RESPeCT Summer Institute Professional Development Leader Guide (PDLG)

Grade Level	3	**Day**	4	**STeLLA Strategy**	STL Strategy 6: Use and Apply New Science Ideas	**Subject Matter Focus**	Variation in Traits (VIT)
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 Variation in Traits lessons? • How would biologists explain how a trait changes within a population over time? • How can multiplicative reasoning allow us to use mathematics to make predictions based on experimental data?						
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. • Variation in traits and the environment affect which plants or animals of the same kind survive long enough to produce young, and thus, which variations become more common in the next generation. • Natural selection is a nonrandom evolutionary process resulting from trait variation among individuals in a population, inheritance that produces trait variation among offspring, selection of offspring that are better equipped to compete for limited resources and are thus more likely to survive and reproduce, and adaptation as the frequencies of traits and the genes that code for them change within a population over time. • Multiplicative reasoning is a powerful way to make comparisons between quantities and lends itself to scenarios in which additive reasoning isn't appropriate. • There are different ways of thinking about multiplicative comparisons, and visual representations can support these ways of thinking.						

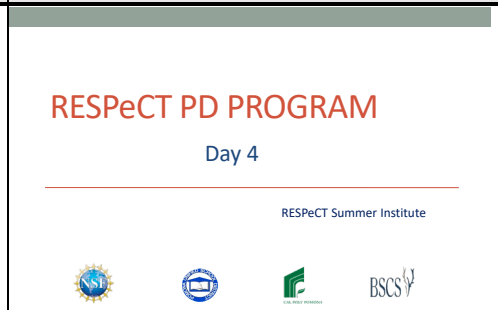
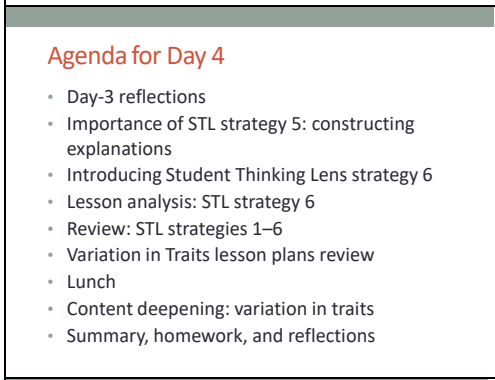
Preparation	**Materials**	**Videos**
Daily Setup Tasks • Check that video clips are correctly linked to PowerPoint (PPT) slides. • Set up PowerPoint. • Make sure video clips play correctly with good sound. • Arrange furniture and food. • Arrange participant materials. • Put up posters and charts. **Planning and Preparation Tasks** • Study the PDLG, PowerPoint slides (PPTs), video clips, and handouts. Make changes to PPTs if needed. • Review the reflections from day 3 and	**Posters and Charts** • STeLLA Framework and Strategies poster • Day-4 Agenda (chart) • Day-4 Focus Questions (chart) • Norms for Working Together (chart) • Strategy charts from days 1–3 (STL strategies 1–5) • Chart of STL strategies highlighted in Variation in Traits 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 **Handouts in RESPeCT PD Binder, Day 4**	• Hershberger video clip, *Introducing the CER* (on companion DVD for Zembal-Saul book *What's Your Evidence?*) • Video Clip 4.1: Wilde classroom (use and apply, strategy 6); 4.1_mspcp _gr.3.variations.traits_wilde_L7_c1-2 • Video Clip 4.2: Wilde classroom (review Student Thinking Lens strategies); 4.2_mspcp_gr.3.variations.traits_wilde_L6 _c2 For content deepening: • *The Making of the Fittest: Natural Selection and Adaptation* (video download); http://www.hhmi.org/biointeractive/making

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 Variation in Traits lesson plans.
• Review the activities for Variation in Traits lessons 3b and 7a/b in the lesson plans binder.
• Content deepening:
  • Register for the free BSCS course Across the Sciences at online.bscs.org. (Click on the course link on the navigation bar from the home page.)
  • After registering for the course and logging in, access the mouse simulation by clicking on Evolution; then Explore Evolution; then Predator and Prey. Once on the web page, find the link that says "Click here to view the 'Predator and Prey' Interactive." Click on the link to open a new window and begin the simulation.
  • Run through the simulations you'll be conducting during the content deepening phase to make sure the setup is working properly.
  • Before you begin the content deepening session, log into the course so it's ready to go.
	• 3.11 Natural Selection Explanation Table (from day 3)
	• 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 Transcript for *The Making of the Fittest: Natural Selection and Adaptation*
	• 4.8 Cartoon Summary of Mice in a Lava Environment (from VIT lesson 7b)
	• 4.9 Using Math to Make Predictions
	• 4.10 Comparing Mathematical Visual Representations of the Problem
	• 4.11 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
	
	PD Resources
	• STeLLA strategies booklet
	• RESPeCT PD program binder
	• RESPeCT lesson plans binder
	
	Resources in Lesson Plans Binder
	Resources section:
	• Variation in Plants and Animals and Variation in Traits: Content Background Document
	• Common Student Ideas about Variation in Traits
		-fittest-natural-selection-and-adaptation

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 variation in traits 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	**Variation in Traits Lesson Plans Review**	• Understand why the Variation in Traits lesson plans are so scripted and how they should be used before and during the lessons. • Understand the conceptual flow within and across the 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)	**Science and Math Content Deepening: Variation in Traits**	• Deepen understandings of variation in traits related to science content from VIT lessons 7a and 7b. • Continue learning about the range of evidence biologists collect to support the argument that traits evolve over time because of natural selection. • Understand the similarities and differences between multiplicative and additive comparisons. • Explore different ways of thinking about multiplicative comparisons and how visual representations can support these ways of thinking.
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.

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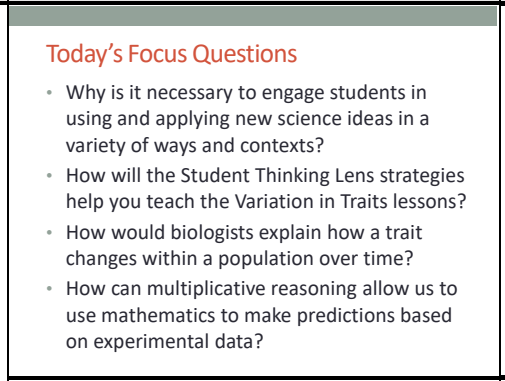
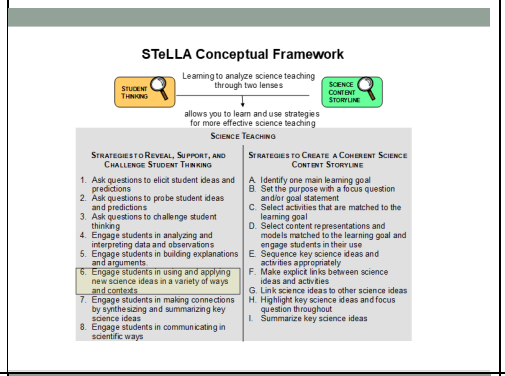
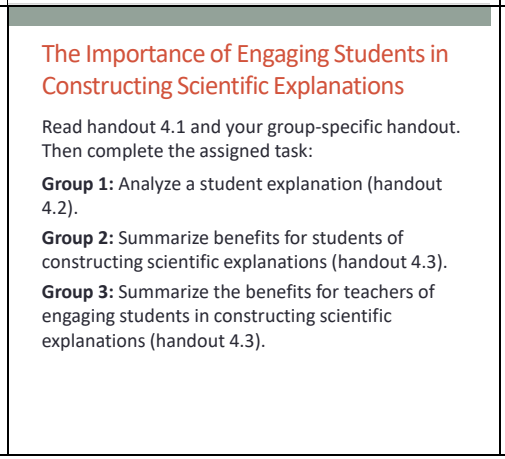
			**Display Slide 4.** Today's Focus Questions (1 min) a. Introduce the focus questions that will guide today's work. b. "Like STeLLA strategies 4 and 5, the goal of strategy 6 is to move student thinking forward toward deeper understandings of science ideas."
			**Display Slide 5.** STeLLA Conceptual 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		**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.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	and how scientists work. **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		a. Divide participants into three groups or pairs. Assign 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

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			strategies." c. After watching the clip, discuss participants' 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**	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

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	• Chart paper and markers **PD Resources** • STeLLA strategies booklet • STL Z-fold summary chart (front pocket of PD binder)		questions or activities *assess* student learning. Teachers often talk about asking these kinds of 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 variation in traits 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.	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.

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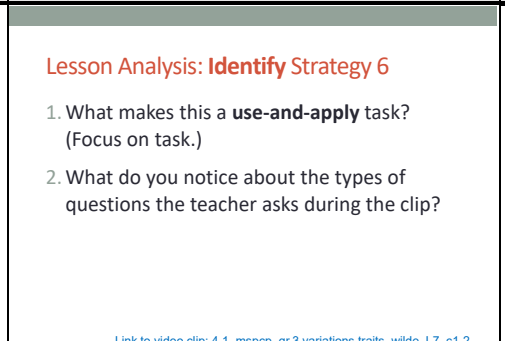
	Videos • Video Clip 4.1, Wilde classroom **Handouts in PD Binder** • 4.4 Transcript for Video Clip 4.1 **PD Resources** • STeLLA strategies booklet **Resources in Lesson Plans Binder** *Resources section:* • Content background document		**Display Slide 11.** Lesson Analysis: Identify Strategy 6 (25 min) 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. **Note:** Make sure participants recognize that this clip isn't a strong example of teacher questioning in a use-and-apply activity. **Ideal observations:** • This is a use-and-apply task because students are considering a new set of circumstances they're challenged to explain using the science ideas they've learned. Students must use the science idea that in different environments, different traits will be favored for survival. In use-and-apply tasks, challenge questions should be used if students aren't applying the science ideas they've learned to explain the new situation (e.g., "How does your idea connect to what we've learned?"). • In both clip segments, the teacher begins by *eliciting* students' ideas (see video segments 00:00:00–00:08; 00:01:34–01:45). • In the first clip segment, the teacher doesn't probe or challenge student ideas that are elicited, missing an opportunity for students to clarify why the environment and variation in color matter. • At video segment 00:02:22, the teacher asks a good

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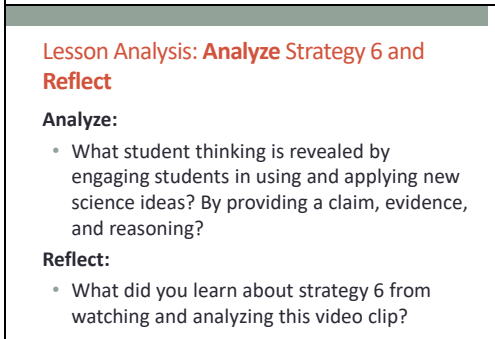
			challenge question but missed an opportunity to push the student who responded to more clearly link her response to the science idea developed in the beetle simulation that different traits are favored for survival in different environments. • The use-and-apply task might have been stronger if the variation in trait that provided an advantage was something other than body color (as it was with the beetles). This might have allowed students to think about other ways that traits give organisms a survival advantage, leading to a more general science concept related to the impact of trait variations on survival patterns.
			**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.

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			Observations: • **Video segments 00:00:33–00:35:** Ally immediately linked this question to the desert simulation with the beetles, focusing on how the mice could blend in with the environment if they were "greenish" like grass. (Does she think mice can be green?) • **Segments 00:00:15 and 00:00:45–00:54:** Given that the desert simulation emphasized color variation in beetles, it's interesting that two students in this conversation thought about a different trait variation: size. These students thought mice have an advantage over large predators because they can dig and go underground. However, they only observed that mice are small compared to predators; they didn't talk about mice varying in size so that smaller mice might survive better than bigger ones. • **Segment 00:01:17:** This student had an interesting idea that the mice can get food (and grow stronger) while they're blending in to hide from predators. He might have been suggesting that blending in is better than digging underground. • **Segment 00:02:27:** Lacey gave an appropriate reason for why the black mice would survive best, but the teacher's follow-up question confused her and led to a focus on offspring being the same color as their parents rather than a focus on the main learning goal. A better follow-up question would have been, "Can you tell me more about that?" or "Why does it matter that the environment is mostly black?" This would have encouraged Lacey to talk more about the relationship between the environment and color variation in mice.

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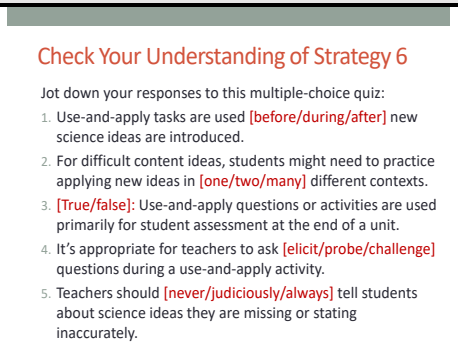
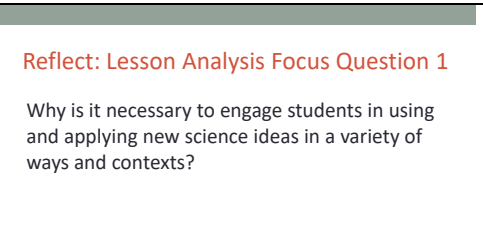
			**Display Slide 13.** Check Your Understanding of Strategy 6 (5 min) **Note:** This activity is optional if time is running short. a. "To check your understanding of STL strategy 6, jot down your responses to this multiple-choice quiz." b. Have participants discuss their answers either in pairs or as 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. **Ideal responses:** • The first time students try to use and apply new science ideas, they'll struggle and make mistakes. This is helpful because it gives teachers an opportunity to diagnose where students are having trouble and clarify the concepts. Students truly understand and internalize new science ideas only after making multiple attempts at using and applying them. • Using and applying new science ideas in a variety of ways and contexts can help students see how important and useful these ideas are in explaining a

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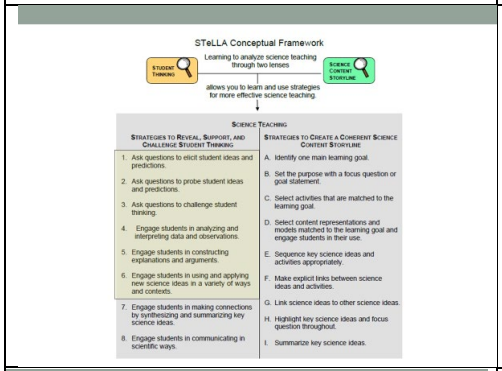
			variety of phenomena in the world around them.
10:10–10:55 45 min (Includes 10-min break) **Review: STL Strategies 1–6** Slides 15–19	**Purpose** • Review and deepen understandings of key similarities and differences among STL strategies 1–6. **Content** • STL strategies 1–6 reveal, support, and challenge 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, Wilde 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	Lesson Analysis: Focus Question 2 How will the Student Thinking Lens strategies help you teach the Variation in Traits 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 Variation in Traits 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 forces and variation in traits next year."
		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

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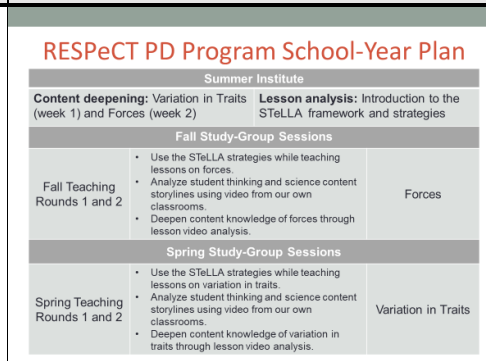
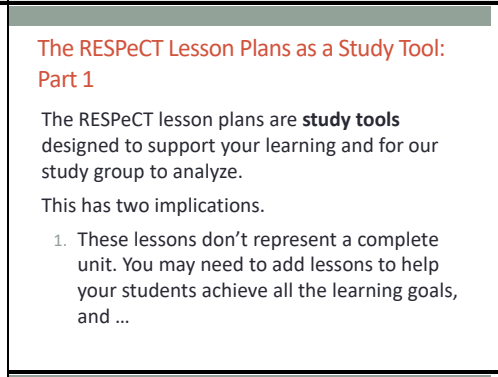
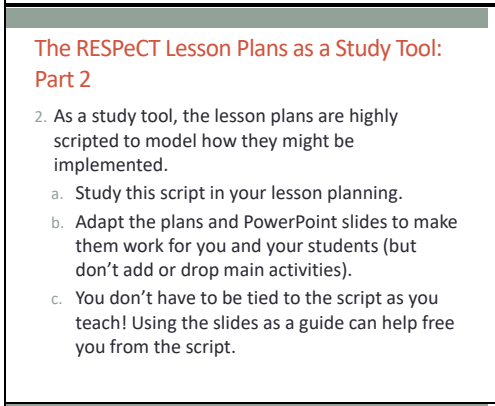
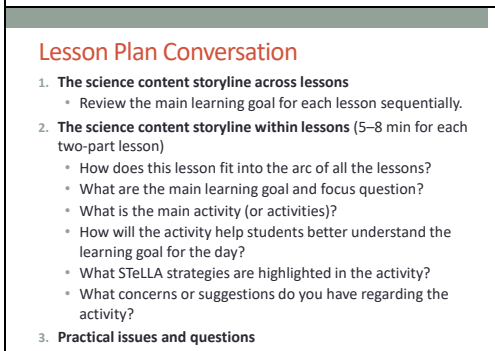
	Student Thinking Lens Strategies (Answer Key) **PD Resources** • STeLLA strategies booklet		student thinking forward toward more-scientific understandings. • Some strategies are used at any time during the lesson (e.g., probe questions); others are used at specific times (e.g., elicit questions used *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.
		Lesson Analysis: **Review** Lesson Context Read the lesson context for this video clip at the top of the transcript (handout 4.5 in your PD program binder).	**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.
		Lesson Analysis: **Identify** Student Thinking Lens Strategies • What Student Thinking Lens strategies can you identify in this video clip? • After watching the video, study the transcript (handout 4.5) and fill in handout 4.6 (Identifying Student thinking Lens Strategies). • Be ready to share your findings with the group, including any missed opportunities. Link to video clip: 4.2_mspcp_gr.3.variations.traits_wilde_L6_c2	**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

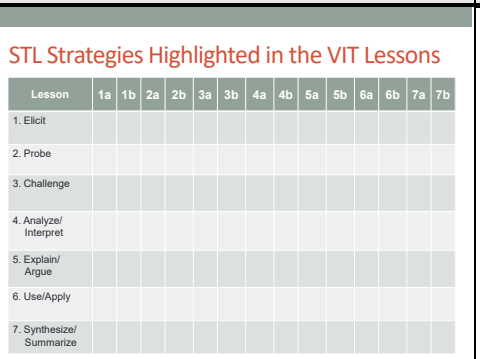
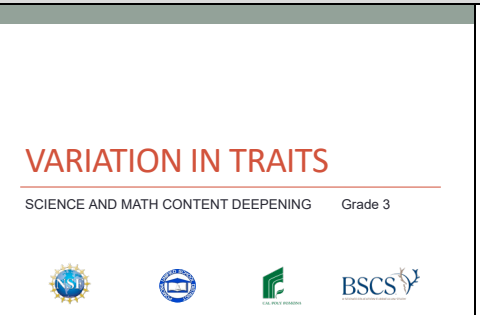
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			Lens Strategies." e. **Whole group:** "What STL strategies did you identify in the video transcript? Did you spot any missed opportunities?" **Note:** See PD Leader Master: Identifying Student Thinking Lens Strategies (Answer Key) for possible responses and examples from the video clip. Participants may come up with different responses. **Observations:** • There is a leading question at segment 00:01:07: "Let's look up here. So who has the most check marks?" • The teacher also leads at segment 00:01:27 with the statement, "That's true. But if this one's got the most checks, I might lean towards that one." • The teacher missed an opportunity to correct the student at segment 00:01:46 who erroneously says, "The gray mice still only has one check mark gone, and the brown mice also only have one check mark gone." The data clearly show that the gray and the brown mice don't have the same number of check marks.
10:45–10:55 10 min	**BREAK**		

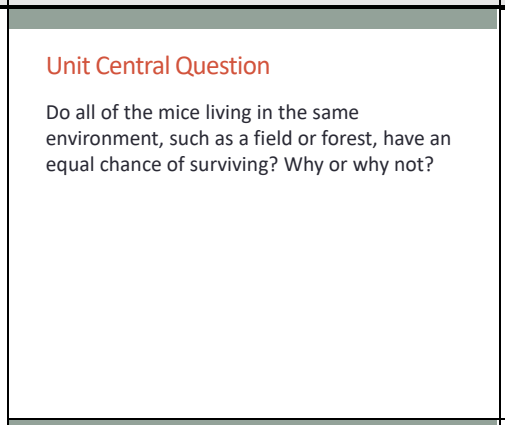
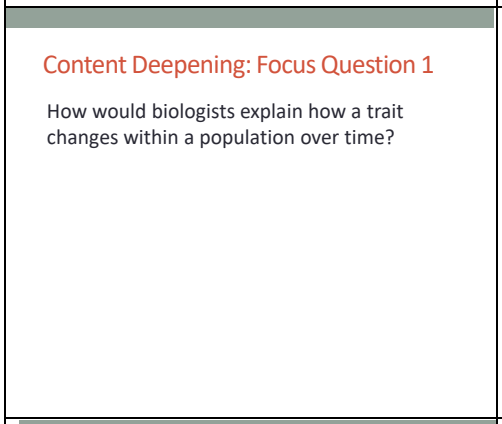
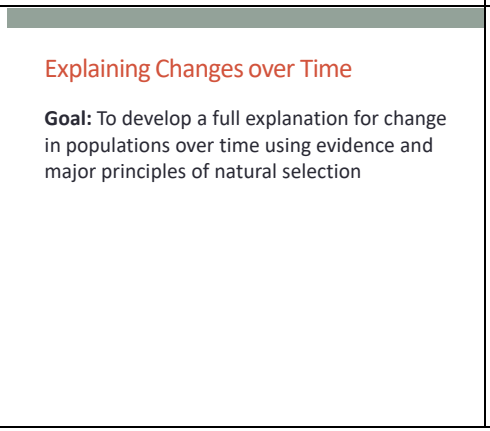
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process

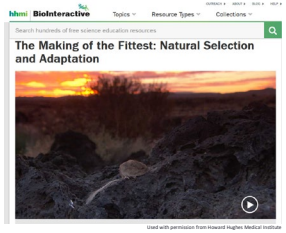
10:55–12:00
 	
65 min
 	
Variation in Traits Lesson Plans Review
 	
Slides 20–24
	Purpose
	• Understand why the Variation in Traits lesson plans are so scripted and how they should be used before and during the lessons.
	• Understand the conceptual flow within and across the lessons.
	• Understand the 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.
	• 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.
			**Display Slide 20.** RESPeCT PD Program School-Year Plan (1 min)
			
			a. "Before we share our reports about each of the Variation in Traits 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 **Forces** 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 **Variation in Traits** lessons, and we'll meet in our study group to analyze video clips and student work from these lessons. Do you have any questions?"
			
			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."

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

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

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 24.** STL Strategies Highlighted in Variation in Traits Lessons a. Use this slide in conjunction with the previous slide.
12:00–12:45 45 min	**LUNCH**		
12:45–3:15 150 min (Includes 10-min break) **Content Deepening: Variation in Traits** Slides 25–52	**Purpose** • Deepen understandings of variation in traits related to science content from VIT lessons 7a and 7b. • Continue learning about the range of evidence biologists collect to support the argument that traits evolve over time because of natural selection. • Understand the similarities and differences between multiplicative and additive comparisons. • Explore different ways of thinking about multiplicative comparisons and how visual representations can		**Display Slide 25.** Content Deepening: Variation in Traits (Less than 1 min) a. "Let's dig into our content deepening work for today." **Note:** Refer to the content background document and Common Student Ideas about Variation in Traits as needed throughout this phase.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	support these ways of thinking. **Content** • Variation in traits and the environment affect which plants or animals of the same kind survive long enough to produce young, and thus, which variations become more common in the next generation. • Natural selection is a nonrandom evolutionary process resulting from trait variation among individuals in a population, inheritance that produces trait variation among offspring, selection of offspring that are better equipped to compete for limited resources and are thus more likely to survive and reproduce, and adaptation as the frequencies of traits and the genes that code for them change within a population over time. • Multiplicative reasoning is a powerful way to make comparisons between quantities and lends itself to scenarios in which additive reasoning isn't appropriate. • There are different ways of thinking about multiplicative comparisons, and visual representations can support these ways of thinking. **What Participants Do** • Watch the rest of a short film about natural selection and adaptation. • Record evidence needed to develop a full explanation of how traits change in a population over time.	  	**Display Slide 26.** Unit Central Questions (Less than 1 min) a. Revisit the unit central questions and announce that participants will use the science ideas they've learned about this week to answer these questions at the end of the session. **Display Slide 27.** Content Deepening: Focus Question 1 (Less than 1 min) a. Review the focus question on the slide. b. "Today we'll continue exploring this focus question from our previous content deepening session." **Display Slide 28.** Explaining Changes over Time (Less than 1 min) a. Review the goal from the previous session. b. "We started working toward this goal in our last content deepening session, and by the end of today's session, we'll have a complete explanation for change within populations over time."

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	• Practice linking evidence to a scientific explanation based on natural selection. • Use a simulation to collect additional data that supports an explanation of trait changes in populations over time. • Listen to a story about mice living near a volcano and consider what happens when their environment changes. • Complete a summary from VIT lesson 7 predicting what the next generation of mice in the story will look like. • Use science ideas about variation in traits to answer the unit central question. • Use mathematical reasoning to make predictions about a population of beetles based on experimental data. **Videos** • *The Making of the Fittest: Natural Selection and Adaptation* **Handouts in PD Binder**	Investigation 1: Explaining Changes over Time  http://www.hhmi.org/biointeractive/making-fittest-natural-selection-and-adaptation	**Display Slide 29.** Investigation 1: Explaining Changes over Time (10 min) a. "Next, we'll watch the rest of the short film *The Making of the Fittest: Natural Selection and Adaptation."* **Note:** You may want to start over at the beginning of the video or continue from the 2:37 time mark. b. Have participants locate their Natural-Selection Explanation Table (handout 3.11) from the previous session. c. "As you watch the video, look for evidence that supports each principle of natural selection on the handout for changes in the fur-color trait in the rock pocket mouse population. Record this evidence on the handout." d. Show the video. e. Following the video, distribute handout 4.7 (Transcript for *The Making of the Fittest: Natural Selection and Adaptation*). f. **Individuals:** "Now read through the video transcript and identify evidence that supports each principle on the handout for the pocket mouse population and add any new evidence to the handout."

<table>
<tr><th>PD Model: Time/Phase</th><th>Purpose, Content, and What Participants Do</th><th>Slides</th><th>Process</th></tr>
<tr>
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4.7 Transcript for The Making of the Fittest: Natural Selection and Adaptation
4.8 Cartoon Summary of Mice in a Lava Environment (from VIT lesson 7b)
4.9 Using Math to Make Predictions
4.10 Comparing Mathematical Visual Representations of the Problem

Supplies

Science notebooks
Chart paper and markers

PD Resources

RESPeCT lesson plans binder

Resources in Lesson Plans Binder
Resources section:

Content background document
Common Student Ideas

</td>
<td>
Investigation 1: Explaining Changes over Time
<table>
<tr><th colspan="3">Constructing a Natural-Selection Explanation</th></tr>
<tr><th>Principle</th><th>Definition</th><th>Evidence</th></tr>
<tr><td>Variation</td><td>(See handout for definitions.)</td><td></td></tr>
<tr><td>Inheritance</td><td></td><td></td></tr>
<tr><td>Selection</td><td></td><td></td></tr>
<tr><td>Adaptation</td><td></td><td></td></tr>
</table>
</td>
<td>Display Slide 30. Investigation 1: Explaining Changes over Time (7 min)

a. Whole-group discussion: Compare the evidence participants collected from the video and the transcript.</td>
</tr>
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<td></td>
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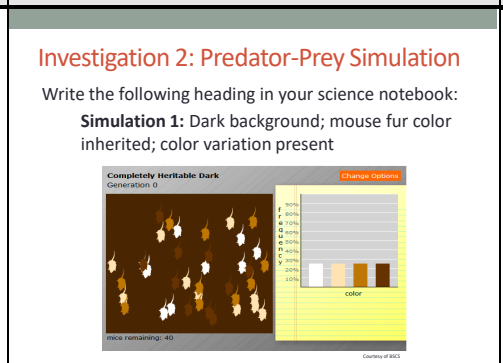
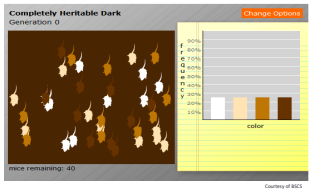
<td>
Investigation 1: Explaining Changes over Time
<table>
<tr><th colspan="3">Constructing a Natural-Selection Explanation</th></tr>
<tr><th>Principle</th><th>Definition</th><th>Evidence</th></tr>
<tr><td>Variation</td><td></td><td>The black rock pocket mice and the tan rock pocket mice in the video are the same species. In this population, one black mouse is born for every 100,000 tan mice.</td></tr>
<tr><td>Inheritance</td><td></td><td>New mutations cause black fur color (segment 3:24). Many genes control fur color (4:29). Most genes are identical, but dark and light rock pocket mice differ in one gene: MC1R (segment 4:55).</td></tr>
<tr><td>Selection</td><td></td><td>A survival advantage of 1% for dark rock pocket mice on a dark background would result in 95% of the mice being dark in 1,000 years. A survival advantage of 10% would cause the same change in the mouse population in only 100 years.</td></tr>
<tr><td>Adaptation</td><td></td><td>The video suggests that there are more dark-colored rock pocket mice on the dark lava flows than light-colored rock pocket mice. The same phenotype evolved in different groups of mice on different lava flows, and the genetic bases for these changes in phenotype are different.</td></tr>
</table>
</td>
<td>Display Slide 31. Investigation 1: Explaining Changes over Time (6 min)

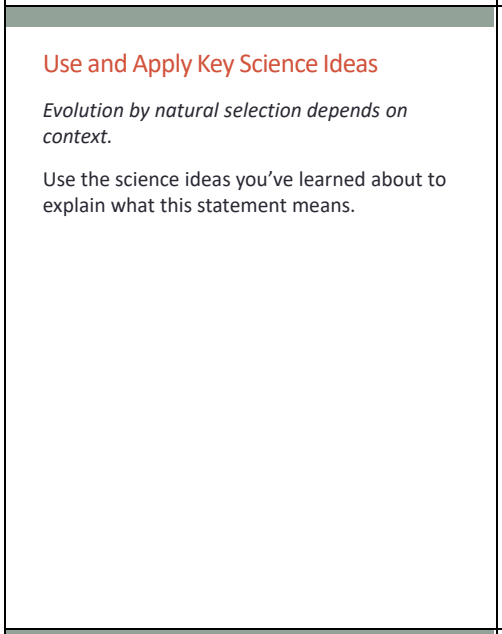
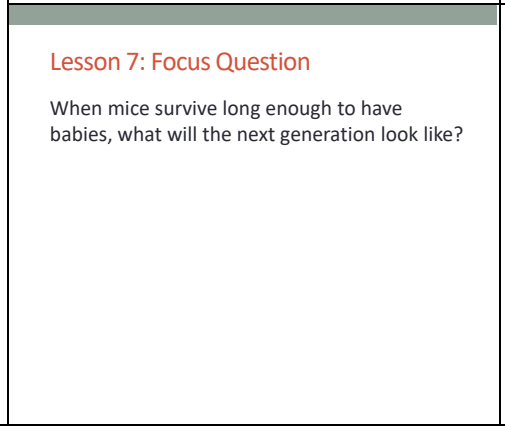
a. Review the evidence on the slide.

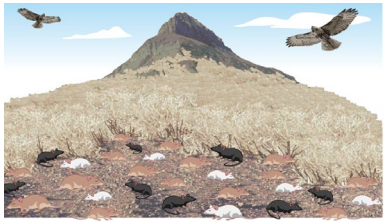
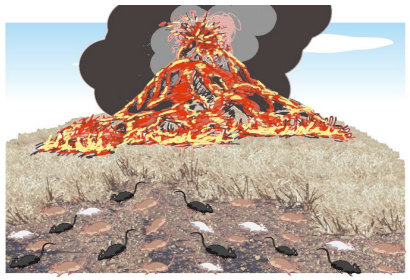
b. Individuals: Ask participants to compare the evidence on the slide with the evidence they recorded on their handouts and identify any information they didn’t consider in their own analyses.

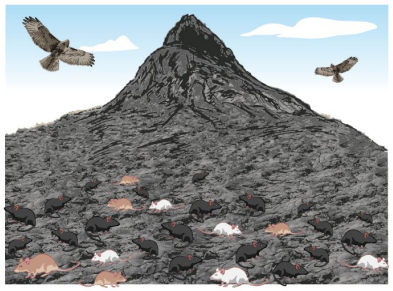
c. Whole group: “What evidence do you see on this table that you didn’t consider?”</td>
</tr>
</table>

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 32.** Investigation 2: Predator-Prey Simulation (15 min) **Note:** You should already have set up the "Predator and Prey" interactive in advance (see instructions on overview page). If you didn't log into the simulation earlier, do so now. a. Introduce the predator-and-prey simulation in the BSCS Across the Sciences online course. b. Ask participants to write the following information in their science notebooks: **Simulation 1:** Dark background; mouse fur color inherited; color variation present c. Select Option 1 in the simulation menu (click on the Change Options button) and have participants sketch the initial graph in their notebooks. d. Run the simulation for one round of hunting. Then direct participants to sketch the resulting graph in their notebooks. e. Run the simulation again for a second round of hunting and have participants sketch the resulting graph. f. Following the simulation, ask participants, "What claim can you make based on the data in the graphs? Make sure to include your evidence." g. "What do you think will happen if the mouse's environment changes? Let's find out!" h. Ask participants to write the following information in their science notebooks: **Simulation 2:** Light background; mouse fur color inherited; color variation present i. Select Option 2 in the simulation menu (light background) and have participants sketch the initial graph in their notebooks. Complete two rounds of

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			hunting and direct participants to sketch the resulting graphs in their notebooks. j. Then ask participants to make a claim supported with evidence from the graphs that answers the question, "What happens if the environment changes?"
		Investigation 2: Predator-Prey Simulation What would happen if the fur-color variation wasn't inherited or there was no variation in this trait at all?  	**Display Slide 33.** Investigation 2: Predator-Prey Simulation (10 min) a. "What would happen if the fur-color variation wasn't inherited or there was no variation in this trait at all? That's what we'll explore next." b. Select Option 3 (variation not inherited) and run the simulation again. c. Then select Option 4 (no variation) and run the simulation. d. Have participants add evidence from these simulations to the Natural-Selection Explanation Table (handout 3.11).
		Lines of Evidence for Evolution How do we know that evolution has occurred? 1. Fossil record 2. Structural similarities among organisms 3. Biogeography 4. Similarities among embryos different types of embryos 5. Similarities among DNA sequences of different organisms 6. Observations of evolutionary changes in the laboratory and in the wild	**Display Slide 34.** Lines of Evidence for Evolution (6 min) **Note:** Initially show only the question at the top of the slide. a. **Individuals:** "Now take out your content background documents and read the last four paragraphs of section 7, Natural Selection and Evolution. As you read, think about the lines of evidence that support the argument for change over time through natural selection." b. **Whole group:** Discuss the lines of evidence for change over time through natural selection presented in the reading and summarized on the slide. During this discussion, record participants'

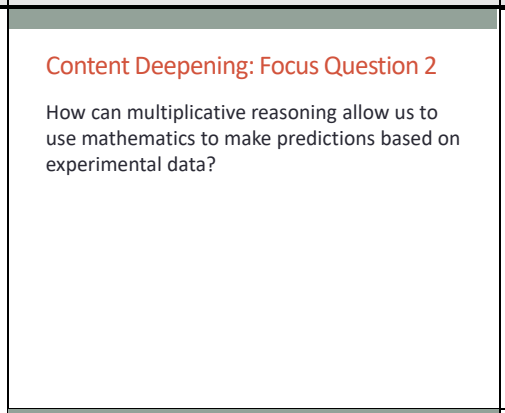
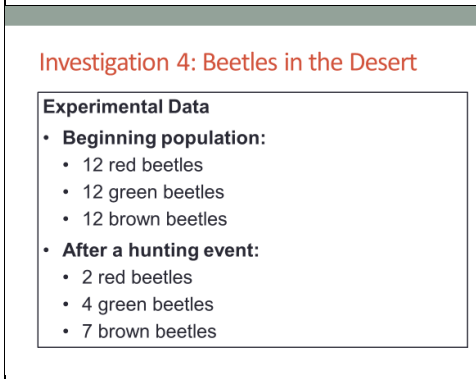
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			ideas on chart paper. **Note:** Reveal one line of evidence on the slide at a time as you present it.
			**Display Slide 35.** Use and Apply Key Science Ideas (7 min) a. Read the statement on the slide. b. **Individuals:** "Use the science ideas you've learned about to explain what this statement means. Write your explanations in your notebooks and make sure to include evidence and reasoning." c. **Whole group:** Invite participants to share their explanations, evidence, and reasoning with the group. Record participants' ideas on chart paper. **Key ideas:** • Natural selection is highly dependent on context. • A trait that works well in one environment may not work well in a different environment. This argues against evolution being goal directed and moving toward perfection.
			**Display Slide 36.** Lesson 7: Focus Question (Less than 1 min) a. "Next, we'll explore ideas about trait variation from lesson 7." b. Read the focus question on the slide.

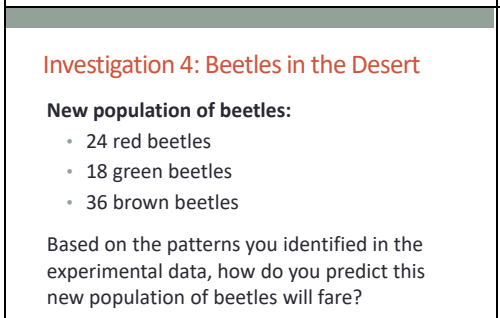
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Investigation 3: Mice in a Field  Which color variation (tan, white, or black) will help the mice survive best in this environment?	**Display Slide 37.** Investigation 3: Mice in a Field (5 min) a. Have participants locate the scope and sequence document in their lesson plans binders and review the main learning goal for VIT lessons 7a/b. b. "In a moment, I'll tell you a story about mice living in a field near a mountaintop. As you listen to the story, think about which variation in the mice's fur-color trait will give them a survival advantage in this environment. Jot down your ideas and key details about the story in your notebooks." c. Tell participants the first part of the story: A lot of mice lived in a field near the top of a mountain. Most of the mice were light brown, or tan, in color, but this trait varied. Other mice were black or white. Hawks were the mice's main predator. This means that the hawks liked to eat mice. As the hawks flew over the field, they would spot the mice and swoop down to catch them. Whenever a hawk caught a mouse, the hawk would eat it.
		Investigation 3: Mice in a Field 	**Display Slide 38.** Investigation 3: Mice in a Field (Less than 1 min) a. Tell participants the next part of the story: The mountain in our story was actually a volcano. One day the volcano erupted! Red-hot lava flowed out of the volcano and burned up all the trees and plants in its path. But the mice were able to run away and escape the lava. Weeks after the eruption, the ground was covered with lava that turned black as it hardened.

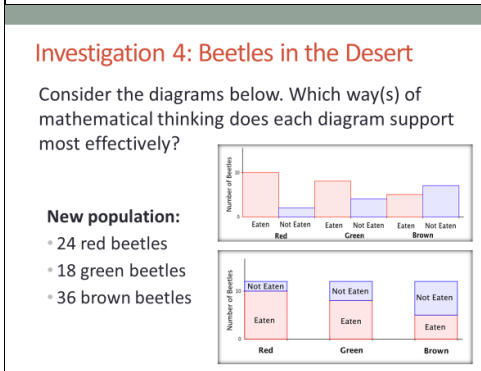
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Investigation 3: Mice in a Field 	**Display Slide 39.** Investigation 3: Mice in a Field (Less than 1 min) a. Tell participants the end of the story: A few years later, new plants started growing, and the ground was covered with seeds and nuts. Eventually, some of the mice came back looking for food. The hawks came back too, looking for mice to eat.
		Investigation 3: Mice in a Field *Which mice do you think are more likely to survive in the changed environment? Why do you think so?* Share your predictions and reasoning using this sentence starter: *I predict the [tan/white/black] mice are more likely to survive in the changed environment because _____.*	**Display Slide 40.** Investigation 3: Mice in a Field (3 min) a. Read the questions on the slide and invite participants to share their predictions using the sentence starter on the slide. b. Note that in the lesson, students share their predictions in a Turn and Talk before recording their ideas in their notebooks.

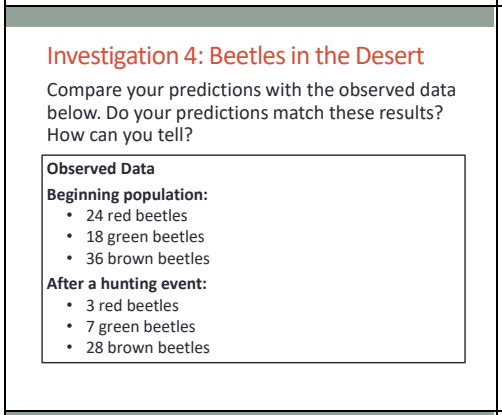
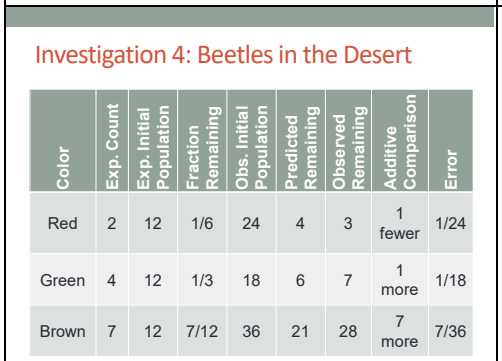
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Investigation 3: Mice in a Field **Lesson-7 focus question:** *When mice survive long enough to have babies, what will the next generation look like?* Share your predictions using this sentence starter: *I think the next generation of mice will have [tan/white/black] fur because _____.*	**Display Slide 41.** Investigation 3: Mice in a Field (7 min) a. Review the lesson-7 focus question on the slide and invite a few participants to share their predictions using the sentence starter on the slide. b. Distribute handout 4.8 (Cartoon Summary of Mice in a Lava Environment) and tell participants that in lessons 7a and 7b, students complete a cartoon summary for each environment. c. **Individuals:** Ask participants to complete the summary for the mice in the lava environment as a model student summary. d. **Whole group:** Invite participants to share their summaries and compare their ideas. **Note:** Alternatively, have participants share and compare their summaries with an elbow partner.
		Reflect: Content Deepening Focus Question 1 How would biologists explain how a trait changes within a population over time?	**Display Slide 42.** Reflect: Content Deepening Focus Question 1 (5 min) **Note:** If there isn't enough time for the writing activity, have a group discussion and highlight key ideas that answer the focus question. a. Revisit the first content deepening focus question and ask participants to write an answer in their science notebooks. Encourage them to use available resources (e.g., Natural Selection Explanation Table, content background document) as they work on this task. b. **Whole group:** Invite one or two participants to share their answers with the group.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Unit Central Question Do all of the mice living in the same environment, such as a field or forest, have an equal chance of surviving? Why or why not?	**Display Slide 43.** Unit Central Question (5 min) a. Revisit the unit central questions and ask participants to answer it in their science notebooks using evidence and reasoning to support their claims. b. Before having participants answer these questions, you may want to review key science ideas from this week's content deepening sessions.
		Analyze Strategy 6 1. Think about the mice simulation we conducted earlier. What made this a use-and-apply task? 2. How did this use-and-apply activity change your thinking about inheritance as a way of explaining changes in trait variation that occur over time in populations of living things?	**Display Slide 44.** Analyze Strategy 6 (5 min) a. Ask participants to think about the questions on the slide and record their ideas in their science notebooks. b. **Whole group:** Invite one or two participants to share their ideas with the group. **Ideal response to question 1:** • The mice simulation was a use-and-apply task because participants were introduced to the major concepts of natural selection in previous activities and had to use and apply what they learned to make sense of their observations in the simulation.
	10-MINUTE BREAK		

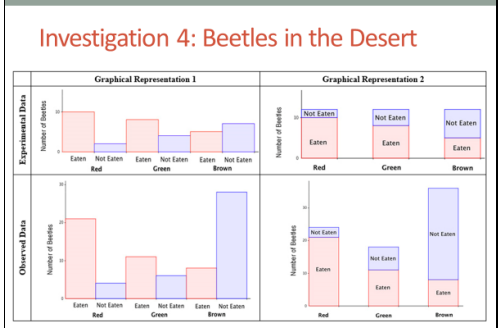
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 45.** Content Deepening: Focus Question 2 (Less than 1 min) a. Introduce the second content deepening focus question and ask participants to write it in their notebooks.
			**Display Slide 46.** Investigation 4: Beetles in the Desert (4 min) a. "In an earlier session, we conducted a simulation from VIT lesson 3 showing which colored beetles would have a better chance of surviving in a desert environment. We used a piece of fabric to represent the environment, and we used different-colored pom-poms to represent the beetles. We counted the number of beetles of each color before the hunting began and then counted again at the end. The starting population of beetles was exactly the same for each color. This setup enables students to explain the scenario without using multiple comparisons or fractions." b. Distribute handout 4.9 (Using Math to Make Predictions). c. "For today's math content deepening investigation, we'll use experimental data and results. So let's say we start off with 12 red beetles, 12 green beetles, and 12 brown beetles. After a hunting event, 2 red beetles, 4 green beetles, and 7 brown beetles have survived." d. Ask participants, "What patterns do you notice in this

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			data?" and record their observations on chart paper. e. **Highlight:** Many students will simply say that the number of red beetles is smaller than the number of green beetles, which is smaller than the number of brown beetles (2 < 4 < 7). This is a justifiable use of additive reasoning, but it's limited to scenarios in which all of the beetles have the same initial population.
			**Display Slide 47.** Investigation 4: Beetles in the Desert (7 min) a. "Let's say we have a new population of beetles comprised of 24 red beetles, 18 green beetles, and 36 brown beetles. Based on the patterns you identified in the experimental data, how do you predict this new population of beetles will fare?" b. **Individuals:** Have participants record their predictions and explanations on their handouts and answer the reflection question. c. **Whole group:** Invite participants to share their predictions and explanations, as well as their answers to the reflection question. Elicit at least two different ways of thinking about this question. Then highlight the explanations below. **Possible explanations:** 1. The initial red-beetle population doubled, so the number of beetles remaining should be double (i.e., 2(2) = 4 red beetles). The initial green-beetle population of 18 beetles is 1.5 times as large as the 12 beetles in the experimental population, so we expect the number of remaining beetles to be 1.5 times as large (i.e., 4(1.5) = 6 green beetles). The initial brown-beetle population of 36 is triple the experimental population of 12, so we anticipate the number of remaining beetles to be three times as many (i.e., 7(3) = 21 brown beetles). 2. One could consider the ratio of surviving beetles to

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			the initial population (S:IP) for each color of beetle. From the experimental data, the ratios are 2:12, 4:12, and 7:12 for red, green, and brown beetles, respectively. You can then scale up the ratios to equivalent ratios with the given initial populations of the new set, yielding 4:24, 6:18, and 21:36 for red, green, and brown beetles, respectively. 3. In the experimental data, 2/12 of the red beetles survived, so we expect (2/12) of the 24 red beetles to survive in the new population: (2/12) of 24 is 4. Likewise, 4/12 of the green beetles survived in the experimental data, so we expect (4/12) of 18 green beetles to survive in the new population: (4/12) of 18 is 6. Finally, 7/12 of the brown beetles survived in the experiment, so we expect (7/12) of 36 brown beetles to survive in the new population: (7/12) of 36 is 21.
			**Display Slide 48.** Beetles in the Desert (6 min) a. **Think-Pair-Share:** Give participants 1 or 2 minutes of think time to consider how they might use the diagrams on the slide to predict the number of surviving beetles in the new population. Then have them share their ideas with an elbow partner. b. **Whole group:** Invite participants to share their ideas with the group. Try to elicit a broad range of ideas and then highlight the ideas below. Note that these ideas reflect the explanations on the previous slide. **Possible responses:** 1. For the top graphic, envision doubling the size of the rectangles corresponding to red-beetle counts, scaling the rectangles for green-beetle counts to 1.5 times as large, and tripling the size of the rectangles for brown-beetle counts. 2. The ratio of surviving beetles to the initial population (S:IP) is less obvious in both graphics, since you have to take the additional step of imagining the combined red and blue rectangles for each color as

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			representing the initial population. 3. The bottom graphic lends itself to reasoning about fractions if we view the blue rectangle as some fractional part of the entire stacked rectangle.
			**Display Slide 49.** Investigation 4: Beetles in the Desert (5 min) a. **Think-Pair-Share:** Ask participants to compare their predictions with the observed data and answer the final questions on their handouts. Then have them pair up and share their responses with an elbow partner. b. **Whole group:** "What criteria did you use to determine whether your predictions matched the observed data?"
			**Display Slide 50.** Investigation 4: Beetles in the Desert (10 min) a. Walk participants through the data on the slide and make sure they understand what it shows. b. Ask, "What questions do you have about this table and what it shows?" **Note:** The "Additive Comparison" column indicates the surviving beetles observed relative to predictions. The "Error" column indicates by what fraction of the observed initial population the prediction was off. c. **Pairs:** Have participants work with an elbow partner to compare the accuracy of their predictions with the observed data and identify the specific criteria they're using in this analysis. Circulate as pairs work on this task and challenge them to be specific and mathematical in their analyses (i.e., go beyond a general assessment such as "The predictions were pretty good but not exactly correct").

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			d. **Whole group:** Discuss the results of participants' comparisons and the criteria they used in their analyses. e. Emphasize the following points during the group discussion: 1. An additive comparison of predicted results to observed counts for the red and green beetles suggests that the predictions were equally good: Each was off by 1 beetle (i.e., 4 red beetles predicted and 3 observed; 6 green beetles predicted and 7 observed). The difference for the red-beetle population was 1 out of 24, making it *less erroneous* than for the green population, which was a smaller population to start with. 2. Alternative comparisons not explicitly shown in the table: predicted 1/6 of the red-beetle population would survive, but only 1/8 did (red beetles did slightly worse than predicted). Likewise, predicted 1/3 of the green-beetle population would survive, and 7/18 did (green beetles did slightly better than predicted). Finally, predicted 7/12 of the brown-beetle population would survive, and a staggering 7/9 did. 3. If these results don't seem that impressive, introduce larger initial populations and observe the difference between 7/12 of 8,400 beetles (4,900) and 7/9 of 8,400 beetles (6,533).

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 51.** Investigation 4: Beetles in the Desert (10 min) a. Distribute handout 4.10 (Comparing Mathematical Visual Representations of the Problem). b. Point out that the first row shows two graphical representations of the *experimental* data and the second row shows two graphical representations of the *observed* data. c. Ask participants to brainstorm different ways to think about multiplicative comparisons. Then work together to fill in the first three blanks on the handout. **Answers:** (1) part-part comparison; (2a) part-whole comparison; (2b) part-part. d. **Pairs:** Have participants pair up and discuss how they can use the graphics on the handout to highlight three ways of thinking about multiplicative comparisons, or fractions: (1) part-whole; (2) division–relative size; (3) multiplication-scaling. e. **Whole group:** Invite pairs to share their ideas for answering the last question on the handout. **Ideal responses to question 3 on the handout:** • The graphics in the second column can be used readily to highlight the **part-whole** view of fractions, since we can "see" the whole (i.e., the total number of beetles of each color) and the part with the whole (i.e., beetles not eaten or eaten depending on which part of the scenario is in focus). • The graphics in the first column can be readily used to highlight a **division–relative-size** meaning for fractions. By comparing how large the blue bars are in relation to the red bars, we can describe fractions to capture the relative sizes of the number of beetles not eaten compared to the number of beetles eaten. For instance, in the *upper left-hand graph*, we see

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			the number of not-eaten red beetles is roughly 1/4 or 1/5 as large as the number of eaten red beetles. The number of not-eaten green beetles is half as large as the number of eaten green beetles. And the number of not-eaten brown beetles is roughly 4/3 as large as the number of eaten brown beetles. • To think about **multiplication-scaling**, we can look *across* the graphs. The scale on the vertical axis of the top row of graphs is different from the scale of the vertical axis on the bottom row of graphs, but we can still make comparisons. For instance, the number of eaten red beetles roughly doubles from the experimental data to the observed data. Likewise, the number of not-eaten red beetles roughly doubles from the experimental data to the observed data. So the fraction of red beetles that are eaten in experimental data is roughly the same as it is in the observed data. In contrast, the number of not-eaten brown beetles appears to more than triple from the experimental data to the observed data, while the number of eaten brown beetles doesn't scale by that large of a factor (i.e., the number of brown beetles eaten almost doubled from the experimental data to the observed data).
		Reflect: Content Deepening Focus Question 2 How can multiplicative reasoning allow us to use mathematics to make predictions based on experimental data?	**Display Slide 52.** Reflect: Content Deepening Focus Question 2 (5 min) a. Review the second content deepening focus question. b. **Individuals:** Have participants answer the question in their science notebooks using up to four complete sentences. c. **Whole group:** Invite participants to share their answers with the group. Make sure the following key ideas surface during the discussion: • Multiplicative reasoning is useful for making predictions based on given relationships

<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>between quantities (e.g., the number of beetles remaining relative to initial population of beetles).
• There are several ways of thinking about multiplicative comparisons (e.g., part-whole, part-part, relative size, scaling).
• Some graphics are more effective at highlighting different ways of thinking about multiplicative comparisons.</td></tr>
<tr><td rowspan="2">3:15–3:30

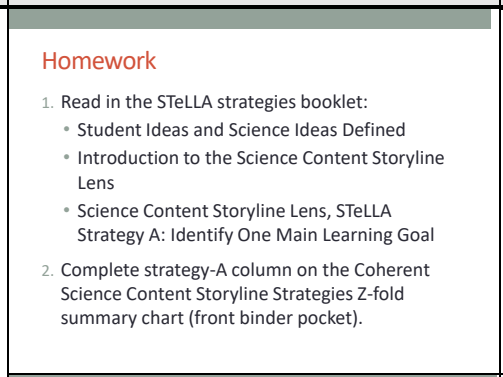
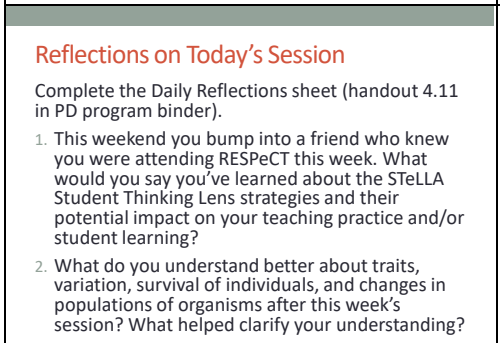
15 min

Wrap-Up: Summary, Homework, and Reflections

Slides 53–56</td><td rowspan="2">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
• 4.11 Daily Reflections—Day 4
Supplies
• Science notebooks</td><td>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 Variation in Traits lessons?
• How would biologists explain how a trait changes within a population over time?
• How can multiplicative reasoning allow us to use mathematics to make predictions based on experimental data?</td><td>Display Slide 53. 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.</td></tr>
<tr><td>Let's Summarize!
Lesson Analysis Strategy 6
• What new understandings did you develop?
• What do you still have questions about?
Lesson Plans Review
• What new insight(s) did you gain?
• What do you still have questions about?
Content Deepening
• What did you learn?
• What do you still have questions about?</td><td>Display Slide 54. 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.</td></tr>
</table>

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 55.** Homework (3 min) a. "Next week we'll focus on the Science Content Storyline Lens strategies and explore a new content area: forces. To prepare, complete the homework tasks on the slide." b. Make sure participants copy the assignment into their science notebooks.
			**Display Slide 56.** 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 4.11 in PD program binder).