plans Binder** *Resources section:* • Content background document • Common Student Ideas •		camera-ready mobile devices, such as smartphones and tablets. c. “Even for a group of educated working professionals, coming up with meanings for the larger numbers was hard. Most of these examples, which are often in the news, are related to demographics or commerce. To understand what they mean, we need to be aware of large-scale social issues, but this is often not enough. Most of us don’t deal with enormous quantities of money like this in our own finances. It’s not as if banks keep piles of cash on hand in these amounts. Likewise, people don’t typically gather in one place in numbers greater than 100,000. Have you ever seen the entire population of Pomona together in a public place at the same time? These are just a few of the reasons why it’s so difficult for us to attach meaning to large numbers.”
			**Display Slide 29.** Key Points about Large Numbers (Less than 1 min) a. “*Place value* can help us make sense of large numbers by enabling us to think of these numbers as smaller numbers of medium-sized groups. For example, the number 10,000 could mean 10 groups of 1,000 each. Or 1,000,000 could mean 1,000 thousands or 1,000 groups of 1,000 each. Using place value enables us to ascribe meaning to larger numbers by stepping up through a meaningful number of groups, each of a meaningful size, such

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			as 1,000 groups of 1,000 each.”
		 	**Display Slide 30.** Common Core Math Standards (3 min) a. Read the 2nd-grade Common Core math standards on the slide. b. “The aim of the Common Core state math standards is to develop number sense in 2nd graders. Skip counting by 10s and 100s helps students understand that the three digits of a three-digit number represent the amounts of 100s, 10s, and ones.” c. Demonstrate the familiar strategy of keeping track of 10s while skip counting: Count aloud up to 200 by 10s, holding out a finger for each 10 (i.e.,10, 20, 30, 40, and so on). Emphasize that this is how to show kids that 200 is 20 tens.
		 	**Display Slide 31.** Metric Units (7 min) a. Introduce the metric units on the slide. Ask participants, “What does this have to do with science?” b. Emphasize the following key points: • Scientists use numbers in a variety of ways, mainly for measurement and enumeration. • The standard metric unit for measuring length is 1 meter. • To simplify communication, 1,000 meters is

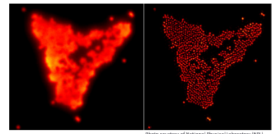
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			called a *kilometer*. A large number like 100,000 meters can be thought of as 100 groups of 1,000 meters. Using place value, it can also be described as 100 kilometers. This is not only easier to say, but it's also easier to ascribe meaning to, since 100 kilometers is only three digits. • To measure smaller objects, however, scientists use smaller units. One *nanometer* is a very small unit of length. One thousand nanometers (laid end to end) make a *micrometer*, a larger but still very small unit of length. One thousand micrometers (laid end to end) make a *millimeter*. c. "Let's reflect on just how small a micrometer—and thus a nanometer—would be." d. Hold up a meter stick for everyone to see and point out the millimeter markings along the stick. Remind participants that there are 1,000 millimeters in a meter, so there are 1,000 such tick marks along the length of the stick. Then place your fingernails on two consecutive millimeter tick marks to highlight the extremely narrow area between them that makes up one millimeter. e. "There are 1,000 micrometers between these two millimeter tick marks. And if we could draw them on the stick, we'd see 1,000 nanometers between any two micrometers. A nanometer is an *extremely* small unit of length!"

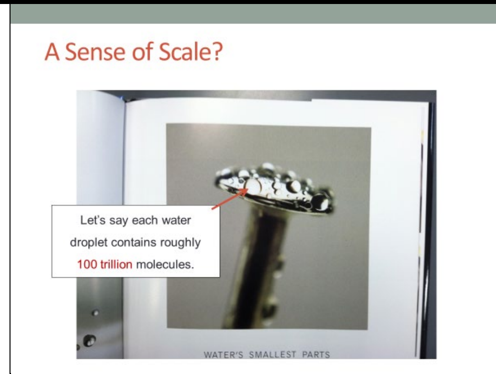
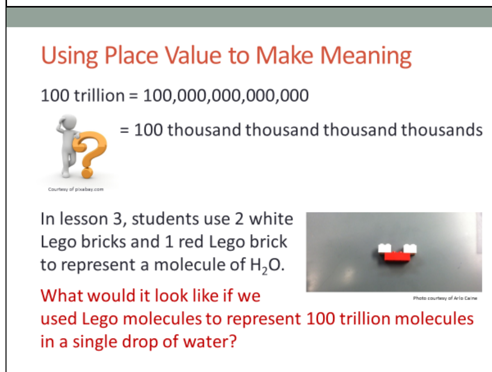
<table>
<tr><th>PD Model: Time/Phase</th><th>Purpose, Content, and What Participants Do</th><th>Slides</th><th>Process</th></tr>
<tr><td></td><td></td><td>
</td><td>Display Slide 32. How Small Is a Molecule of Water? (5 min)

a. "In the Properties of Matter unit, students learn about the smallest pieces of water called molecules and explore how they interact with one another. Learning about molecules helps students understand the liquid and solid states of water and the processes of freezing and melting."

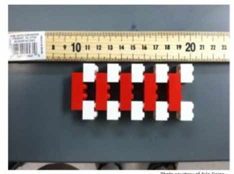
b. "Water is a very small molecule, significantly less than 1 nanometer across. Individual water molecules are several hundred times smaller than a threshold size called the diffraction limit. Objects with diameters smaller than this threshold are similar in size to the wavelengths of visible light. Physics gets in the way and makes such objects, like molecules, impossible to see."

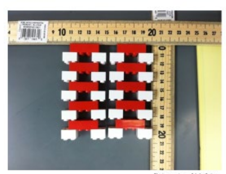
c. Highlight: A mitochondrion, which is a component of an individual cell, is less than 1 micrometer in size but is visible under a microscope. Large molecules like proteins are many times smaller than the mitochondrion, and because they're smaller than the diffraction limit, they can't be seen even with the most powerful optical microscope. A water molecule is even smaller than the smallest molecule on the slide graphic!</td></tr>
</table>

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		The Diffraction Limit  • A collection of beads, each roughly 100 nm in diameter, was manufactured and imaged. • The image on the left is what you would actually see with a microscope. The blurring is the result of the diffraction limit. • The computer graphic on the right shows what the beads would look like if physics didn't get in the way.	**Display Slide 33.** The Diffraction Limit (2 min) a. "To help us understand the diffraction limit, let's examine the graphics on this slide. A collection of beads was manufactured and then imaged under a very precise and powerful optical microscope. Each bead was roughly 100 nanometers in diameter, which is smaller than the wavelengths of visible light. The resulting image on the left is blurry, making it difficult to differentiate the individual beads. But this is best image anyone could get. No amount of focusing would improve the image. It will always be blurry because the beads are smaller than the diffraction limit." b. "The image on the right is a computer simulation of what the beads would look like if physics didn't get in the way of our ability to see them."
		A Sense of Scale?  	**Display Slide 34.** A Sense of Scale? (Less than 1 min) a. "In lesson 3, you'll read an excerpt from the book *A Drop of Water*. To impress upon students just how small a water molecule is, the author shows a highly magnified image of water droplets on the head of a straight pin and notes that the smallest visible droplet contains three hundred trillion water molecules." b. "We might expect students to respond, 'Wow! Three hundred trillion is a big number! Water molecules must be really, really small if such a small water droplet is made up of such a large number of pieces!' But given the fact that it's difficult to assign meaning to numbers larger than 10,000, how likely is it that our students will be able to assign any real meaning to 300 trillion, or a 3 followed by 14 zeros?"

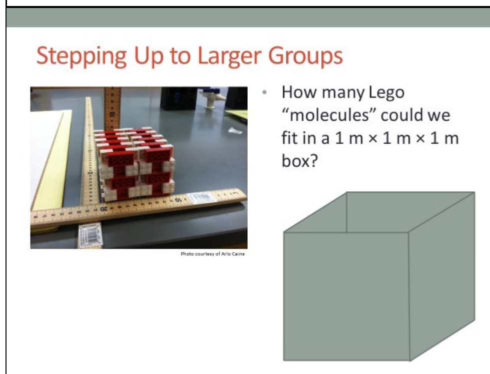
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		 	**Display Slide 35.** A Sense of Scale (Less than 1 min) a. "Let's say there are roughly 100 trillion water molecules in a single drop of water. If we focus on the power of 10 in that number, how many molecules is that? Can we attach a meaning to this number? Think about these questions for a moment." **Note:** Don't discuss these questions now. Advance to the next slide.
		 	**Display Slide 36.** Using Place Value to Make Meaning (1 min) a. "Using place value, we can try to attach meaning to the number 100 trillion. Since 1 trillion is 1,000 billions, we can think of 100 trillion as 100 thousand billions. And since 1 billion is 1,000 millions, we can also think of 100 trillion as 100 thousand thousand millions. Going further, 1 million is 1,000 thousands, so we can think of 100 trillion as 100 thousand thousand thousand thousands. Although thinking of 100,000 as 100 groups of 1,000 each is fairly easy, thinking of 100 trillion as 100 thousand thousand thousand thousands can still be difficult to understand in a meaningful way." b. "In lesson 3, students assemble two white Lego bricks of hydrogen and one red Lego brick of oxygen to represent a water molecule. What would it look like if we used Lego molecules to represent 100 trillion molecules in a single drop of water?"

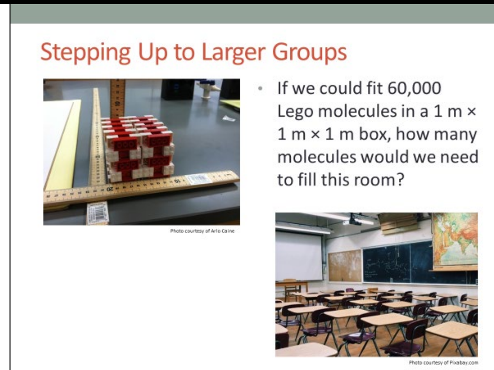
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Challenge Question If one Lego "molecule" can be used to represent one water molecule, what could represent a single droplet of water made up of 100 trillion molecules?	**Display Slide 37.** Challenge Question (7 min) a. "More precisely, if one Lego 'molecule' represents one molecule of water, what could represent a single *droplet* of water made up of 100 trillion molecules?" b. **Turn and Talk:** Have participants discuss their ideas with an elbow partner. c. **Whole group:** Invite participants to share their ideas with the group. Record ideas on chart paper and ask elicit and probe questions to make participants' thinking visible. **Note:** It's quite possible that participants will have no idea how to represent 100 trillion molecules with Legos. Most people have never considered how to make sense of such a large number. Participants might think about how big a pile such a collection of Lego molecules would make, how large an area the molecules would cover, or how much space they could be packed into. It's doubtful, however, that they'll have any confidence in their ideas. d. "It's OK if you're having trouble with this. Next, we'll see if we can make sense of this number by visualizing progressively larger groups of Lego molecules."

<table>
<tr><th>PD Model: Time/Phase</th><th>Purpose, Content, and What Participants Do</th><th>Slides</th><th>Process</th></tr>
<tr><td></td><td></td><td>Stepping Up to Larger Groups

• We can stack 5 Lego “molecules” along a 10 cm segment.
• How many molecules can we fit in a 10 cm × 10 cm square?</td><td>Display Slide 38. Stepping Up to Larger Groups (6 min)

a. Have participants pair up. Then give each pair a zip-seal bag of Lego bricks and a meter stick.
b. Read the information on the slide and then pose the question. Ask pairs to demonstrate their answers to the question using their Lego molecules and meter sticks.
Note: If necessary, demonstrate that five Lego molecules can be placed along a 10 centimeter segment of one meter stick, as shown on the slide.
c. As pairs work on the task, set up a large two-column table on chart paper, with the column headings “Space” and “Number of Molecules.” Then under the first column heading, write “10 cm × 10 cm × 1 block layer,” and under the second column heading, write “10.”</td></tr>
<tr><td></td><td></td><td>Stepping Up to Larger Groups

• We can stack 10 Lego “molecules” on top of a 10 cm × 10 cm square.
• How many molecules can we fit in a 10 cm × 10 cm × 10 cm box?</td><td>Display Slide 39. Stepping Up to Larger Groups (10 min)

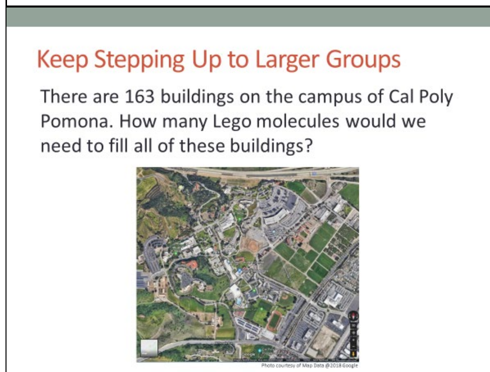
a. Read the information on the slide and then pose the question. Have pairs join together to combine resources (Lego molecules and meter sticks) and answer the question by reaching a consensus.
b. As participants work on this task, ask elicit and probe questions to prompt them to consider whether they could compute the approximate number of blocks through measurement and arithmetic instead.
Note: If necessary, demonstrate that 10 Lego molecules can be arranged on a 10 cm × 10 cm square to form a 1-block-thick layer, and then 6 of these layers can be stacked to fill a 10 cm × 10 cm × 10 cm box. Adding a sixth layer will slightly exceed the 10 cm height requirement, but it’s good for</td></tr>
</table>

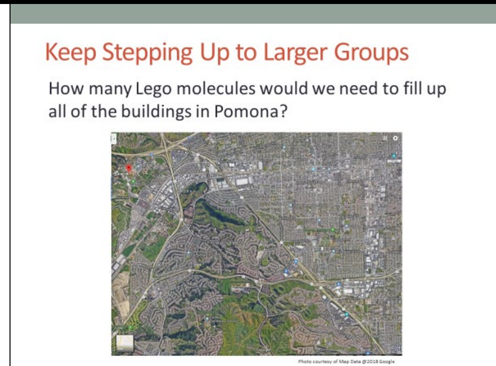
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			participants to observe that the fit isn't perfect. As you continue the activity, it will be less important to get the exact number and more important to keep track of the approximate total. c. On the chart, write "10 cm × 10 cm × 10 cm block" in the first (Space) column of the table and "60" in the second (Number) column.
			**Display Slide 40.** Stepping Up to Larger Groups (10 min) a. Pose the question on the slide and have participants work together as a group to answer the question by reaching a consensus. b. As participants work on this task, ask elicit and probe questions to make their thinking visible and clarify math concepts. c. Suggest that participants draw a diagram showing how many boxes of Lego molecules they could stack along one meter stick (10), and then how many rows they could lay alongside each other to make a 1 m × 1 m × 10 cm layer (10 of those for a total of 100 boxes). Then suggest they compute the total number of boxes involved if they stack 10 of those layers on top of one another to make a 1 m × 1 m × 1 m cube (10 of those for a total of 10 × 100 = 1,000 boxes). Since each box contains 60 Lego molecules, they should make about 60,000 molecules. d. Once the group reaches a consensus, write "1 m × 1 m × 1 m box" in the first column of the table and "60,000" in the second column. e. **Emphasize:** "Remember the goal. We're trying to make sense of the number 100 trillion. Although 60,000 is a large number, we still have a ways to go."

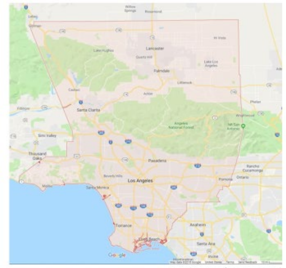
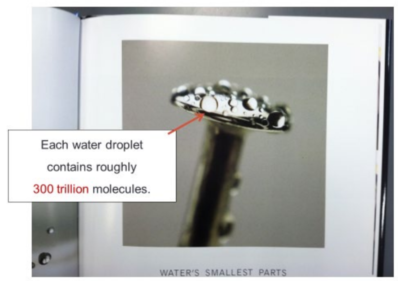
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 41.** Stepping Up to Larger Groups (10 min) a. Pose the next challenge question on the slide. Ask participants to think about how they could use the tools at their disposal (meter sticks, math, and their previous calculations) to step up to this larger estimate. b. The number the group obtains will depend on the size and shape of the room. If the room is rectangular, one can measure the length, width, and height using the meter sticks and compute the volume in cubic meters by multiplying these measurements. Since each cubic meter could be filled with about 60,000 Lego molecules, multiplying the volume by 60,000 produces an estimate for the desired number. c. Cell-phone calculators might be useful here. For example, if the room is 10 m × 10 m × 3 m, the volume would be 300 cubic meters, and it would take 18,000,000 Lego molecules to fill the room (empty of furniture). If the room dimensions aren't in round numbers, the total won't work out as a round number either. At this point, it's important to start rounding to a few significant digits and emphasizing the size of the number involved. d. When the group obtains an estimate, round it to the nearest million and record it on the data table under the second column. In the first column, write "The room." e. Remind participants that even though this is a large number, they still have a long way to go to reach 100 trillion.
	10-MINUTE BREAK		

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process

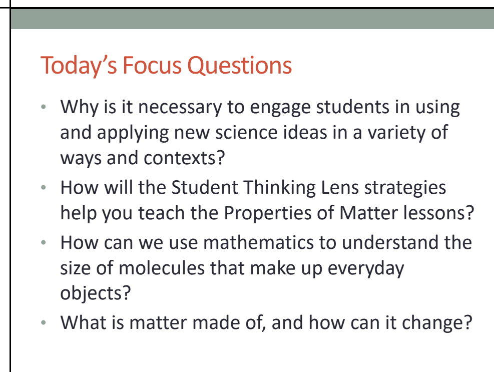
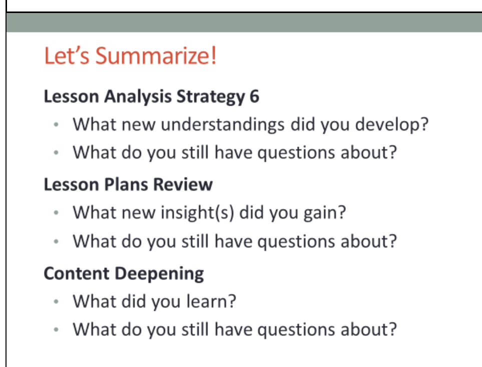
			**Display Slide 42.** Stepping Up to Larger Groups (10 min)
			
			a. Read the question on the slide.
			b. "To answer this new challenge question, we'll head outside to survey the size of the building."
			c. Discuss with the group whether to continue measuring in meters to obtain their estimate or calculate the estimate based on room size.
			• **Option 1: Measure in meters.**
			  • It the group wants to continue measuring in meters, split participants up into teams. Have one team measure length and the other measure width (or something like that). If more than one team is measuring the same dimension, you can average the two measurements they obtain and use this number for the calculation.
			  • Individual errors in measurement will begin appearing, but it's unlikely that estimates will be off by significant figures. Emphasize that the purpose is to obtain a rough estimate and encourage the participants to measure to the nearest whole meter.
			• **Option 2: Calculate the estimate based on room size.**
			  • If the building (like a school) consists of a number of identical rooms arranged on floors, participants could solve this problem by counting the number of rooms filling the building the same way they counted the number of 10 cm × 10 cm × 10 cm boxes filling a 1 m × 1 m × 1 m box and then multiplying by the number of Lego molecules filling a room. Again, cell-phone calculators could be useful here.
			
			d. After the group has reached a consensus on an

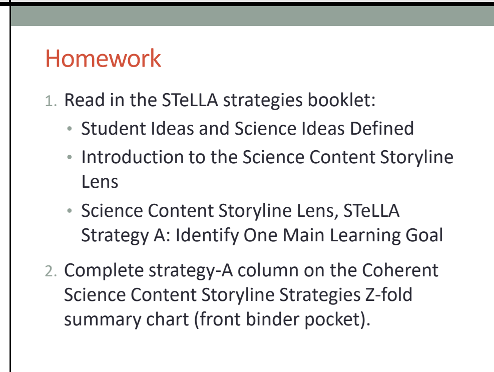
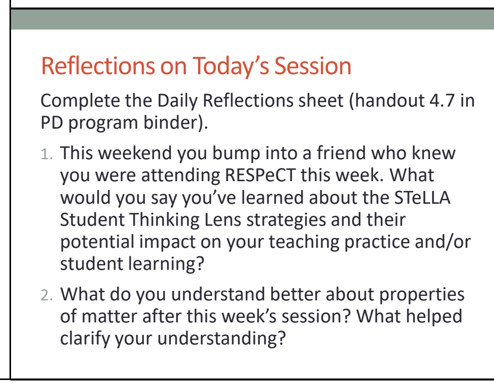
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			estimate, go back inside and record this number on the data table (“Number” column); then write “The building” in the “Space” column. e. “Even with this large number, we still have a ways to go to reach 100 trillion. What can we do next?”
			**Display Slide 43.** Keep Stepping Up to Larger Groups (7 min) a. “How many Lego molecules would we need to fill all of the buildings on the Cal Poly Pomona campus?” b. Ask elicit, probe, and challenge questions to guide participants toward the idea that they can multiply their previous estimate (number of Lego molecules needed to fill one building) by the total number of buildings on the Cal Poly campus. **Note:** Although the buildings on campus aren’t all the same size, as long as the previous estimate was based on a medium-sized building, this technique should yield a reasonable estimate. However, multiplying by 163 will increase the number by only two or three more digits. c. When the group reaches a consensus on an estimate, record this number in the second column on the data table and write “All buildings on Cal Poly campus” in the first column. d. Elicit participants’ ideas for what large group they could consider next.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		 	**Display Slide 44.** Keep Stepping Up to Larger Groups (7 min) a. "Here's a satellite map of the Pomona area. The red dot in the upper-left-hand corner is the location of the Cal Poly Pomona campus. How many Lego molecules would we need to fill up all of the buildings in Pomona?" b. "To answer this question, we'll need to estimate a number of things. Let's brainstorm some ideas for how to approach this challenge." c. Elicit participants' ideas for how they could estimate the number of Legos. Reassure participants that exact values aren't important at this point. They just need to get a sense of the quantity. **Note:** One possible solution is to figure out how many copies of the Cal Poly campus could be arranged to cover this map and then multiply this number by the previous round number of Lego bricks. Although the Cal Poly campus has green spaces without buildings, it has many more tall buildings than the rest of Pomona. If participants imagine separating the floors of the tall buildings and laying them out as single-story structures across the campus, they could achieve a structure density similar to the rest of the city. Looking at the satellite map, it appears that about 10 copies of the Cal Poly campus would cover this area of Pomona, so multiplying their previous result by this amount will only add one more digit. d. When the group reaches a consensus on an estimate, record this round number in the second column on the data table and write "All buildings in Pomona" in the first column. e. Elicit participants' ideas for what large group they could consider next.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Keep Stepping Up to Larger Groups 	**Display Slide 45.** Keep Stepping Up to Larger Groups (7 min) a. Challenge participants to continue stepping up to larger land areas (groups) until they achieve an estimate for the number Lego molecules that would represent 100 trillion. For example, filling all of the buildings in LA County with Lego molecules would be about right. b. Record the final estimate on the data table.
		How Small Is a Water Molecule? 	**Display Slide 46.** How Small Is a Water Molecule? (Less than 1 min) a. "Now that we have a sense of just how large a number 100 trillion is, we can appreciate how small water molecules really are. Roughly 300 trillion water molecules make up a single tiny drop of water on the head of a pin. The smallest pieces of water are so phenomenally small that it's literally impossible to see them individually."
		Reflect: Content Deepening Focus Question 1 How can we use mathematics to understand the size of molecules that make up everyday objects?	**Display Slide 47.** Reflect: Content Deepening Focus Question 1 (7 min) a. Review the focus question on the slide. b. **Individuals:** Direct participants to answer this question in their science notebooks, using evidence and observations from the Lego water-molecule investigation to support their ideas. c. **Whole group:** Invite participants to share their answers with the group and relate their ideas to today's water-molecule investigation. If time allows,

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			encourage them to brainstorm ideas that will help their students think mathematically so they can attach meaning to large number like 300 trillion. d. Following this discussion, ask participants to place their Legos back in the zip-seal, plastic bags.
		Content Deepening: Focus Question 2 What is matter made of, and how can it change?	**Display Slide 48.** Content Deepening: Focus Question 2 (Less than 1 min) a. Read the question on the slide. b. Remind participants that this focus question and the unit central questions are the same. c. “To help us answer this question, let’s spend some time synthesizing everything we’ve learned this week about matter and how it can change.”
		Putting It All Together! • Create a comic strip that illustrates what you’ve learned about matter and how it can change. Be creative!  Courtesy of Cal Poly Pomona • **Science terms/ideas to use:** atoms, molecules, matter, solid/liquid, ice/liquid water, crayons, chocolate, butter, vinegar and baking soda, melting/freezing, neutralization reaction, physical (state) change/chemical change, conservation of matter	**Display Slide 49.** Putting It All Together (25 min) a. “Next, I’d like you to create a comic strip that illustrates the key science ideas we’ve explored this week. Your comic strip should answer our focus question and unit central questions, *What is matter made of, and how can it change?* Be sure to get down to the molecular level!” b. Distribute sheets of blank, letter-sized paper for participants to use for drawing their comic strips. c. Suggest that participants include labels, captions, and/or talk bubbles with their drawings and use key science terms and ideas to describe changes in matter. Refer them to the list of key terms and ideas on the slide. d. Ask participants, “What STeLLA Student Thinking Lens strategies will we be using for this task?” **Answer:** Strategies 6 and 7—use and apply and

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			synthesize and summarize. e. **Whole-group share-out:** Have participants present their comic strips to the group using a document reader. Make sure the comic strips answer the focus question/unit central questions. **Note:** Give participants 15 minutes to create their comic strips and allow 8–10 minutes for presentations.
3:15–3:30 15 min **Wrap-Up: Summary, Homework, and Reflections** Slides 50–53	**Purpose** • Summarize and reflect on key ideas from today's learning and preview the transition to the Science Content Storyline Lens (SCSL) strategies. **What Participants Do** • Review today's focus questions. • Share key ideas from the lesson analysis (strategy 6), lesson plan review, and content deepening work. • Copy down the homework assignment. • Write their reflections on today's learning. **Handouts in PD Binder** • 4.7 Daily Reflections—Day 4 **Supplies** • Science notebooks		**Display Slide 50.** Today's Focus Questions (2 min) a. Review today's focus questions. b. **Individual think time (1 min):** Ask participants to reflect on these questions and think about how they might revise their answers.
			**Display Slide 51.** Let's Summarize! (5 min) a. **Individual think time (1 min):** Give participants a minute to think about the questions on the slide and consider questions they still have. Challenge them to formulate a statement summarizing what they learned in each area. b. **Whole-group share-out:** Have participants share at least two different statements about each of the areas on the slide. Elicit more if time allows.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 52.** Homework (3 min) a. "Next week we'll focus on the Science Content Storyline Lens strategies and explore a new content area: Earth's changing surface. To prepare, complete the homework tasks on the slide." b. Make sure participants copy the assignment into their science notebooks.
			**Display Slide 53.** Reflections on Today's Session (5 min) a. Give participants time to reflect on today's session and write their responses to the questions on the Daily Reflections sheet (handout 4.7 in PD program binder).