RESPeCT Summer Institute Professional Development Leader Guide (PDLG)

Grade Level	3	**Day**	3	**STeLLA Strategy**	STL Strategy 4: Analyze and Interpret Data and Observations STL Strategy 5: Construct Explanations and Arguments	**Subject Matter Focus**	Variation in Traits (VIT)
Focus Questions	• How can analyzing data and constructing explanations help students *move forward* toward deeper understandings of science ideas? • How can we design experiments to test for genetic and environmental causes of trait variation? • How would biologists explain how a trait changes within a population over time?						
Main Learning Goals	Participants will understand the following: • In addition to challenge questions, the Student Thinking Lens (STL) strategies include activities that move student thinking forward toward more-scientific understandings. • STL strategies 4 and 5 are two activities that can be used to move student thinking forward: Engage students in analyzing and interpreting data and observations (strategy 4), and engage students in constructing explanations and arguments (strategy 5). • Analyzing and interpreting go beyond making observations to organizing data, identifying patterns and looking for meaning in the data, and searching for relationships between science ideas and data. • Constructing explanations involves making a claim, supporting the claim with evidence and reasoning, and coming up with alternatives that challenge the claim (argumentation). • Organisms inherit many traits from their parents. • 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. • Trait variations in sexually reproducing organisms occur as a result of random mutations. • 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.						

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.	**Posters and Charts** • STeLLA Framework and Strategies poster • Day-3 Agenda (chart) • Day-3 Focus Questions (chart) • Norms for Working Together (chart) • Effective Science Teaching chart (from day 1) • Strategy charts from days 1 and 2 (STL strategies 1–3) • Parking Lot poster **Handouts in RESPeCT PD Binder Front Pocket**	• Video Clip 3.1: Wilde classroom (analyze and interpret, strategy 4); 3.1_mspcp_gr.3 .variations. traits_wilde_L5_c1 • Video Clip 3.2: Wilde classroom (construct explanations and arguments, strategy 5); 3.2_mspcp_gr.3.variations.traits_wilde_L4 _c1–3 • Video Clip 3.3: Wilde classroom—optional alternative to replace Video Clip 3.2 (analyze and interpret, strategy 4; construct

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 2 and create a summary slide.
- Watch video clips and anticipate participant responses.
- Prepare charts for the day's agenda and focus questions.
- Review the activities for Variation in Traits lessons 6a/b in the lesson plans binder.
- For content deepening:
  - Download or prepare to stream the short film *The Making of the Fittest: Natural Selection and Adaptation* from http://www.hhmi.org/biointeractive/making-fittest-natural-selection-and-adaptation.
  - To access handout 3.9 (Increasing Seeds spreadsheet), you'll need to use Microsoft Excel.

- Z-fold summary chart: Student Thinking Lens Strategies

Handouts in RESPeCT PD Binder, Day 3

- 3.1 Quick Reference Tools for Strategies 4 and 5
- 3.2 Practice Identifying Strategies 4 and 5 in Student Work
- 3.3 Transcript for Video Clip 3.1
- 3.4 Transcript for Video Clip 3.2
- 3.5 Transcript for Video Clip 3.3 (optional alternative to replace Video Clip 3.2)
- 3.6 Novelty-Seeking-Behavior Survey
- 3.7 Mouse Traits (1 per pair) (from VIT lesson 6a)
- 3.8 Counting Seeds (1 per pair)
- 3.9 Increasing Seeds (Excel spreadsheet)
- 3.10 Developing an Explanation for Mouse Fur Color
- 3.11 Natural Selection Explanation Table
- 3.12 Daily Reflections—Day 3

PD Leader Masters, Days 1–4

- PD Leader Master: Practice Identifying Strategies 4 and 5 in Student Work

Supplies

- Science notebooks
- Chart paper and markers
- Lesson materials kit
- For content deepening:
  - Apples (1 per pair)
  - 1 paring knife
  - 10 napkins or paper towels

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

explanations and arguments, strategy 5); 3.3_alternative_ mspcp_gr.3 .variations. traits_wilde_L6_c3–4

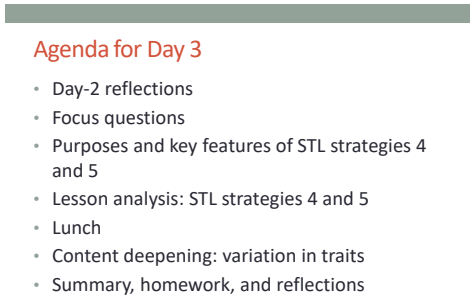
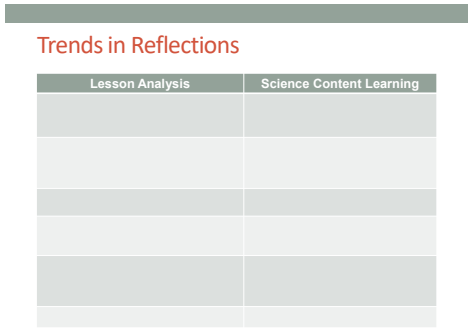
For content deepening:

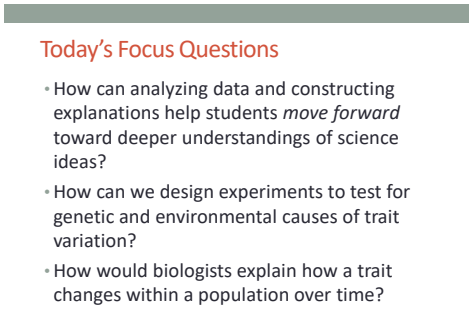
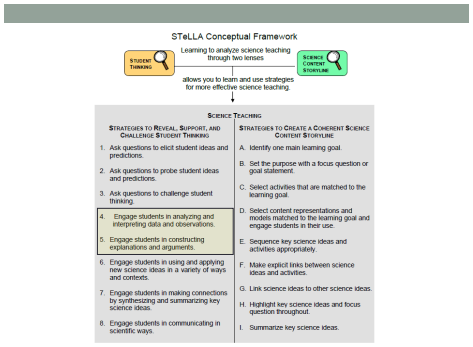
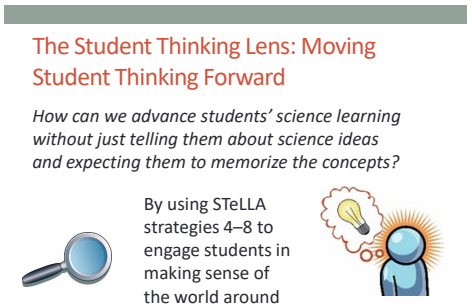
- *The Making of the Fittest: Natural Selection and Adaptation* (video download); http://www.hhmi.org/biointeractive/making-fittest-natural-selection-and-adaptation

DAY 3 SESSION OUTLINE

Time	Activities	Purpose
8:00–8:35 35 min	**Getting Started: Housekeeping, Agenda, Day-2 Reflections, Focus Questions, STL Strategies**	• Build community by sharing participants' reflections from day 2. • Set the stage for a day of learning. • Emphasize the theme for the rest of the week: What do we do with the ideas we've elicited from students? How do we help them change and advance their understandings of science concepts?
8:35–9:35 60 min	**Introducing Student Thinking Lens (STL) Strategies 4 and 5**	• Develop an initial understanding of strategy 4: Engage students in analyzing and interpreting data and observations. • Develop an initial understanding of strategy 5: Engage students in constructing explanations and arguments. • Examine the relationships among the science practices of observing, analyzing and interpreting, and constructing explanations and arguments.
9:35–12:00 145 min (Includes 10-min break)	**Lesson Analysis: STL Strategies 4 and 5**	• Use lesson analysis of classroom videos to better understand strategies 4 and 5, how they're related, and how they can challenge student thinking to move forward. • Deepen science-content knowledge of variation in traits through lesson analysis.
12:00–12:45 45 min	**LUNCH**	
12:45–3:15 150 min (Includes 10-min break)	**Content Deepening: Variation in Traits**	• Deepen participants' understandings of trait variation and the process of natural selection. • Develop understandings of scientific methods used to determine whether variation in traits is caused by genetics and/or the environment. • Explore the evidence biologists collect to support the argument that traits evolve because of natural selection.
3:15–3:30 15 min	**Wrap-Up: Summary, Homework, and Reflections**	• Reflect on the day's learning and summarize key ideas about the science content and strategies 4 and 5, linking those ideas to participants' images of effective science teaching and changes they want to make in their individual teaching practices.

DAY 3

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
8:00–8:35 35 min **Getting Started** Slides 1–8	**Purpose** • Build community by sharing participants' reflections from day 2. • Set the stage for a day of learning. • Emphasize the theme for the rest of the week: What do we do with the ideas we've elicited from students? How do we help them change and advance their understandings of science concepts? **Content** • Student Thinking Lens (STL) strategies reveal student thinking (elicit and probe strategies) and challenge student thinking (the rest of the strategies). • STL strategies are divided into questions (elicit, probe, and challenge) and activities. • A variety of strategies can be used to move student thinking forward. Today's focus is STL strategy 4 (Engage students in analyzing and interpreting data and observations) and strategy 5 (Engage students in constructing explanations and arguments). **What Participants Do** • Discuss the reflections from day 2. • Listen to an overview of the agenda, the focus questions, and the theme for the day and the rest of the week: *moving student thinking forward*.		**Display Slide 1.** RESPeCT PD Program (5 min) a. Take care of any housekeeping issues.
			**Display Slide 2.** Agenda for Day 3 (2 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 2 and offer reactions, comments, or follow-up questions. b. **Optional:** Give participants an opportunity to refine the norms for working together.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	• Review Summary of STeLLA Student Thinking Lens Strategies in the STeLLA strategies booklet and recognize two patterns: 1. Some strategies are designed only to reveal student thinking (strategies 1 and 2), while most are also designed to challenge student thinking. 2. The Student Thinking Lens includes three questioning strategies and five activity strategies. **Posters and Charts** • STeLLA Framework and Strategies poster • Day-3 Agenda (chart) • Day-3 Focus Questions (chart) • Strategy charts from day 1 (STL strategies 1–3) **PD Resources** • STeLLA strategies booklet		**Display Slide 4.** Today's Focus Questions (2 min) a. Introduce the focus questions that will guide today's session. b. "The words *moving forward* are in bold on the slide because that's our theme for today and the rest of the week. Yesterday we practiced asking elicit and probe questions, which are great for revealing student ideas. But what do we do with those ideas once we've elicited them? How do we support students in moving forward toward deeper understandings of science ideas?"
			**Display Slide 5.** STeLLA Conceptual Framework (1 min) a. Point out the strategies highlighted on the slide. b. "We'll continue working on understanding and using the Student Thinking Lens *questioning* strategies, but today we'll focus on two closely related *activity* strategies. Strategy 4 engages students in analyzing and interpreting data and observations, and strategy 5 engages students in constructing explanations and arguments."
			**Display Slide 6.** The Student Thinking Lens: Moving Student Thinking Forward (10 min) a. Initially, reveal **only** the question on the slide. b. Have participants think about the question for a minute; then open up a brief conversation about it. c. Ask the following questions to stimulate discussion if participants are struggling: • What was your experience as a science

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			student in school or college? • How were you expected to learn science ideas? What learning methods were used? • Did you ever have the opportunity in science classes to make sense of the experiments you performed (instead of just recording the correct answers in a lab report)? • Did science teachers ever support your learning in ways that went beyond merely having you take lecture notes, read from a textbook, or record the correct answers in lab reports? d. After discussing the questions, reveal the second part of the slide and emphasize the following points: • "Strategies 4 and 5 (as well as 6, 7, and 8) are designed to move student thinking forward by engaging students in sensemaking as they observe data. Rather than just spoon-feeding students science content to read or memorize, these activities lead them toward deeper understandings of science ideas as they construct meaning from evidence." • "Telling students about science ideas is important, but teachers tend to tell students too much. Instead of doing the hard cognitive work for them, we need to create more opportunities for students to do the thinking and sensemaking *themselves* so they can truly understand the science concepts. So don't be in such a hurry to tell students the right answers. **Slow down and give them a chance to think!**"

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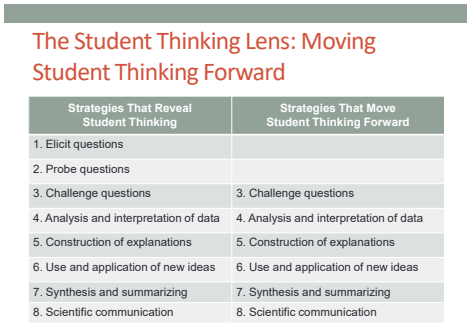
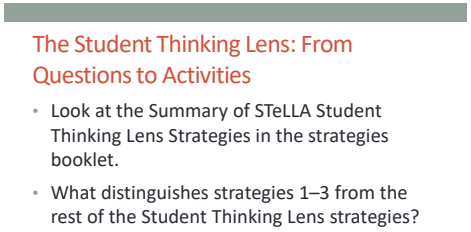
			**Display Slide 7.** The Student Thinking Lens: Moving Student Thinking Forward (5 min) a. Have participants look at the slide representation of the Student Thinking Lens strategies. b. **Ask:** "What do you notice?" **Key ideas:** • Elicit and probe questions are designed *only* to reveal student thinking, not to challenge it. • The rest of the strategies reveal *and* challenge student thinking.
			**Display Slide 8.** The Student Thinking Lens: From Questions to Activities (5 min) a. **Individuals:** Have participants briefly examine the summary chart of STL strategies in the STeLLA strategies booklet (Summary of STeLLA Student Thinking Lens Strategies). **Note:** Direct participants to the correct page in the strategies booklet or have them consult the table of contents. b. **Whole group:** "How are the first three strategies different from the rest?" **Key ideas:** • Strategies 1–3 are questions; the rest are activities. • Probe and challenge questions can and should be asked during all types of activities.

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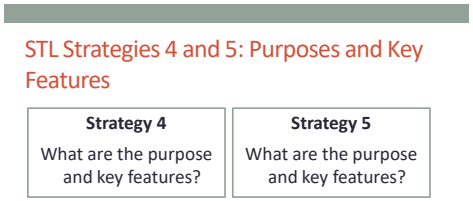
8:35–9:35 60 min **Introducing Student Thinking Lens (STL) Strategies 4 and 5** Slides 9–11	**Purpose** • Develop an initial understanding of strategy 4: Engage students in analyzing and interpreting data and observations. • Develop an initial understanding of strategy 5: Engage students in constructing explanations and arguments. • Examine the relationships among the science practices of observing, analyzing and interpreting, and constructing explanations and arguments. **Content** • STL strategy 4 engages students in analyzing and interpreting data and observations. Activities involve organizing data and/or observations, identifying patterns, and looking for meaning in the data. • STL strategy 5 engages students in constructing explanations and arguments. Activities involve using logical thinking, evidence, and science ideas to construct explanations of scientific data or observed phenomena, as well as critiquing proposed explanations using scientific argumentation. **What Participants Do** • Create and discuss strategy charts summarizing the purposes and key features of strategies 4 and 5. • Discuss the differences and relationships among observing,		**Display Slide 9.** STL Strategies 4 and 5: Purposes and Key Features (30 min) a. **Small groups (12 min):** Divide participants into two groups and assign one strategy to each group. Have one group create a chart listing the purpose and key features of strategy 4, and have the other group chart the purpose and key features of strategy 5. Each group should be prepared to answer the discussion question for the assigned strategy. b. **Whole-group share-out (18 min):** Have groups report on the purpose and key features of each strategy. **Key ideas:** • Strategy 4 involves activities that engage students in organizing their data and/or observations and looking for patterns and meaning in them. They aren't just "doing" activities or describing their observations. • Strategy 5 engages students in learning how to use logical thinking, evidence, and science ideas to construct explanations of scientific data or phenomena they have observed. It also engages them in critiquing various proposed explanations through scientific argumentation. • Remind participants that these strategies are closely related and will overlap in some activities. However, each has a specific purpose and unique attributes.

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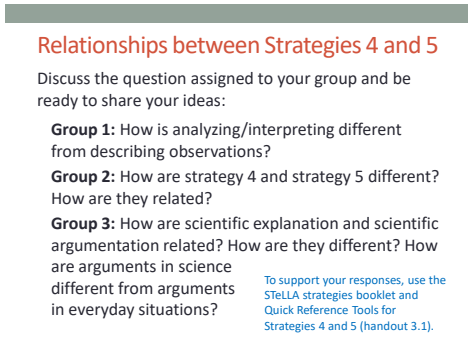
	analyzing and interpreting, and constructing explanations and arguments. • Use written scenarios to practice identifying instances of observing, analyzing and interpreting, and constructing explanations and arguments. **Handouts in PD Binder** • 3.1 Quick Reference Tools for Strategies 4 and 5 • 3.2 Practice Identifying Strategies 4 and 5 **PD Leader Masters** • PD Leader Master: Practice Identifying Strategies 4 and 5 **Supplies** • Chart paper and markers **PD Resources** • STeLLA strategies booklet		**Display Slide 10.** Relationships between Strategies 4 and 5 (15 min) a. **Small groups (5 min):** Divide participants into three small groups or pairs. Assign each group one question to discuss and tell participants to be ready to share their ideas with the entire group. b. **Emphasize:** Participants should use the STeLLA strategies booklet and Quick Reference Tools for Strategies 4 and 5 (PD handout 3.1) to support their responses. c. **Whole-group share-out (10 min):** • "What did you come up with for the first question?" • **Key ideas for question 1:** Analysis and interpretation involve moving beyond simply describing observations to *doing* something with the data, including (but not limited to) making comparisons, identifying relationships, and organizing data in ways that will reveal patterns (such as using charts, diagrams, and graphs). • "What did you come up with for the second question?" • **Key ideas for question 2:** Strategy 4 lays the groundwork for strategy 5. Before we can build a scientific explanation for a specific phenomenon, we need to make some observations, analyze the data to reveal patterns, and organize the data to gather the necessary evidence to support construction of a scientific explanation. A scientific explanation includes a claim that answers the question being studied, evidence that supports the claim, and reasoning that links the claim to the evidence and to science ideas.

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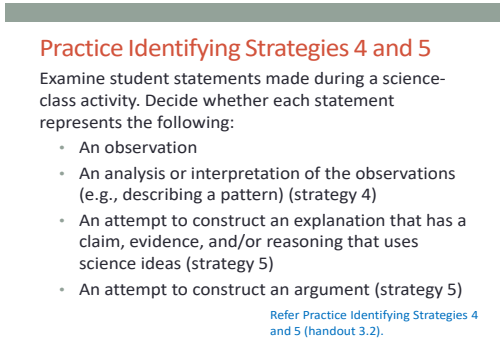
			• "What did you come up with for the third question?" **Key ideas for question 3:** A scientific explanation includes a claim that answers the question being studied, evidence that supports the claim, and reasoning that links the claim to the evidence and to science ideas. Scientific arguments involve assessing the strength and quality of the evidence and reasoning in different scientific explanations for the same observations and determining which proposed explanation has the best supporting evidence, science ideas, and reasoning.
			**Display Slide 11.** Practice Identifying Strategies 4 and 5 (15 min) a. "Before we view classroom video clips to identify and analyze strategies 4 and 5, we're going to practice identifying observations, analyses, interpretations, explanations, and arguments from a handout of student statements. Learning to distinguish which strategy students are using in these examples will help us when we review the classroom videos, where the strategies aren't always as clear cut." b. Refer participants to handout 3.2 in their PD program binders (Practice Identifying Strategies 4 and 5). c. **Pairs:** Have participants work in pairs to analyze student statements in the handout. d. **Whole group:** As participants discuss and clarify their analyses of the student statements, encourage them to refer frequently to the STeLLA strategies booklet and the Quick Reference Tools handout (PD handout 3.1).

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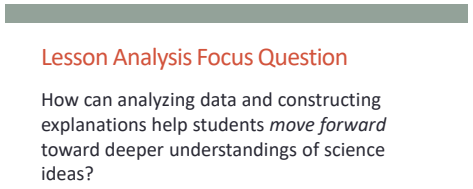
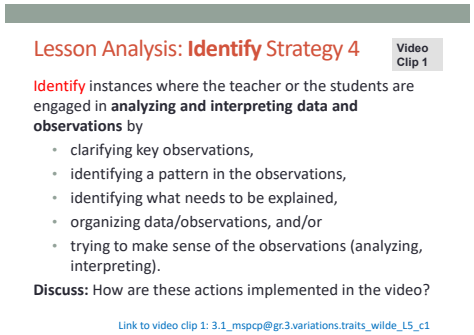
			Note: For examples of ideal participant responses, see PD Leader Master: Practice Identifying Strategies 4 and 5.
9:35–12:00 145 min (Includes 10-min break) **Lesson Analysis: STL Strategies 4 and 5** Slides 12–22	**Purpose** • Use lesson analysis of classroom videos to better understand strategies 4 and 5, how they're related, and how they can challenge student thinking to move forward. • Deepen science-content knowledge of variation in traits through lesson analysis. **Content** • STL strategy 4 engages students in analyzing and interpreting data and observations. Activities involve organizing data and/or observations, identifying patterns, and looking for meaning in the data. • STL strategy 5 engages students in constructing explanations and arguments. Activities involve using logical thinking, evidence, and science ideas to construct explanations of scientific data or observed phenomena, as well as critiquing proposed explanations using scientific argumentation. **What Participants Do** • Watch one classroom video clip to identify strategy 4 and analyze		**Display Slide 12.** Lesson Analysis Focus Question (Less than 1 min) a. Review the focus question that will guide today's lesson analysis work.
			**Display Slide 13.** Lesson Analysis: Review Lesson Context, Video Clip 1 (2 min) a. "Now let's see if we can recognize students analyzing and interpreting data in a classroom video clip." b. Review the lesson context at the top of the transcript for video clip 1 (handout 3.3 in PD binder), making sure participants understand both the content and activity in focus. c. "In this clip, students compare data on colored pom-pom beetles that survive in different environment simulations."

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	student thinking that this strategy reveals and challenges. • Examine transcript excerpts in the STeLLA strategies booklet for practice identifying strategies 4 and 5. • Watch a second classroom video clip to identify strategy 5 and analyze student thinking that this strategy reveals and challenges. • Summarize key ideas about the relationships between strategies 4 and 5. **Videos** • Video Clip 3.1, Wilde classroom • Video Clip 3.2, Wilde classroom **Handouts in PD Binder** • 3.1 Quick Reference Tools for Strategies 4 and 5 • 3.3 Transcript for Video Clip 3.1 • 3.4 Transcript for Video Clip 3.2 • 3.5 Transcript for Video Clip 3.3 (optional alternative for clip 2) **PD Resources** • STeLLA strategies booklet		**Display Slide 14.** Lesson Analysis: Identify Strategy 4, Video Clip 1 (25 min) a. "As we watch the video clip, we'll identify actions that illustrate strategy 4. Be on the lookout for instances where the teacher or the students do something listed on the slide. That's what we'll discuss first." b. Show the video clip. c. **Individuals:** "Think about the strategy 4 actions listed on the slide." d. **Whole group:** "Discuss the question on the slide. Make sure to support your claims with evidence from the video transcript." **Observations:** • At video segments 00:00:00–00:00:18; 00:01:16; 00:01:50; and 00:02:18, the teacher clarifies key observations by comparing the numbers of beetles of certain colors that survived in different environments. • At segments 00:00:32; 00:01:16; and 00:02:27, when the teacher asks, "What does that say?" or "What does that tell us?" she challenges students to begin making sense of the data. • To identify what needs to be explained, the teacher asks students to compare the numbers of beetles of different colors that survived in different environments (segments 00:00:32; 00:01:16; and 00:02:27). • The teacher also highlights what needs to be emphasized in this simulation by asking, "Why does a different piece of fabric mean that different beetles would get eaten?" (segment 00:02:42) and "Why do different fabrics mean different beetles are eaten?" (segments 00:03:14 and 00:03:28). • The teacher tries to guide students toward a

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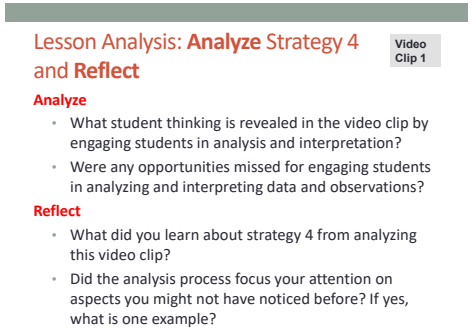
			scientific understanding when she says, "Good deal" (segment 00:01:40) after a student offers a scientifically accurate interpretation by saying that the blue beetles are better camouflaged in the rocky environment. The teacher clearly states that she expected more green beetles to survive in the green environment than in the rocky environment (segments 00:01:50–00:02:08) and expresses her surprise that no black beetles survived in the rocky environment (segment 00:02:18). However, she doesn't engage students in discussing these unexpected results. Perhaps she thought it might distract them from developing the intended understandings. She also highlighted that Savannah provided a good summary explanation for why the fabric colors mattered (segment 00:03:14).
			**Display Slide 15.** Lesson Analysis: Analyze Strategy 4 and Reflect, Video Clip 1 (25 min) a. **Individuals:** "For the first analysis question on the slide, study the transcript for video clip 1 and come up with a claim, evidence, and reasoning to support your claim. For the second analysis question, consider alternative moves the teacher could have made as you identify missed opportunities." b. **Whole group:** After participants have shared their analyses, ask, "Were there any missed opportunities for engaging students in analyzing and interpreting data?" c. **Reflect:** Discuss the reflection questions on the slide, making sure participants share specifically what they learned about strategy 4. **Possible responses:** • *Student thinking revealed:*

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			• **Claim:** Students make a clear connection between the beetles' ability to blend into their environment and the number of beetles that survived. • **Evidence:** Students observe that certain colors "popped out more" or "blended in more" (video segments 00:00:44–00:00:58; 00:04:47). Some students use the word *camouflage* to describe the results (segments 00:01:32; 00:03:36). Savannah explains how beetles of specific colors "might last a little longer" when they're in the same color environment (segments 00:02:53–00:02:59). Students are even able to reason that what they expected to see (based on colors that pop out or blend in) differed from what actually happened (segments 00:04:01–00:04:42). On student suggests a possible reason for unexpected results: "Sometimes people just have really good vision" (00:03:36). • *Missed opportunity:* Although both the teacher and students comment on the unexpected results in the numbers of green and black beetles that survive in the different environments, no one attempts to explain why this occurred. This is a missed opportunity to make sense of the actual data and seems to sweep away or ignore data that doesn't fit the expected pattern.

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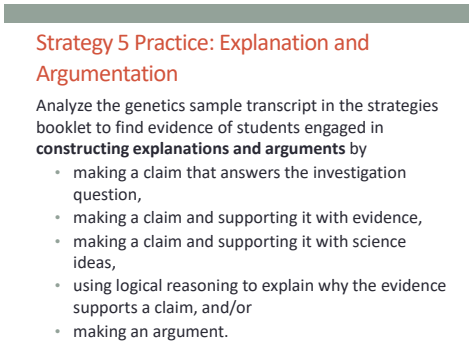
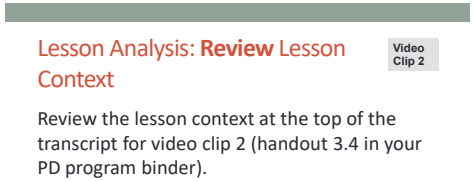
			**Display Slide 16.** Strategy 5 Practice: Explanation and Argumentation (10 min) a. "Strategy 5 is the focus of the next video clip, although you may also see evidence of strategy 4 being used." b. Have participants analyze the transcript example (under "About Weather" in the strategy 5 chapter) in the STeLLA strategies booklet and look for evidence of students engaging in constructing explanations and arguments. **Note:** This is an important activity, but it can be cut if time is short. c. "Before we view another classroom video, let's practice analyzing the example of strategy 5 in the STeLLA strategies booklet. This example comes from a kindergarten lesson on weather. Read the sample transcript in the 'About Weather' section and see if you can find any evidence of the teacher engaging students in constructing explanations and arguments. Refer to the action list on the slide for guidance." **Note:** Emphasize that although the subject matter is different, the purpose of the task is to deepen participants' understandings of how students can engage in different aspects of strategy 5. d. **Individual work time (5 min).** e. **Whole-group share-out:** Have participants share evidence from the transcript of students engaging in strategy 5, noting the specific action illustrated from the list on the slide. **Possible responses:** • Students in the sample transcript demonstrate (a) making a claim, (b) supporting the claim with

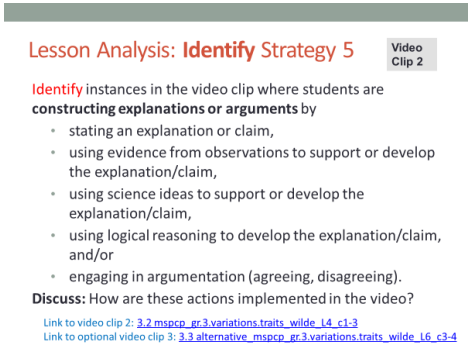
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process

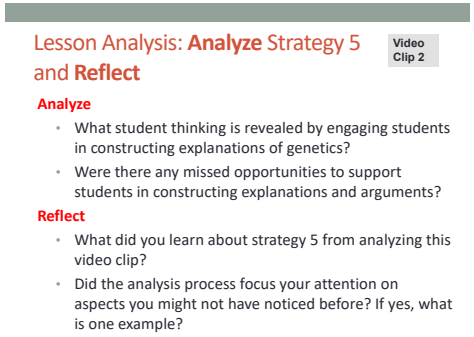
			evidence, (c) using logical reasoning to support the claim, or (d) engaging in argumentation. (**Note:** Students aren't yet using science ideas to support their claims, since this comes later in the lesson sequence.)
			
			• **Student 1:**
			  • **Claim:** "I think our place is sunnier than Place B."
			  • **Evidence:** "Our place has more sunny days than cloudy days.… There were 18 sunny days this month and only five cloudy days."
			• **Student 2:**
			  • **Claim:** "Our weather is mostly sunny, [but] Place B isn't sunny at all."
			  • **Evidence:** "Because 18 is more than five, so that means it's sunny.… Almost all [of Place B's] days are cloudy."
			• **Student 3:**
			  • **Claim:** "Weather isn't the same everywhere."
			  • **Evidence:** "We found out about weather differences in these two places.… We have more sunny days than Place B."
			  • **Logical reasoning:** "There must be some difference between Pomona and Place B.… Maybe Place B is at a higher altitude, because we learned that it's cooler at higher altitudes. Maybe it's cooler because it's cloudy."
			• **Student 4:**
			  • **Argument:** "I agree with [S3's] idea that maybe Place B is at a higher altitude."
			  • **Evidence:** "I sometimes see clouds covering up Mount Baldy when it's sunny down here."
			• **Student 5:**
			  • **Argument:** "Place B could be cloudy for another reason."
			  • **Logical reasoning:** "Maybe it's more polluted in Place B. Pollution causes smog."
			• **Student 6:**

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

			• **Argument and evidence:** "But it's really polluted here, and we have a lot of sunny days."
			• **Student 2:**
			  • **Argument:** "I agree with S3 that weather isn't the same everywhere, and I agree with his evidence. But I have a different reason."
			  • **Evidence:** "We went to San Francisco, and it was, like, cloudy and foggy every morning."
			  • **Logical reasoning:** "I think it was because it was right next to the ocean."

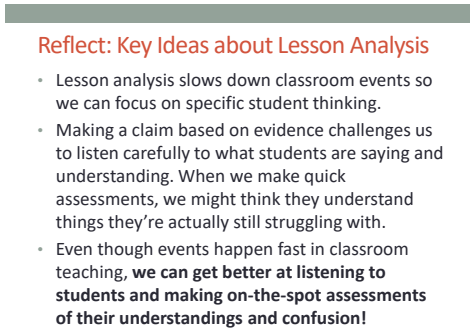
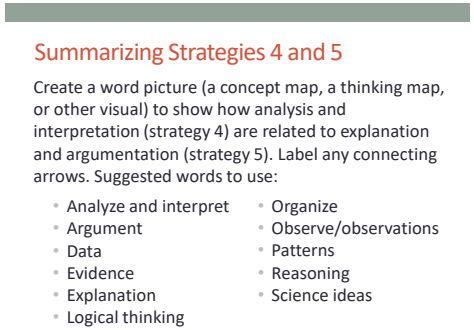
	10-MINUTE BREAK		
			**Display Slide 17.** Lesson Analysis: Review Lesson Context, Video Clip 2 (1 min) a. "Now we're going to look at another video clip and focus on identifying strategy 5: Engage students in constructing explanations and arguments." b. Read the context of the lesson at the top of the transcript for video clip 2 (handout 3.4 in the PD program binder). **Note:** If you decide to replace Video Clip 3.2 with Video Clip 3.3, have participants use handout 3.5 (Transcript for Video Clip 3.3).

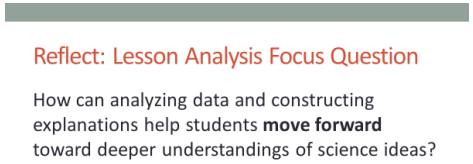
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 18.** Lesson Analysis: Identify Strategy 5, Video Clip 2 (25 min) a. "As you watch the video clip, identify instances where students are engaged in constructing explanations and arguments (strategy 5). You might notice examples of strategy 4 (analyzing and interpreting data), but focus on identifying strategy 5. Also notice the kinds of questions the teacher asks (elicit, probe, or challenge)." b. Before showing the video clip, read the list of actions on the slide. c. **Individuals:** "Think about the strategy 5 actions listed on the slide." d. **Whole group:** "Discuss the question on the slide. Make sure to support your claims with evidence from the video transcript." e. **Emphasize:** "Strategy 5 is designed to help move student thinking forward toward deeper understandings of science ideas, so we should see challenge questions as well as probe questions in the video clip." **Observations:** • At video segments 00:00:52; 00:01:02; and 00:01:19, students make claims and give reasoning related to camouflage (a science idea). • At segments 00:01:36 and 00:02:26, students make claims, but their reasoning is unclear. Perhaps they don't understand the camouflage idea? • At segments 00:01:19 and 00:01:47, two students make claims and provide reasoning related to camouflage (a science idea), as well as logical reasoning and examples. The first student compares green beetles blending in with the grass

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			and black beetles blending with the desert (00:01:19), and the second student uses apples and bananas as examples of how the red and yellow beetles might blend in (00:02:02). • At segment 00:03:03, a student makes a claim that color affects whether beetles get eaten and supports the claim with evidence from the simulation activity showing how many beetles survived (segment 00:03:11).
			**Display Slide 19.** Lesson Analysis: Analyze Strategy 5 and Reflect, Video Clip 2 (25 min) a. **Individuals:** "For the first analysis question on the slide, study the video transcript and come up with a claim, evidence, and reasoning to support your claim. For the second analysis question, consider alternative moves the teacher could have made as you identify any missed opportunities." b. **Whole group:** After participants have shared their analyses, ask, "Were there any missed opportunities for engaging students in constructing explanations and arguments?" c. **Reflect:** Discuss the reflection questions on the slide, making sure participants share specifically what they learned about strategy 5. **Possible responses:** • **Claim:** Students understand the idea that camouflaged animals have a survival advantage in their environment, but they struggle to support that claim with evidence. • **Evidence:** At video segments 00:00:52; 00:01:02; and 00:01:19, students share their claims that color variations among the beetles matter. Their evidence and reasoning are that some beetles blend into their environments better than others.

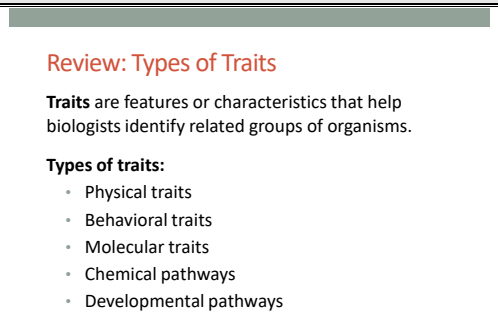
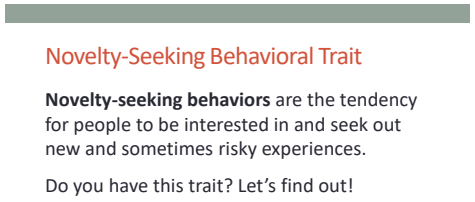
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process

			They don't explicitly give evidence indicating that fewer beetles that blend in get eaten, nor do they provide evidence from the simulation, even when the teacher prompts them to do so: "OK, let's try and be using some of the evidence that we saw as well" (segment 00:01:09). The only student who refers to data from the simulation is the girl in the third segment (2c). During this exchange with the teacher, she finally provides evidence: "Maybe how many [beetles] survived or not" (segment 00:03:11).
			• **Reasoning:** Students in this clip don't supply evidence unless the teacher asks questions that provide significant scaffolding. In the third video segment (2c), after the teacher asks specifically whether color affects whether beetles get eaten (segments 00:02:46–00:02:57 and 00:03:04), a student finally suggests a connection between the simulation observations and her claim, but this happened only after the teacher pointed at the data table and asked, "What here is showing you that?" (segment 00:03:04).
			• **Alternatives:** Overall, these clips suggest that students need more opportunities to support their claims with evidence so they develop a habit of always looking for data to support their claims.
			• **Missed opportunities:**
			  • The teacher could have probed student thinking at segment 00:03:11 by saying, "Tell me more about that." This would have engaged the student in making connections to the data without requiring the teacher to lead the student toward the supporting evidence.
			  • At segments 00:00:52; 00:01:02; and 00:01:19, the teacher could have asked the challenge question, "How do you know that?" This might have pushed students to consider the simulation data.

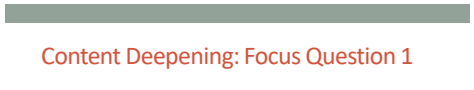
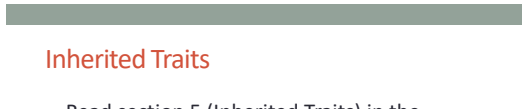
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 20.** Reflect: Key Ideas about Lesson Analysis (2 min) a. "Let's reflect on some key ideas you can take away from your lesson analysis experiences. These ideas may not reflect your personal experiences with lesson analysis so far, but hopefully you'll see their value in the lesson analysis process over time." b. Read the key ideas on the slide. c. Ask participants for their reactions to these ideas.
			**Display Slide 21.** Summarizing Strategies 4 and 5 (15 min) **Note:** Skip this activity if time is short. a. **Individuals:** To summarize strategies 4 and 5, have participants work independently to create visuals that show how analysis and interpretation (strategy 4) are related to explanation and argumentation (strategy 5). b. **Pairs:** "Share and compare your visuals with a partner." c. **Whole group:** "What questions did this activity raise for you?"

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 22.** Reflect: Lesson Analysis Focus Question (5 min) a. Review today's lesson analysis focus question. b. **Think-Pair-Share:** "Think for a moment about this focus question and how you might convince parents or colleagues that analyzing data and constructing explanations moves student thinking forward toward deeper understandings of science ideas. Then share your ideas with an elbow partner."
12:00–12:45 45 min	**LUNCH**		
12:45–3:15 150 min (Includes 10-min break) **Content Deepening: Variation in**	**Purpose** • Deepen participants' understandings of trait variation and the process of natural selection. • Develop understandings of scientific methods used to determine whether variation in traits is caused by genetics and/or the environment. • Explore the evidence biologists collect to support the argument that		**Display Slide 23.** Content Deepening: Variation in Traits (Less than 1 min) a. "Now let's dig into today's content deepening work." **Note:** Refer to the content background document and the Common Student Ideas about Variation in Traits as needed throughout this phase.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
Traits Slides 23–63	traits evolve because of natural selection. **Content** • Organisms inherit many traits from their parents. • 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. • Trait variations in sexually reproducing organisms occur as a result of random mutations. • 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.	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 24.** Unit Central Question (1 min) a. Remind participants of the unit central question that students will explore during the Variation in Traits lesson sequence. b. "Today we'll gather more information to help us answer this question. How do the investigations we've completed so far link to our unit central question?"
		Review: Variation in Traits  	**Display Slide 25.** Review: Variation in Traits (3 min) a. "This living graph is similar to the graphs you created during the Celebrate Variation activity in our first session." b. Ask participants how this graph relates to the investigations they conducted in previous sessions on trait variation.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	What Participants Do • Review key science ideas about trait variation from previous sessions. • Complete a novelty-seeking survey that highlights behavioral traits. • Read about inheritance of traits and natural selection in the content background document. • Review the NGSS standards for grade 3. • Conduct investigations from VIT lessons 6a and 6b. • Discuss ways to conduct experiments that test for genetic and environmental causes of trait variation. • Use a mathematical model to investigate the major postulates of an argument for natural selection. • Collect evidence for natural selection from a real-life example. • Watch a video on natural selection and adaptation **Videos** • *The Making of the Fittest: Natural Selection and Adaptation* **Handouts in PD Binder** • 3.6 Novelty-Seeking-Behavior Survey • 3.7 Mouse Traits (1 per pair) (from VIT lesson 6a) • 3.8 Counting Seeds (1 per pair)		**Display Slide 26.** Review: Types of Traits (1 min) a. Review the definition of traits on the slide and the different types of traits found in living things.
			**Display Slide 27.** Novelty-Seeking Behavioral Trait (5 min) a. "One type of behavioral trait involves seeking out new and sometimes risky experiences. This trait is referred to as *novelty-seeking behavior*." b. "Do you think you have this trait? Let's find out!" c. Distribute handout 3.6 (Novelty-Seeking-Behavior Survey) and read the question at the top of the page. Then ask participants to begin the survey. d. After participants have completed their surveys, direct them to calculate their scores by counting the number of yes responses and giving themselves one point for each yes. e. **Whole-group share-out:** Invite participants to share the results of their surveys with the group.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	• 3.9 Increasing Seeds (Excel spreadsheet) • 3.10 Developing an Explanation for Mouse Fur Color • 3.11 Natural Selection Explanation Table **Supplies** • Science notebooks • Chart paper and markers • Lesson materials kit • Apples (1 per pair) • 1 paring knife • 10 napkins or paper towels **PD Resources** • RESPeCT lesson plans binder **Resources in Lesson Plans Binder** *Resources section:* • Content background document • Common Student Ideas		**Display Slide 28.** Novelty-Seeking Behavioral Trait (5 min) a. Orient participants to the sample bar graph on the slide and ask the following questions: • "How does this graph show variation for the novelty-seeking behavioral trait?" • "To what extent do you think behavioral traits like novelty seeking are passed from parents to offspring?" **Note:** If time allows, invite participants to reflect on how their own novelty-seeking score relates to the sample data. b. Elicit a variety of ideas from participants for the second question. c. **Emphasize:** "Biologists recognize two major origins of trait variation: (1) inherited changes that are encoded in genes and DNA, and (2) environmental causes that include life experiences, the chemical environment in the womb, and educational learning experiences." d. "Next, we'll consider how scientists identify the causes of trait variation in populations of living things."

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 29.** Content Deepening: Focus Question 1 (2 min) a. Read the focus question on the slide. b. Ask participants to write the question in their science notebooks and jot down their initial ideas.
			**Display Slide 30.** Inherited Traits (5 min) a. **Individuals:** Have participants read section 5 (Inherited Traits) in the content background document and answer the questions on the slide in their notebooks. **Note:** For additional context on the finches, you may also want to have participants read the second half of section 4. b. **Whole group:** Invite participants to share their responses. **Ideal responses:** • **Question 1:** After measuring and analyzing beak depth in finches, researchers discovered that beak depth is an inherited trait. Parents with larger beaks that survived a drought passed on this trait to their offspring. • **Question 2:** The text says, "Variation can also occur because of mutations, or changes, in the DNA sequence. In some cases, a change happens within a gene sequence. Since genes contain the instructions for the production of proteins in the body, this change affects the specific proteins that are made, which can have a positive or negative

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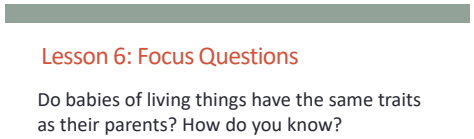
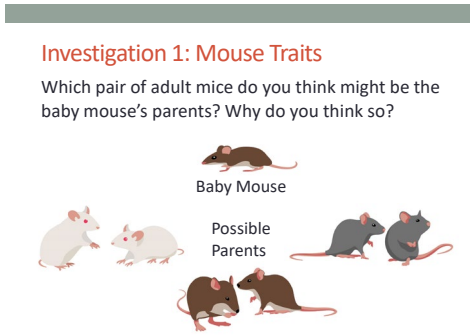
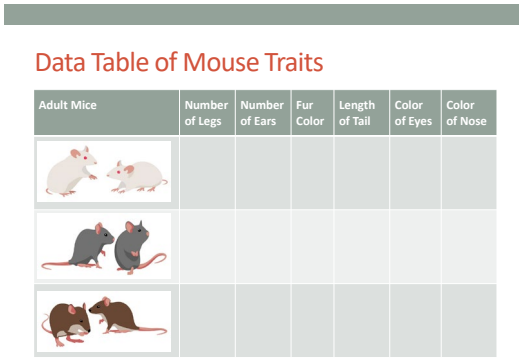
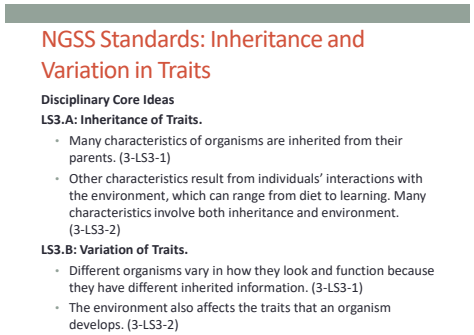
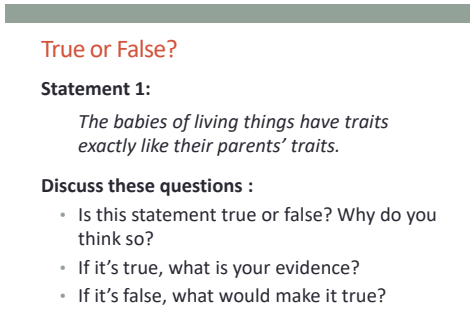
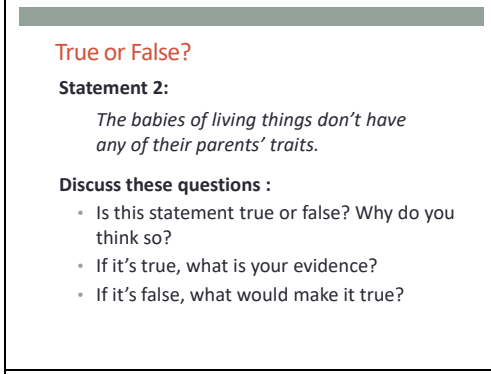
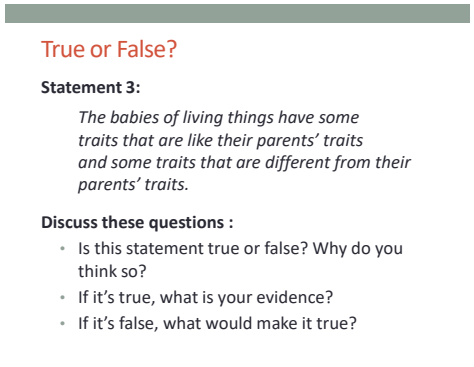
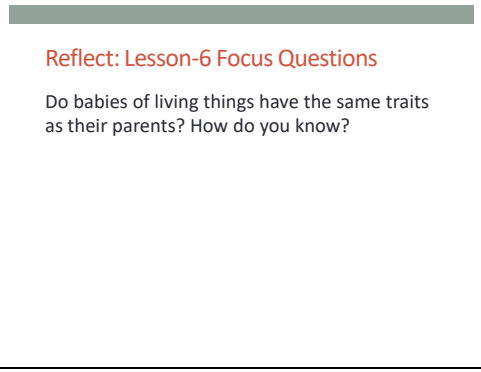
			effect on the organism, or no effect at all."
		NGSS Standards: Inheritance and Variation in Traits **3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.** [Clarification Statement: Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings. Emphasis is on organisms other than humans.] [*Assessment Boundary: Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.*]	**Display Slide 31.** NGSS Standards: Inheritance and Variation in Traits (Less than 1 min) a. Read the NGSS standard on the slide.
		NGSS Standards: Inheritance and Variation in Traits **Disciplinary Core Ideas** **LS3.A: Inheritance of Traits.** • Many characteristics of organisms are inherited from their parents. (3-LS3-1) • Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. (3-LS3-2) **LS3.B: Variation of Traits.** • Different organisms vary in how they look and function because they have different inherited information. (3-LS3-1) • The environment also affects the traits that an organism develops. (3-LS3-2)	**Display Slide 32.** NGSS Standards: Inheritance and Variation in Traits (2 min) a. Read the NGSS Disciplinary Core Ideas on the slide. b. Ask participants, "How does our discussion about novelty-seeking behavior relate to these core standards?" [*Answer:* The standards talk about how both genetics and the environment can influence variation in traits.] c. "We haven't yet discussed how to determine the extent to which genetics and the environment influence a trait, but to prepare for addressing this more difficult question, we'll investigate inherited traits passed from parents to offspring."

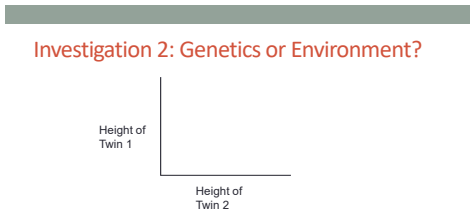
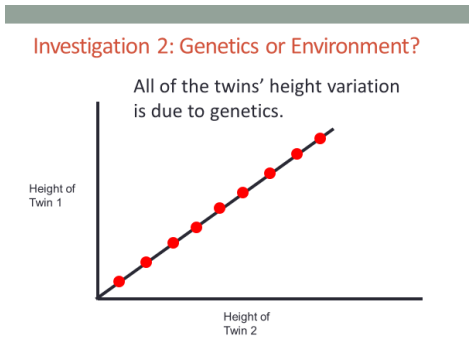
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 33.** Lesson 6: Focus Questions (5 min) a. Read the focus question on the slide and ask participants to write it in their science notebooks. b. "To help us answer these questions, we'll conduct an investigation from lesson 6 in the Variation in Traits unit. In this activity, students compare the traits of a baby mouse with the traits of three adult mice and try to determine which adult mice are likely to be the parents." c. Direct participants to prepare for the investigation by quickly reading through lessons 6a and 6b in their lesson plans binders.
			**Display Slide 34.** Investigation 1: Mouse Traits (1 min) a. Read the questions on the slide and elicit participants' predictions and reasoning. b. "Let's see if our predictions are right."

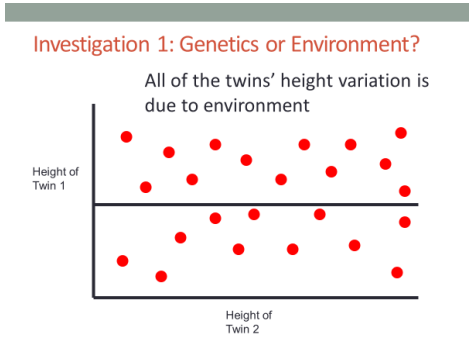
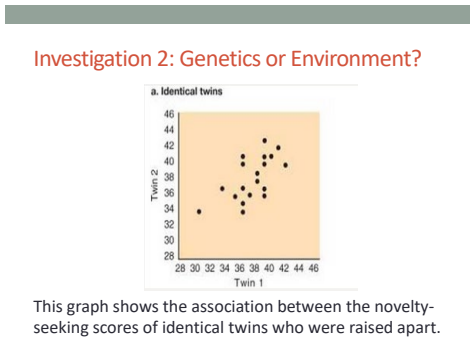
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 35.** Investigation 1: Mouse Traits (10 min) a. "To find out which set of adult mice are the baby mouse's parents, you'll examine the traits of each set of mice and record your observations on a data table." b. Have participants pair up with an elbow partner. Then distribute handout 3.7 (Mouse Traits) to each pair and go over the instructions. c. **Pairs:** Direct pairs to complete the data table for all three sets of adult mice and look for any patterns in the data that might help them determine which set of mice are most likely to be the baby mouse's parents. d. **Whole group:** "Based on the data you collected, which set of adult mice are most likely to be the brown mouse's parents? What trait patterns did you identify that helped you reach this conclusion?" **Ideal response:** The brown adult mice and the brown baby mouse share the most traits, so the brown adult mice are most likely the parents. e. **Individuals:** Following the group discussion, have participants locate their STeLLA strategies booklets and read the chapter on strategy 4. f. **Turn and Talk:** "Now I'd like you to discuss with your elbow partner how you can best engage students in analyzing and interpreting their data and observations from this activity. Then write your ideas in your notebooks." g. **Whole group:** Invite a few participants to share their ideas with the group.

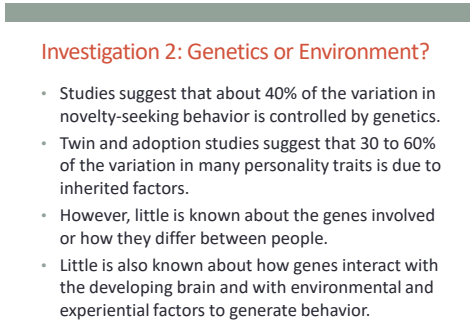
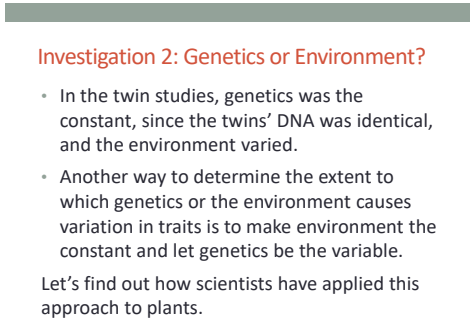
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 36.** NGSS Standards: Inheritance and Variation in Traits (2 min) a. Briefly review the NGSS Disciplinary Core Ideas on the slide. b. Ask participants, "What other core science ideas could come out of the mouse-traits activity?" **Possible responses:** • The brown parents and the brown baby mouse shared many but not all traits. This is related to one of the NGSS disciplinary core ideas: "Many characteristics of organisms are inherited from their parents." • Some mouse traits don't vary (such as the number of legs and number of ears).
			**Display Slide 37.** True or False? (5 min) a. "Next, we'll consider three statements about the traits of parents and offspring and decide whether each statement is true or false." b. Read the first statement on the slide and ask participants to write it in their science notebooks. c. **Turn and Talk:** "Discuss the questions on the slide with an elbow partner; then write your answers in your notebooks." d. **Whole-group share-out:** Invite pairs to share their conclusions and reasoning with the group.

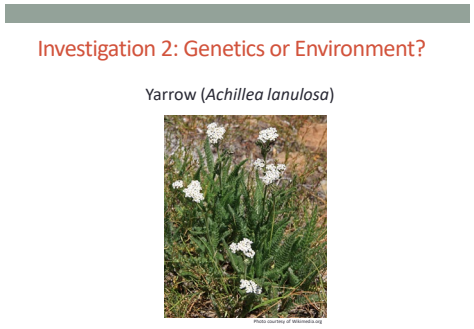
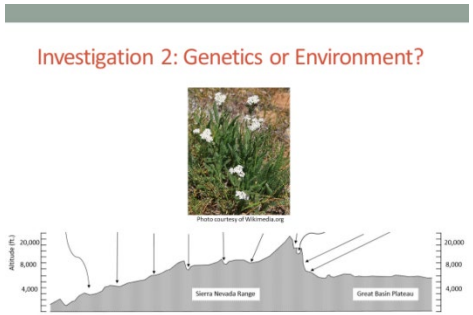
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 38.** True or False? (5 min) a. Read the second statement on the slide and ask participants to write it in their science notebooks. b. **Turn and Talk:** "Discuss the questions on the slide with an elbow partner; then write your answers in your notebooks." c. **Whole-group share-out:** Invite pairs to share their conclusions and reasoning with the group.
			**Display Slide 39.** True or False? (5 min) a. Read the third statement on the slide and ask participants to write it in their science notebooks. b. **Turn and Talk:** "Discuss the questions on the slide with an elbow partner; then write your answers in your notebooks." c. **Whole-group share-out:** Invite pairs to share their conclusions and reasoning with the group. **Ideal response:** Participants should conclude that statements 1 and 2 are false, and statement 3 is true.
			**Display Slide 40.** Reflect: Lesson-6 Focus Questions (1 min) a. Revisit the focus questions on the slide. b. **Whole-group discussion:** "How can engaging students in analyzing and interpreting data and observations help them answer these focus questions?"

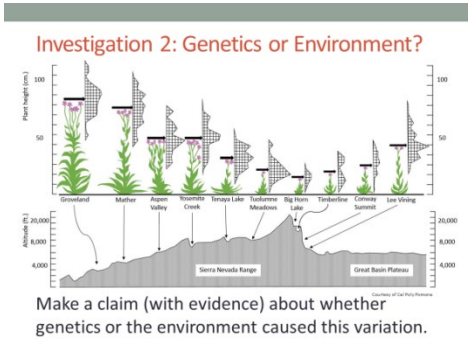
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		 Reflect: Content Deepening Focus Question 1 How can we design experiments to test for genetic and environmental causes of trait variation?	**Display Slide 41.** Reflect: Content Deepening Focus Question 1 (3 min) a. Review the first content deepening focus question. b. **Whole group:** "What have we learned so far that can help us answer this question?" c. "So do we all agree that one way we can test for genetic and environmental causes of trait variation is to measure a specific trait in parents and offspring?" d. "Next, we'll explore another way we can determine the extent to which genetics and the environment control variation in traits."
	10-MINUTE BREAK		
		 Investigation 2: Genetics or Environment? **Focus question:** How can we design experiments to test for genetic and environmental causes of trait variation?	**Display Slide 42.** Investigation 2: Genetics or Environment? (3 min) a. "One of the most powerful ways to approach this focus question is to explore traits in siblings who share identical DNA but were raised in different environments. By investigating traits in identical twins who were raised apart, we can determine whether genetics or the environment causes variation in a particular trait." b. "What might we learn from such a research approach? What might the results tell us?" c. Emphasize that if a trait of identical twins shows variation, environmental differences must be the

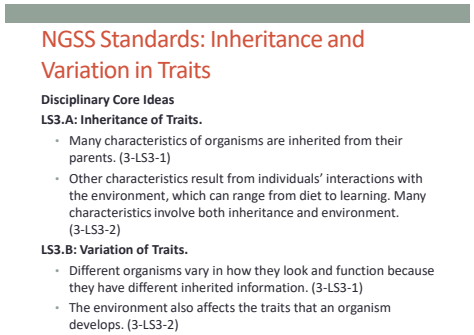
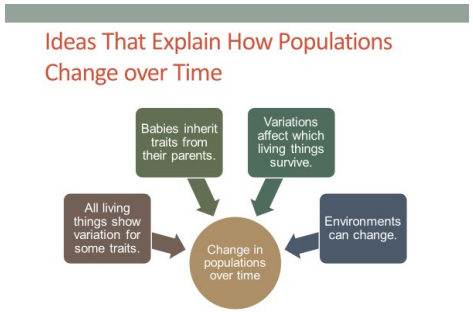
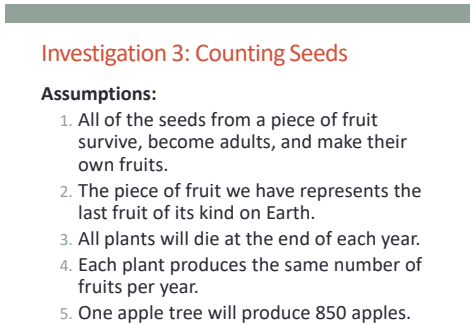
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			cause, since the twins share the same DNA.
			**Display Slide 43.** Investigation 2: Genetics or Environment? (5 min) a. "Think about a graph that shows variations in height for 100 pairs of identical twins. For each pair, Twin 1's height would be plotted on the *y*-axis, and Twin 2's height would be plotted on the *x*-axis." b. **Whole group:** Walk participants through the hypothetical example of twin height variation and discuss the questions on the slide. Elicit a variety of predictions and ideas. c. **Individuals:** Have participants draw two graphs in their science notebooks to illustrate their predictions. One graph should show genetics as the causal factor in the twins' height variations, and the other graph should show environment as the causal factor.
			**Display Slide 44.** Investigation 2: Genetics or Environment? (Less than 1 min) a. "This slide shows what a graph would look like if genetics caused all of the trait variation in the identical twins. Does your graph reflect these results?" b. "In this case, the height of one twin always matches the height of the other twin. The height trait shows a predictable pattern based on the identical genetic makeup of each twin, and environment plays no role at all in this trait."

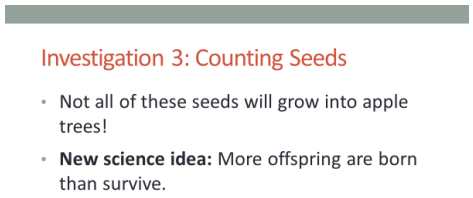
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 45.** Investigation 2: Genetics or Environment? (Less than 1 min) a. "This slide shows what a graph would look like if environment caused all of the trait variation in the identical twins. Does your graph reflect these results?" b. "In this case, there is no identifiable pattern in the height trait of twins raised in different environments. None of the variation in this trait can be predicted based on the environment of each twin, and genetics plays no role in the variation."
			**Display Slide 46.** Investigation 2: Genetics or Environment? (5 min) a. "Now let's look at novelty-seeking behavior among twins who were raised apart." b. "What does this graph tell us about the cause of variation in the novelty-seeking trait? Do you think the cause is genetics, the environmental, or possibly both? How do you know?" c. **Pairs:** Ask participants to discuss these questions with an elbow partner. d. **Whole group:** Invite pairs to share their ideas and evidence with the group. **Ideal response:** • The data show some relationship between the novelty-seeking scores for identical twins raised apart. This means that both genetics and the environment are involved in causing variation in this trait. This is true of many traits, as the NGSS Disciplinary Core Ideas indicate: "Many characteristics involve both inheritance and

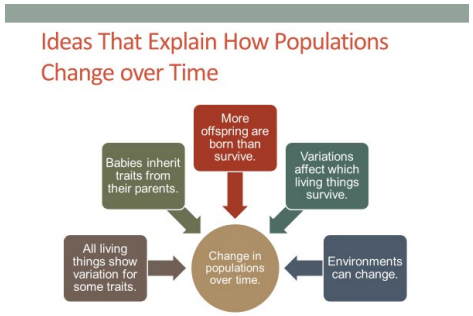
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			environment."
			**Display Slide 47.** Investigation 2: Genetics or Environment? (Less than 1 min) a. Share the information on the slide about the causes of variation in behavioral traits like novelty seeking.
			**Display Slide 48.** Investigation 2: Genetics or Environment? (Less than 1 min) a. Show the first point on the slide. b. "In our previous examples, researchers measured trait variations in identical twins raised apart. In both the height and novelty-seeking studies, genetics was fixed or constant, and the environment varied." c. Show the second point on the slide. d. "Another way to determine the extent to which genetics and the environment cause variation in traits is to make environment the constant factor and genetics the variable." e. "Let's find out how scientists have applied this approach to plants."

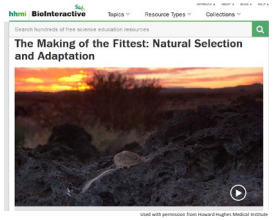
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 49.** Investigation 2: Genetics or Environment? (Less than 1 min) a. "In their research on trait variation in plants, scientists have found it especially useful to apply the approach we just discussed: keeping the environment constant and allowing genetics to vary. One of the plants scientists have studied is yarrow, a common landscape plant that grows throughout California."
			**Display Slide 50.** Investigation 2: Genetics or Environment? (5 min) a. "Many decades ago, researchers traveled east to west across Northern California collecting plants at various elevations, from sea level to more than 10,000 feet. They noticed that the plants from higher elevations were quite short, and the plants from lower elevation were very tall. The researchers wondered whether genetics or the environment caused this variation in plant height. To answer this question, they gathered seeds from all of the plants they collected and grew them in the same garden at sea level. The experiment was designed with environment as the constant and genetics as the variable." b. "What do you think the results of the experiment would look like if genetics caused all of the variation in the height trait? What would the results look like if the environment caused all of the variation?" c. **Turn and Talk:** "Share your ideas and reasoning with an elbow partner. Then write your predictions in your science notebooks."

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			d. **Whole group:** Invite a few participants to share their predictions and reasoning with the group.
			**Display Slide 51.** Investigation 2: Genetics or Environment? (5 min) a. "This slide shows the results of the plant experiment. Remember that all of the plants were grown in the same garden at sea level. The graph at the top of the slide shows plant height, and the graph at the bottom shows where the seeds originally came from." b. **Individuals:** "Study these graphs and then write a claim in your notebooks about whether genetics or the environment caused the variation in plant height. Make sure to include evidence and reasoning to support your claim." c. **Whole group:** Invite participants to share their claims, evidence, and reasoning with the group. **Ideal claim and evidence:** • **Claim:** The variation in plant height seems to be strongly influenced by genetics. • **Evidence:** The evidence is that the height of plants grown in the common garden varied based on where the seeds came from. The seeds from higher elevations (e.g., Big Horn Lake) yielded the shortest plants, whereas the seeds from lower elevations (e.g. Groveland) yielded the tallest plants.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 52.** NGSS Standards: Inheritance and Variation in Traits (3 min) a. Briefly review the NGSS Disciplinary Core Ideas on the slide. b. "How have our investigations of trait variations in twins and yarrow plants affected your understandings of these core ideas? Write down your thoughts in your science notebooks."
			**Display Slide 53.** Ideas That Explain How Populations Change over Time (Less than 1 min) a. Read the information on the slide and review how the investigations participants have completed so far can help them explain how populations of living things change over time. b. "Our next investigation will add another key idea to this growing list."
			**Display Slide 54.** Investigation 3: Counting Seeds (10 min) a. Initially, show only the first assumption on the slide. b. "In this investigation, we'll use a mathematical model to test five assumptions about survival in plants." c. Read the first assumption and then reveal and read the other assumptions one at a time. d. Have participants pair up with an elbow partner.

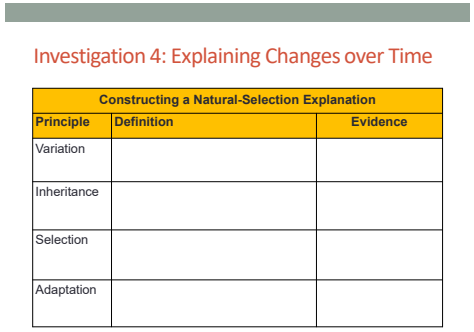
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			Then distribute one copy of handout 3.8 (Counting Seeds) to each pair. e. "To complete this handout, you'll need one more piece of information: the number of apple seeds." f. Give each pair of participants an apple and cut it so they can count the number of seeds. g. Ask participants to calculate the number of apple trees and the number of seeds for four generations and record this data on the handout. h. Participants should notice that the numbers of trees and fruits increase rapidly. Have them complete several calculations on the handout; then display the Excel spreadsheet (handout 3.9, Increasing Seeds) and perform the remaining calculations. If you enter 5 for the number of seeds per fruit (row 5) under Generation 0 (column 3), the rest of the numbers for that column should fill in automatically. Then enter the number of fruits per plant (850 per assumption 5) in row 3 for Generation 1 and enter 5 seeds in row 5 for Generation 1. Continue this for all four generations. i. Have participants record the remaining spreadsheet data on their handouts.
			**Display Slide 55.** Investigation 3: Counting Seeds (Less than 1 min) a. Show only the first point on the slide. b. Ask, "Can you image what would happen if all of these seeds survived?" c. **Emphasize:** Not all of these seeds will grow into apple trees! d. Reveal the second point on the slide and introduce the new science idea: *More offspring are born than*

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			survive.
			**Display Slide 56.** Ideas That Explain How Populations Change over Time (Less than 1 min) a. Revisit the graphic on the slide that explains how populations of living things change over time. b. Emphasize the new idea that has been added: *More offspring are born than survive*. c. "In our final investigation, we'll use all of these ideas to help us explain how changes in populations of living things happen over time."
			**Display Slide 57.** Reflect: Content Deepening Focus Question 1 (4 min) a. Review the focus question on the slide b. **Individuals:** Ask participants to answer the question in their science notebooks using evidence from the investigations to support their ideas. c. **Whole group:** Based on the previous investigations, briefly summarize the key ways experiments can be designed to test for genetic and environmental causes of trait variation. **Key ways to design experiments:** • Measure specific traits in parents and offspring. • Measure specific traits in populations by making either genetics or the environment the constant and making the other factor a variable. • Use a mathematical model to test assumptions about inheritance and survival.

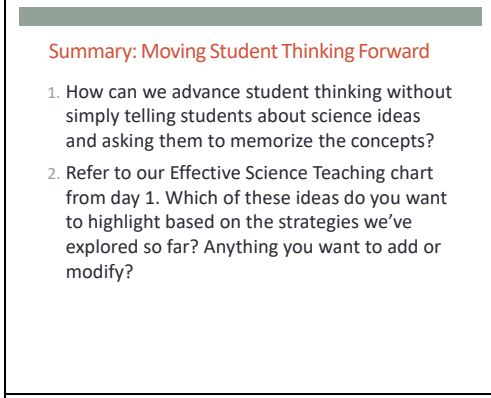
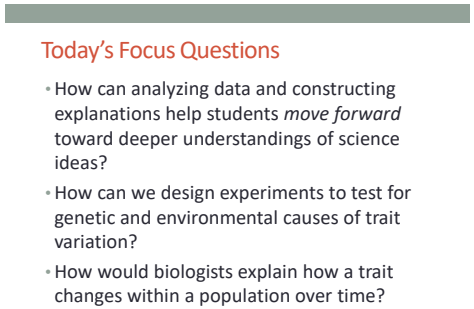
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Content Deepening: Focus Question 2 How would biologists explain how a trait changes within a population over time?	**Display Slide 58.** Content Deepening: Focus Question 2 (Less than 1 min) a. Read the focus question on the slide. b. "This focus question will guide the rest of our content deepening work today and into our next session." c. Have participants write this question in their science notebooks.
		Investigation 4: Explaining Changes over Time **Goal:** To develop a full explanation for change in populations over time using evidence and major principles of natural selection	**Display Slide 59.** Investigation 4: Explaining Changes over Time (Less than 1 min) a. Read the goal on the slide. b. "The science ideas we explore and the evidence we gather during the next investigation will help us accomplish this goal."
		Investigation 4: Explaining Changes over Time  http://www.hhmi.org/biointeractive/making-fittest-natural-selection-and-adaptation	**Display Slide 60.** Investigation 4: Explaining Changes over Time (10 min) a. "In this investigation, we'll explore the evolution of fur color in rock pocket mice." b. Distribute handout 3.10 (Developing an Explanation for Mouse Fur Color) and have participants read the introduction silently. c. Watch the beginning of *The Making of the Fittest: Natural Selection and Adaptation* and pause the video at the 2:37 time segment, where Dr. Nachman says, "Almost all of them."

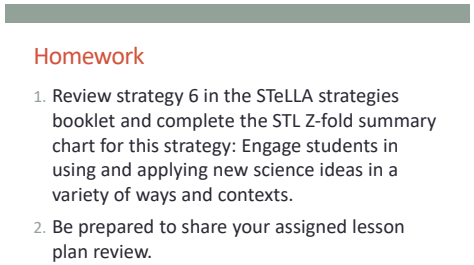
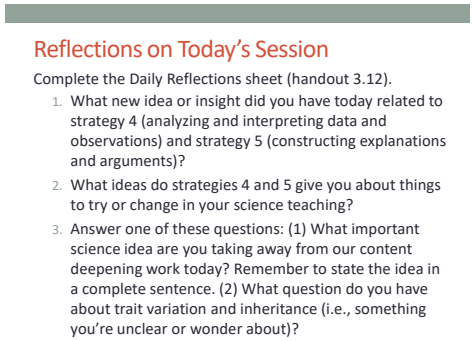
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process

			d. **Individuals:** Have participants complete step 2 on the handout using the science ideas about variation in traits that they've learned about so far.
			e. **Pairs:** Have participants share their responses with an elbow partner.
			f. **Whole group:** Discuss participants' answers to questions 2a and 2b on the handout.
			Notes:
			• **Question 2a:** Participants aren't yet expected to have a fully developed answer to this question, so don't discuss all of the elements of a complete answer at this point. Participants will revisit this question later in the activity when they examine the Natural Selection Explanation Table (handout 3.11). Then they should be able to provide a complete explanation that incorporates the major principles of natural selection as follows:
			  • **Variation:** Within a population of mice living on the lava flow, some individuals had the dark fur trait and others did not.
			  • **Inheritance:** The variations in mouse fur color are inherited (passed from parents to offspring). The origin of the variation stems from random genetic mutations.
			  • **Selection:** More offspring are born than can survive, leading to competition within a species. In certain environments, individual mice that have dark fur will survive and leave more offspring than mice with tan fur.
			  • **Adaptation:** The frequency of the mice with dark fur and the alleles that cause dark fur will increase in the population over generations. In this case, the population will change from one with most individuals having tan fur to one with most individuals having dark fur.
			• **Question 2b:** Address the common student misconception that new traits arise as needed. The mutation for dark-colored fur in rock pocket mice

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			didn't occur simply because the mice needed it. Instead, the new trait arose due to random genetic mutations. Clarify that explanations for change based on the needs or wants of an individual are common but aren't scientifically accurate. Direct participants to the Common Student Ideas document in the resources section of their lesson plans binders.
			**Display Slide 61.** Investigation 4: Explaining Changes over Time (20 min) a. Distribute handout 3.11 (Natural Selection Explanation Table). Point out that an acronym for the natural-selection principles is VISA. b. **Individuals:** Have participants read the definitions on the handout and sections 6 and 7 on natural selection in their content background documents. c. **Pairs:** "Pair up with an elbow partner and summarize how the information in the content background document and your experiences in our content deepening sessions support the definitions in the handout." d. "In our next content deepening session, we'll watch the rest of the video and identify evidence for each natural-selection principle. You'll record this evidence on your handout."

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		 Reflect: Content Deepening Focus Question 2 How would biologists explain how a trait changes within a population over time?	**Display Slide 62.** Reflect: Content Deepening Focus Question 2 (Less than 1 min) a. Revisit the focus question on the slide. b. "In the last activity, you summarized the progress we've made in answering this focus question. We'll continue exploring this question in our next session."
		 Content Deepening Reflections In this content deepening session … • How were you engaged in analyzing and interpreting data? • How were you engaged in constructing explanations and arguments? • How did the investigations move your thinking forward toward more-scientific ideas about variation in traits?	**Display Slide 63.** Content Deepening Reflections (5 min) a. **Pairs:** Ask participants to pair up and discuss the questions on the slide. b. **Whole group:** Invite participants to share their reflections with the group. During this discussion, challenge participants in the following ways: 1. Be clear about when they were simply observing and when they were analyzing and interpreting data and observations. 2. Identify the type of analysis they engaged in: a. Using logic and evidence, and/or b. Using logic, evidence, and science ideas

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
3:15–3:30 15 min **Wrap-Up: Summary, Homework, and Reflections** Slides 64–67	**Purpose** • Reflect on the day's learning and summarize key ideas about the science content and strategies 4 and 5, linking those ideas to participants' images of effective science teaching and changes they want to make in their individual teaching practices. **What Participants Do** • Discuss ways of moving student thinking forward. • Add to/modify the Effective Science Teaching chart. • Review and discuss (as needed) today's focus questions. • Learn about the homework assignment and the focus of tomorrow's work. • Write reflections on today's learning. **Posters and Charts** • Effective Science Teaching chart • Strategy charts created today for STL strategies 4 and 5		**Display Slide 64.** Summary: Moving Student Thinking Forward (5 min) a. Have participants share ideas about the first question on the slide. Then ask, "What are some things we've discussed today that address this question?" b. Refer participants to the Effective Science Teaching chart from day 1 and discuss the remaining questions on the slide. Modify the chart as participants share their ideas.
			**Display Slide 65.** Summary: Today's Focus Questions (5 min) a. Review today's focus questions. b. **Discuss:** "The STeLLA strategies booklet claims that strategies 4 and 5 are ways of moving student thinking forward. How would you support or challenge that claim? In other words, are you convinced that letting students analyze data and construct explanations will help them move forward toward deeper understandings of science ideas?" c. **Ask:** "What key ideas do you now have about how to address our content deepening focus question?"

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	Handouts in PD Binder • 3.12 Daily Reflections—Day 3 **Supplies** • Science notebooks **PD Resources** • STeLLA strategies booklet • STL Z-fold summary chart (front pocket of PD binder)		**Display Slide 66.** Homework (1 min) a. "Tomorrow we'll focus on another strategy to help move student thinking forward toward deeper understandings of science ideas." b. Review the homework assignment and have participants copy it into their science notebooks.
			**Display Slide 67.** Reflections on Today's Session (4 min) a. Have participants reflect on today's session and answer the questions on the Daily Reflections sheet (handout 3.12 in PD program binder). **Note:** To support this task, encourage participants to refer to the STeLLA strategies booklet, the charts they created for STL strategies 4 and 5, the Effective Science Teaching chart, and their STL Z-fold summary charts.