RESPeCT Summer Institute Professional Development Leader Guide (PDLG)

Grade Level	3	**Day**	1	**STeLLA Strategy**	The Two Lenses: Student Thinking Lens (STL) and Science Content Storyline Lens (SCSL) STL Strategies 1, 2, and 3: Elicit, Probe, and Challenge Questions	**Subject Matter Focus**	Variation in Traits (VIT)

Focus Questions	• What is RESPeCT? • What are the STeLLA lenses and teaching strategies, and what is the evidence that they will make a difference in your science teaching? • How do traits of living things help us understand how they're grouped and related? • Why are trait variations important for the survival of living things? • How can we represent patterns of trait variation among individuals of a species?
Main Learning Goals	Participants will understand the following: • The RESPeCT project originally included a professional development program, a leadership development program, and a research study. The district is sustaining the PD professional development program. • The goals of the RESPeCT PD program are to deepen teachers' science-content knowledge and knowledge of effective science teaching; to develop their analytical skills to improve lesson-plan development and the teaching of science; to support teachers in the practical use of new knowledge and analytical skills in their classrooms; to improve students' science learning; and to achieve sustainability by eventually reaching all K–6 teachers. • Research on teacher and student learning has shown that the STeLLA Student Thinking Lens and the Science Content Storyline Lens are important analytical tools for effective teaching and are often neglected in science teaching. • Student thinking can be made more visible in science classrooms when teachers ask questions that elicit and probe student ideas and predictions, as well as challenge student thinking. Each type of question has a specific purpose. • The traits of individuals of the same kind of plant or animal can vary. • The traits of organisms include physical traits, behavioral traits, molecular traits, chemical pathways, and developmental pathways. • Organisms inherit many traits from their parents. • One reason groups of organisms share so many features is common ancestry. • Trait variations in sexually reproducing organisms occur as a result of random mutations.

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.	**Posters and Charts** • STeLLA Framework and Strategies poster • Day-1 Agenda (chart) • Norms for Working Together (chart) • Day-1 Focus Questions (chart) • Effective Science Teaching chart (blank except for title)	• Video Clip 1.1: TIMSS US Lesson 3; 1.1_TIMSS_US_lesson3_c1 • Video Clip 1.2: TIMSS Japan Lesson 1; 1.2_TIMSS_Japan_lesson1_c1_1 • *Minds of Our Own Lessons From Thin Air* video, segments 3:30–5:40; 7:50–16:45 • *The Life Cycle of Painted Lady Butterflies*

• Arrange participant materials.
• Put up posters and charts.
 	
Day-1 Setup Tasks
• Arrange participant materials on tables in grade-level meeting rooms:
  • Tabletop name cards
  • STeLLA strategies booklet
  • RESPeCT PD program binder
  • RESPeCT lesson plans binder
  • Science notebooks
  • Materials kit (1 per topic)
 	
Planning and Preparation Tasks
• Study the PDLG, PowerPoint slides (PPTs), video clips, and handouts. Make changes to PPTs if needed. Modify text highlighted in light-blue font on slides and/or in PDLG to make it specific for your group.
• Make sure you know how to find the *Minds of Our Own Lessons From Thin Air* video segments: 3:30–5:40; 7:50–16:45.
• Check the link for the *Life Cycle of the Painted Butterflies* YouTube video and review the clip.
• Assemble science notebooks and materials.
• Prepare charts for the agenda, focus questions, and norms.
	• Parking Lot poster
	
	Handouts in RESPeCT PD Binder Front Pocket
	• Half-page sheet of norms for participants to paste into their science notebooks
	• Z-fold summary chart: Student Thinking Lens Strategies (blank)
	
	Handouts in RESPeCT PD Binder, Day 1
	• 1.1 Norms for Working Together
	• 1.2 Transcript for Video Clip 1.1
	• 1.3 Transcript for Video Clip 1.2
	• 1.4 TIMSS *Educational Leadership* article
	• 1.5 “Synthesis of Research from *How Students Learn: Science in the Classroom*” (HSL)
	• 1.6 Traits and Groups (1 per pair)
	• 1.7 Celebrate Variation!
	• 1.8 Extended Homework: RESPeCT Lesson Plan Analysis
	• 1.9 Daily Reflections—Day 1
	
	Supplies
	• Science notebooks
	• Chart paper and markers
	• Rulers
	
	PD Resources
	• STeLLA strategies booklet
	• RESPeCT PD program binder
	• RESPeCT lesson plans binder
	• Setting Up Your Summer Institute Notebook (pretabs section in PD binder)
	
	Resources in Lesson Plans Binder
	Resources section:
	• Common Student Ideas about Variation in Traits
	• Variation in Plants and Animals and Variation in Traits: Content Background Document
		YouTube video (4:27 segment); https://www.youtube.com/watch?v=63B1InqPa8k

	Pretabs section: • Variation in Traits: Learning Goals for Students and Teachers	

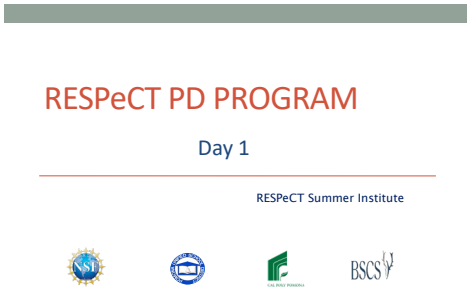
DAY 1 SESSION OUTLINE

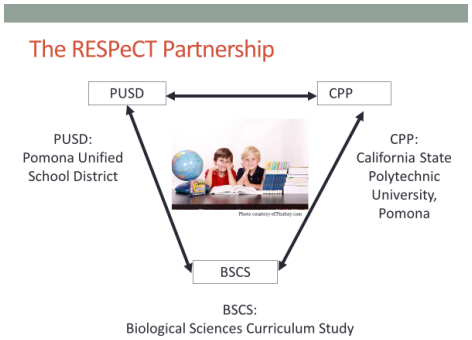
Time	Activities	Purpose
8:00–8:25 25 min	**Whole-Group Gathering: What Is RESPeCT?**	• Orient participants to the overall project. • Introduce participants to the main goals of the project. • Provide details about schedules and logistics that will address participants' immediate concerns.
8:25–8:30 5 min	**Transition to Grade-Level Study-Group Settings**	
8:30–9:20 50 min	**Getting Started: Introductions, Goals, Norms, Agenda, Focus Questions, Ideas about Effective Science Teaching**	• Build community within grade-level study groups. • Set the stage for a day of learning about the RESPeCT PD program (formerly the STeLLA PD program), the STeLLA conceptual framework, and tools for lesson analysis. • Access participants' prior knowledge/beliefs about science teaching and learning. What do participants include in their image of effective science teaching? What's missing?
9:20–10:10 50 min (Includes 10-min break)	**The Case for the Science Content Storyline Lens (SCSL)**	• Draw from the TIMSS video study to build the case for the Science Content Storyline Lens as a core analytical tool in the STeLLA conceptual framework.
10:10–10:40 30 min	**The Case for the Student Thinking Lens (STL)**	• Draw from research on science learning to build the case for the Student Thinking Lens as a core analytical tool in the STeLLA conceptual framework.
10:40–12:00 80 min	**Content Deepening: Variation in Traits**	• Determine participants' previous science-content knowledge related to traits, trait variation, and the levels of diversity in life. • Deepen participants' understandings of shared traits and trait variation among individuals within and across different species. • Consider how similarities and differences in traits across different species can be used to organize individual organisms into groups.
12:00–12:45 45 min	**LUNCH**	
12:45–2:10 85 min (Includes 10-min break)	**Content Deepening (Continued)**	• Explore patterns of trait variation within a species and how evidence of these patterns can be represented.

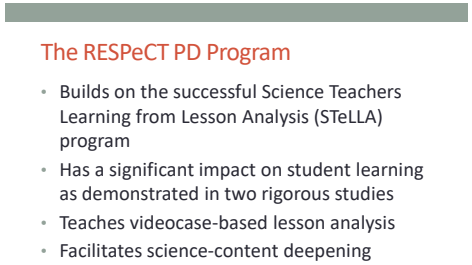
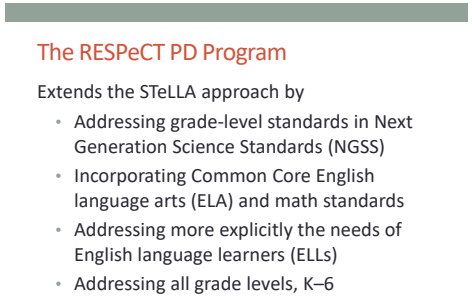
Time	Activities	Purpose
2:10–3:00 50 min	**STL Strategies: Elicit, Probe, and Challenge Questions**	• Begin to develop shared understandings of the Student Thinking Lens (STL) and STeLLA strategies 1, 2, and 3 (elicit, probe, and challenge questions).
3:00–3:30 30 min	**Wrap-Up: Summary, Homework, and Reflections**	• Summarize and reflect on key ideas from today's learning and foreshadow what will be addressed tomorrow and later in the week.

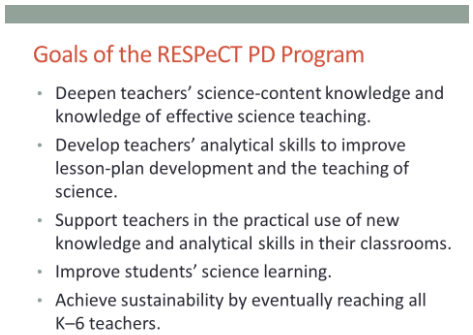
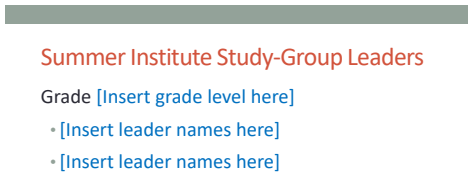
DAY 1

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

8:00–8:25
25 min
 	
Whole-Group Gathering: What Is RESPeCT?
 	
Slides 1–14
	Purpose
	• Orient participants to the overall project.
	• Introduce participants to the main goals of the project.
	• Provide details about schedules and logistics that will address participants' immediate concerns.
	
	Content
	• Discuss the following with participants:
	  • Essential logistics
	  • Components of the RESPeCT project
	  • Members of the RESPeCT partnership
	  • RESPeCT PD program and goals
	  • Summer Institute schedule and overview
	  • School-year schedule and overview
	
	What Participants Do
	• Listen to a brief introduction to the program and how it began.
		
		 
			Display Slide 1. RESPeCT PD Program (5 min)
			
			a. Greet participants as they enter the room.
			b. Help them find their notebooks and table tents.
			
			Display Slide 2. Before We Dig In: Essentials (20 min for slides 2–14, averaging approximately 1 min per slide)
			
			a. Give everyone a big welcome to the RESPeCT PD program!
			b. Fill participants in on the essential details listed on the slide.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 3.** What Is RESPeCT? (Approximately 1 min) a. **Emphasize:** The RESPeCT project began with three main components: • A professional development program • A leadership development program • A research study b. The district now sustains RESPeCT as a professional development program.
			**Display Slide 4.** The RESPeCT Partnership (Approximately 1 min) a. The original RESPeCT partners included the following: • **Cal Poly:** science, science education, and mathematics faculty, as well as the Center for Excellence in Mathematics and Science Teaching (CEMaST) • **PUSD:** district central administrators, principals, teacher specialists, and teachers • **BSCS:** an additional partner located in Colorado that provides expertise on science curriculum development, science teacher professional development, and research on science teaching and learning. **Note:** Established in 1958, BSCS stands for Biological Sciences Curriculum Study, but the organization now deals with all sciences, not just biology. • **Students:** Emphasize that students are at the center of this partnership. Their learning

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			is what the project is all about.
			**Display Slide 5.** The RESPeCT PD Program (Approximately 1 min) a. Let participants know they'll be learning more about the RESPeCT PD program and STeLLA teaching strategies as they experience firsthand what it means to perform videocase-based lesson analysis.
			**Display Slide 6.** The RESPeCT PD Program (Approximately 1 min) a. Read the information on the slide. b. Emphasize the importance of these additions to the STeLLA approach. By integrating Common Core English language arts (ELA) and math standards into the science curriculum, the RESPeCT PD program enables teachers to invest more time in teaching science. The teaching strategies developed in the RESPeCT PD program are also valuable tools in other subject areas.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 7.** Goals of the RESPeCT PD Program (Approximately 1 min) a. **The bottom line:** improving students' science learning—a goal that has been reached in two previous research studies of this approach.
			**Display Slide 8.** Summer Institute Study-Group Leaders (Approximately 1 min) a. Modify this slide to include the grade level of your study group and the names of the Teacher Leaders who will be facilitating the study-group sessions. b. Formally introduce yourselves to the group.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 9.** The Key (Approximately 1 min) a. Many people are involved in organizing, planning, and leading this program, but the teacher-participants are the key to its success.
			**Display Slide 10.** Summer Institute Schedule **Note:** This is a transition slide.

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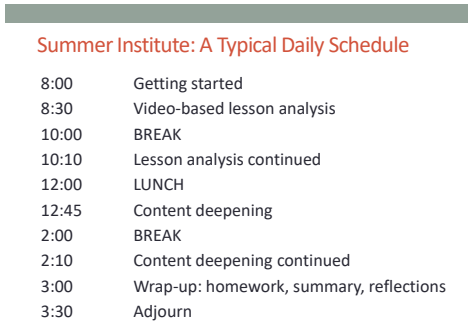
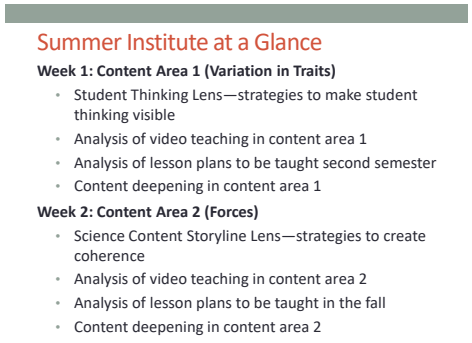
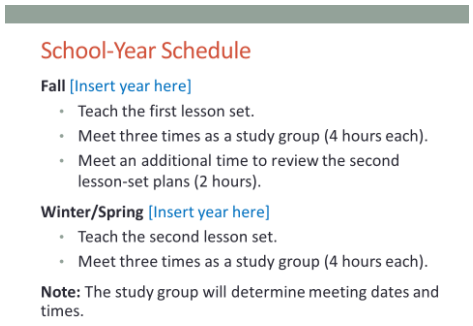
			**Display Slide 11.** Summer Institute: A Typical Daily Schedule (Approximately 1 min) a. A typical daily schedule includes the following: • Time spent on videocase lesson analysis • Time focused on content deepening • Short homework assignments • A morning and an afternoon break, with a 45-minute lunch break
			**Display Slide 12.** Summer Institute at a Glance (Approximately 1 min) a. During the Summer Institute, each grade level will focus on two content areas, with one week devoted to each area. Participants will deepen their science-content knowledge, study lesson plans in each content area, and analyze videocases of teachers presenting this content.
			**Display Slide 13.** School-Year Schedule (Approximately 1 min) a. "The Summer Institute is just the beginning! During the school year, you'll continue meeting with your grade-level study group."

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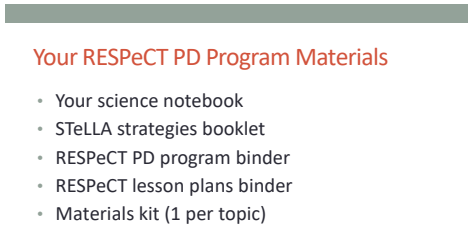
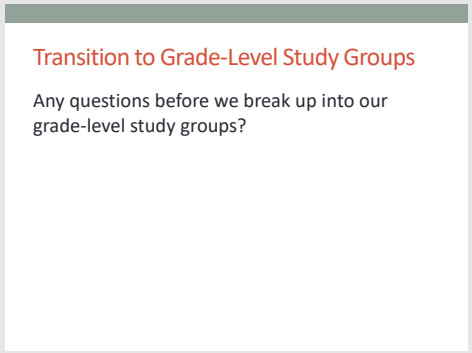
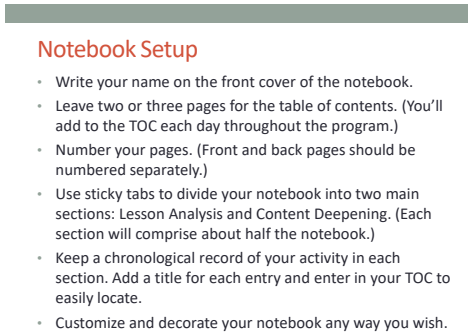
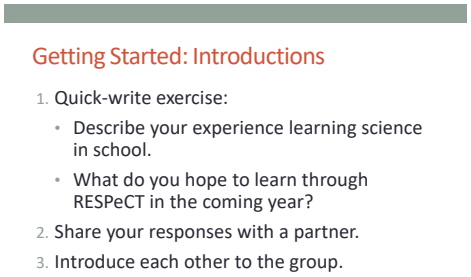
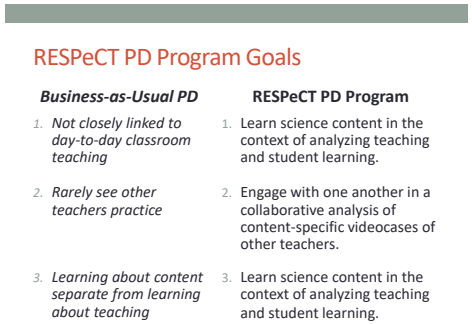
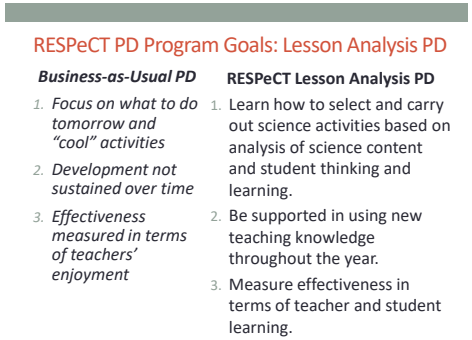
			**Display Slide 14.** Your RESPeCT PD Program Materials (Approximately 1 min) a. **Transition slide:** "In a moment we'll break up into grade-level study groups and dig into the RESPeCT PD program! But first let's review this list of materials you'll receive in your designated meeting rooms."
8:25–8:30 5 min **Transition** Slide 15	**Transition to Grade-Level Study-Group Settings**		**Display Slide 15.** Transition to Grade-Level Study Groups (5 min) a. "Any questions before we head to our grade-level study groups?" b. **Send-off:** "Have a great day and be sure to let us know if there is anything we can do to support you in getting the most out of this experience!"
8:30–9:20 50 min **Getting Started** Slides 16–24	**Purpose** • Build community within grade-level study groups. • Set the stage for a day of learning about the RESPeCT PD program (formerly the STeLLA PD program), the STeLLA conceptual framework, and tools for lesson analysis. • Access participants' prior knowledge/beliefs about science teaching and learning:		**Display Slide 16.** Notebook Setup (8 min) a. Welcome participants to the study group and introduce yourself as they arrive. b. Help participants find their table tents and materials so they can get settled. c. Direct them to the instructions for setting up their notebooks (Setting Up Your Summer Institute Notebook in the pretabs section of their PD program binders) and get them started working on this task. Interact informally with them and

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	What do participants include in their image of effective science teaching? What's missing? **Content** • RESPeCT PD is different from typical PD in a number of ways. • Agreed-upon norms for working together will support our learning. • Focus questions will guide our work in lesson analysis and content deepening activities. • We bring to this work a variety of ideas about effective science teaching. **What Participants Do** • Set up their Summer Institute notebooks. • Quick-write about their school experiences in science and their hopes for learning in this program. • Share their writing with a partner. • Introduce their partners to the group. • Discuss suggested norms for working together. • Brainstorm and discuss ideas about effective science		allow them to chitchat as they work. **Display Slide 17.** Getting Started: Introductions (15 min) a. **Individuals (3 min):** Have participants write their responses to the questions on the slide in their notebooks. Emphasize that this is an independent writing exercise. b. **Pairs (3 min):** Have participants pair up and share their responses to the questions. Encourage them to learn other things about their partners as well (e.g., school, years of teaching, favorite subjects to teach, hobbies). **Note:** If the group has an odd number of participants, pair up with one of them. c. **Whole group (9 min):** Have each participant introduce her or his partner, highlighting what that partner hopes to learn from the RESPeCT PD program. Model the first pair of introductions to demonstrate that they should be brief. **Note:** If you weren't able to pair up with someone, simply introduce yourself. **Monitor the time:** Introductions should be longer than a sentence, but not the length of a full essay!



PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	teaching. **Posters and Charts** • STeLLA Framework and Strategies poster • Norms for Working Together (chart) • Day-1 Agenda (chart) • Day-1 Focus Questions (chart) • Parking Lot poster **Handouts in PD Binder** • 1.1 Norms for Working Together **Supplies** • Table tents with names • Science notebooks • Chart paper and markers **PD Resources** • RESPeCT PD program binder • RESPeCT lesson plans binder • STeLLA strategies booklet • Setting Up Your Summer Institute Notebook (pretabs section in PD binder) • Half-page copy of the norms (front pocket of PD binder)		**Display Slide 18.** RESPeCT PD Program Goals (2 min) a. Talk through this slide, emphasizing how RESPeCT PD is different from many other professional development opportunities.
			**Display Slide 19.** RESPeCT PD Program Goals: Lesson Analysis PD (1 min) a. Highlight the goals of RESPeCT lesson analysis PD and how it differs from other professional development opportunities.

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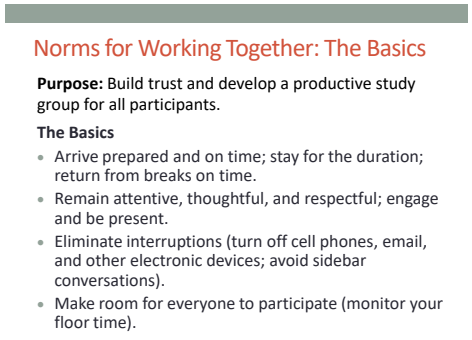
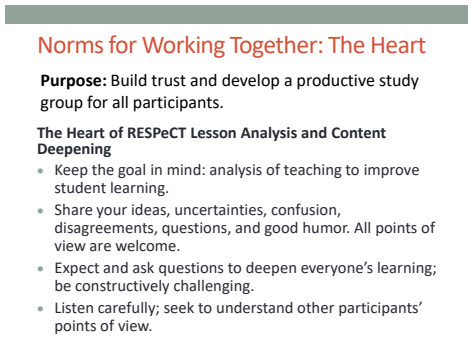
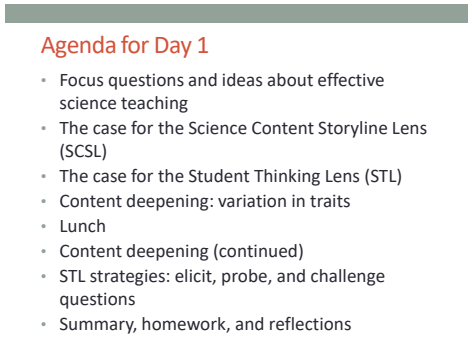
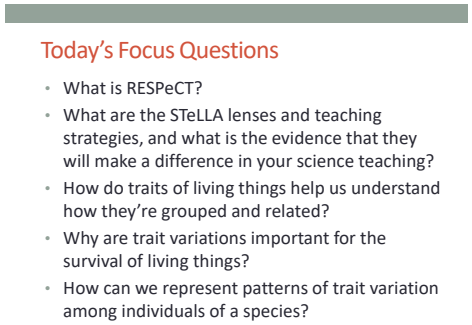
			**Display Slide 20.** Norms for Working Together: The Basics (3 min) a. "To do this kind of work together, we need to develop a strong study group where everyone feels safe sharing their ideas, questions, confusion, successes, and stumbles. Having a set of agreed-upon norms will help us build such a learning community." b. Read over these basic norms. c. "What do you think? Are there any changes or additions you'd like to suggest?"
			**Display Slide 21.** Norms for Working Together: The Heart (5 min) a. "This set of norms moves beyond the basics and targets the heart of RESPeCT PD program goals." b. Read the list. c. "Is anything unclear? Do you have any changes or additions you'd like to suggest? Do you have any concerns about these norms?" d. Direct participants to handout 1.1 (Norms for Working Together) and pass out the half-page copy of the norms for them to paste on the inside front cover of their notebooks. e. Ask participants if they're willing to live with these norms today; then tell them they'll have an opportunity to revise them tomorrow.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 22.** Agenda for Day 1 (Less than 1 min) a. Talk through the agenda for the day.
			**Display Slide 23.** Today's Focus Questions (1 min) a. "Each day we're going to have at least one lesson analysis focus question and one content deepening focus question. These are today's focus questions." b. Read the focus questions on the slide.

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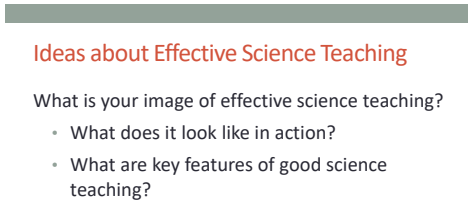
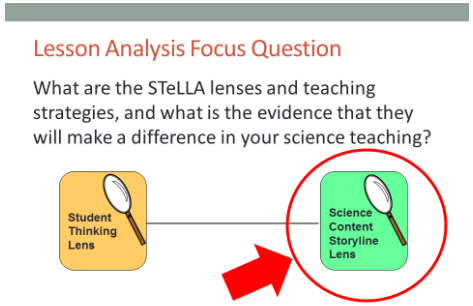
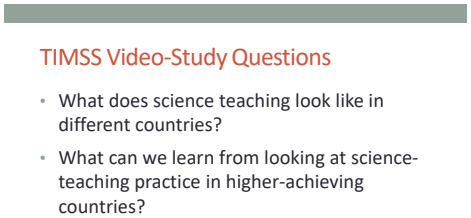
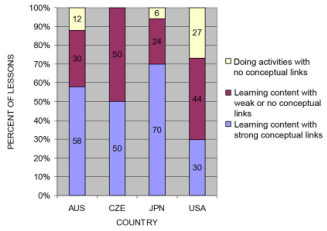
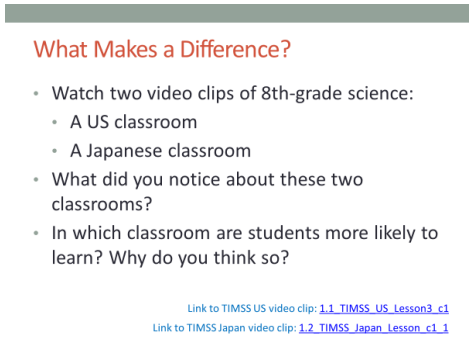
			**Display Slide 24.** Ideas about Effective Science Teaching (15 min) a. "Before we explore these questions, let's create a list of ideas about effective science teaching." b. **Individuals (3 min):** "Take a few minutes to think and write about the questions on the slide." c. **Whole group (10 min):** Go around the group (round-robin) asking everyone to contribute an idea. Write the ideas on chart paper and title the chart "Effective Science Teaching." d. "Throughout the sessions, we'll revisit this list to add new ideas, clarify our thinking, and make other modifications."
9:20–10:10 50 min (Includes 10-min break) **The Case for the Science Content Storyline Lens (SCSL)** Slides 25–34	**Purpose** • Draw from the TIMSS video study to build the case for the Science Content Storyline Lens as a core analytical tool in the STeLLA conceptual framework. **Content** • The TIMSS video study showed the importance of connecting lesson activities to science ideas to form a coherent science content storyline in science lessons. **What Participants Do**		**Display Slide 25.** Lesson Analysis Focus Question (2 min) a. "This PD program will focus on two lenses as analytical tools to guide our learning: the Student Thinking Lens and the Science Content Storyline Lens." b. "Today we're going to examine why these two lenses were chosen for our focus." c. "Let's begin with the Science Content Storyline Lens."

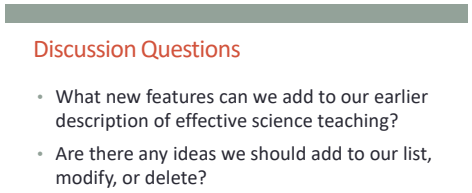
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	• Analyze a results graph from the TIMSS video study. • Watch video clips from US and Japanese classrooms and discuss observed differences. • Discuss key findings from the TIMSS video study and how they relate to the idea of a science content storyline. • Review the chart of participant ideas about effective science teaching in light of the TIMSS video study. **Posters and Charts** • Effective Science Teaching chart **Videos** • Video Clip 1.1, TIMSS US Lesson 3 • Video Clip 1.2, TIMSS Japan Lesson 1 **Handouts in PD Binder** • 1.2 Transcript for Video Clip 1.1 • 1.3 Transcript for Video Clip 1.2 • 1.4 TIMSS *Educational Leadership* article		**Display Slide 26.** TIMSS Video-Study Questions (2 min) a. "A large video study of science teaching in different countries revealed the importance of the Science Content Storyline Lens." b. "The TIMSS video study explored the research questions on this slide." **Background info:** • TIMSS stands for Trends in Mathematics and Science Study. • TIMSS is known for its achievement studies comparing student performance in math and science internationally.
			**Display Slide 27.** TIMSS Video-Study Comparisons (2 min) a. "Australia, the Czech Republic, and Japan are higher-achieving countries in science compared to the United States." b. "In these countries, 100 eighth-grade lessons were randomly video recorded. The goal was to describe typical science teaching in each country."

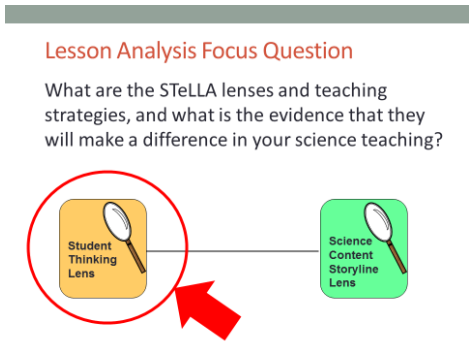
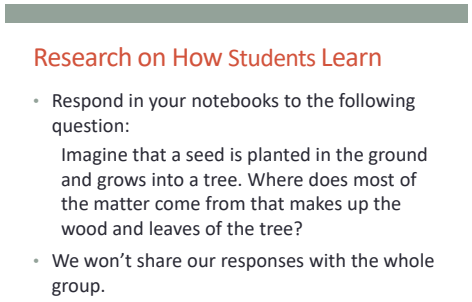
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		TIMSS Video-Study Results • Although each higher-achieving country had its own approach, they all had strategies for engaging students with core science concepts and ideas. • In US lessons, content played a less central role, and sometimes no role at all. Instead, lessons engaged students in carrying out a variety of activities.	**Display Slide 28.** TIMSS Video-Study Results (2 min) a. "The TIMSS video study showed these results."
		TIMSS Video-Study Results • Although each higher-achieving country had its own approach, they all had strategies for engaging students with core science concepts and ideas. • In US lessons, content played a less central role, and sometimes no role at all. Instead, lessons engaged students in carrying out a variety of activities.	**Display Slide 29.** TIMSS Video-Study Results (2 min) a. Call attention to the text highlighted in red to emphasize the difference between US science lessons and science lessons in higher-achieving countries.
		TIMSS: Conceptual Links 	**Display Slide 30.** TIMSS: Conceptual Links (3 min) a. **Ask:** "What do you notice from this graph? What do you make of this data?" b. **Emphasize:** "In the US, more than a quarter of the lessons had no science content; whereas in the other countries, the majority of the randomly selected lessons (or typical lessons) had content with strong conceptual links." c. **Example of a lesson with no science content:**

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			"What's a science lesson with no content? In this research, a lesson with at least one complete statement of a science idea was scored as 'learning content.' Lessons with 'no content' had **only** topic-level mentions of science concepts. For example, one teacher started a lesson by telling students to take out their rockets and get to work. They had directions to follow, but the teacher's only focus in his interactions with students was on how to build the rockets. At the end of the lesson, he told students to clean up and then dismissed them. This is a lesson with no science content!" **Other key ideas to highlight:** • Each higher-achieving country engaged students with core science concepts and ideas (more consistently than the US). • All the higher-achieving countries linked ideas and activities (more consistently than the US). • In US lessons, the focus was on performing activities with less attention to content and even less attention to linking activities and science ideas.
			**Display Slide 31.** What Makes a Difference? (20 min) a. Direct participants to the transcripts for Video Clips 1.1 and 1.2 (handouts 1.2 and 1.3) before showing each clip. b. **Show US classroom video:** Ask participants to focus on what is going on with the science content and storyline. c. **Discuss:** "What did you notice?"

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			Key ideas to emphasize and link back to the results include the following: • The teacher focuses on the activity and the procedure needed to complete the activity. • The teacher and students place no real focus on important science ideas. • There's only a topic-level mention of science ideas ("pulleys," "effort distance," "resistance force"). d. **Show Japanese classroom video:** Ask participants to focus on what is going on with the science content. e. **Discuss:** "What did you notice?" **Key ideas to emphasize and link back to the results include the following:** • Content ideas are made clear to students (focus question, pairs talk) before doing any activity. • Students are asked to talk about science ideas, not just procedures. • The lesson purpose is made clear to students. f. **Ending discussion:** "In which classroom are students more likely to learn science concepts? Why?" **Note:** Participants may be critical of both classrooms because student thinking isn't made visible. This is true, but bring their focus back to the science content and storyline. They should see a clear distinction between the science content storylines in the Japanese and US lessons. Students in the Japanese classroom are more likely to learn because science-content ideas are made visible, and students are engaged in thinking about these ideas, not

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			just science activities.
			**Display Slide 32.** The TIMSS Findings Show … (1 min) a. Use this slide and the next to summarize key ideas from the TIMSS video study.
			**Display Slide 33.** What Can We Learn from the Research? (1 min) a. After reading this slide, share with participants that the Science Content Storyline Lens addresses the need uncovered in the TIMSS video study: to strengthen the links between science ideas and lesson activities. b. Encourage participants to read handout 1.4 (TIMSS *Educational Leadership* article) for further insight.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 34.** Discussion Questions (5 min) a. "What features on our list of ideas about effective science teaching are consistent with the TIMSS video-study findings?" b. "Are there any ideas you'd like to add to our list, delete, or modify?" **Note: Use a different color** to add/delete/modify ideas. Encourage participants to keep an open mind about changing their ideas. Provide opportunities for them to reflect on any changes and the reasons for those changes. c. **Transition:** "During week 2 of the Summer Institute, we'll focus on strategies for creating a strong, coherent science content storyline. This week, we'll focus on the Student Thinking Lens. Right now, let's consider the reasons for this focus."
10:00–10:10 10 min	**BREAK**		

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
10:10–10:40 30 min **The Case for the Student Thinking Lens (STL)** Slides 35–39	**Purpose** • Draw from research on science learning to build the case for the Student Thinking Lens as a core analytical tool in the STeLLA conceptual framework. **Content** • Research on science teaching and learning shows that learners cling to important misconceptions even after what we usually consider to be good hands-on science instruction. • To help students change their ideas and truly understand science concepts, we need to engage them in more thinking and sensemaking. • Making students' ideas and misconceptions visible is essential to effective science teaching. • For teachers, knowledge of students' ideas can guide them in designing instruction to provide evidence and support that will help students change their ideas and find science ideas meaningful. • For students, making their thinking visible engages them actively in the learning process.		**Display Slide 35.** Lesson Analysis Focus Question (Less than 1 min) a. "At this point, we'll transition from a focus on the Science Content Storyline Lens (SCSL) to the Student Thinking Lens (STL)." b. "We'll be focusing on the Student Thinking Lens the rest of the day and throughout this week."
			**Display Slide 36.** Research on How Students Learn (3 min) a. **Individuals:** Have participants answer the question on the slide in their science notebooks. **Background for PD leaders:** Participants will likely have the same misconceptions revealed in the video, but they may not yet be comfortable sharing their confusion. At this point, don't ask them to share their ideas with the group. It will be interesting to see if some of them voluntarily share their "wrong" ideas after they see the video.

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What Participants Do
• Write about where the added mass comes from when a tiny seed becomes a full-grown tree.
• Watch Minds of Our Own Lessons From Thin Air video clips in which Harvard graduates and an 8th-grade student answer the same question.
• Discuss ideas about research on student thinking addressed in the video.
• Review the chart of participant ideas about effective science teaching in light of this research.

Posters and Charts
• Effective Science Teaching chart

Videos
• Minds of Our Own

Handouts in PD Binder
• 1.5 “Synthesis of Research from How Students Learn: Science in the Classroom”

Supplies
• Science notebooks
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Minds of Our Own

Minds of Our Own is a video that visually summarizes a large body of research on student learning in science classrooms.

As you watch, think about the following questions:
• How do Harvard graduates answer the question about the mass of a tree? Is their response the same as or different from yours?
• Does this give you any new ideas about effective science teaching?

Link to Minds of Our Own video clip.
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Display Slide 37. Minds of Our Own (10 min)

a. Read the information and instructions on the slide.

b. Watch the Minds of Our Own Lessons From Thin Air video. Total viewing time is approximately 10 minutes. (https://www.learner.org/series/minds-of-our-own/2-lessons-from-thin-air/?jwsource=cl)
• MIT/Harvard interview—start at segment 3:30 and end at 5:40.
• John preinterview, class, and postinterview—start at segment 7:50 and end at 16:45.

Note: If time is short, stop after Phil Sadler. If you have enough time, you can show the entire segment from 3:30 to 16:45.
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Discussion Questions

• What did you notice in the Minds of Our Own video?
• What does research on learning say to us about effective science teaching?
• What new features can we add to our description of effective science teaching?
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Display Slide 38. Discussion Questions (15 min)

a. There’s a lot to talk about in this video! Here are some additional questions you might pose:
• Did John’s ideas about photosynthesis change through instruction?
• What did the teacher say about his instruction?
• What did the experts say?
• How do the Harvard students’ responses compare with your own? What ideas does this give you about your own science learning experiences?

Key idea to emphasize: Research shows that we not only need to engage students in more thinking and sensemaking, but we also need to
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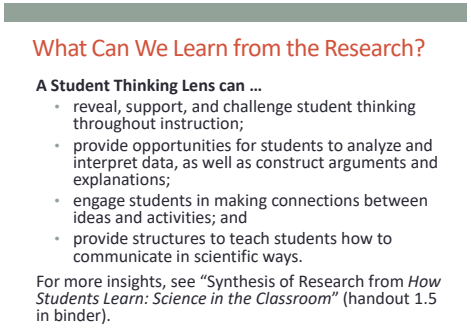
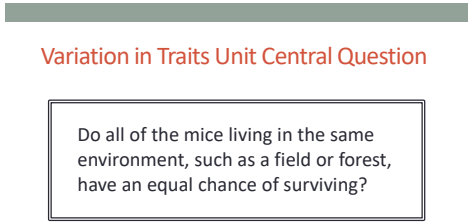
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			listen to their ideas—*especially when they're wrong*—and use them to guide our instruction. b. Modify the chart of ideas about effective science teaching as participants share features from the research.
			**Display Slide 39.** What Can We Learn from the Research? (2 min) a. "This slide nicely summarizes some of the ways we get students thinking and make their thinking visible." **Note:** Encourage participants to read handout 1.5 ("Synthesis of Research from *How Students Learn: Science in the Classroom*") for further insight. b. **Transition:** "Today we'll start learning some particular strategies for making student thinking more prominent in science lessons." **Background for PD leaders:** The STeLLA conceptual framework addresses the need uncovered in this and other studies on how people learn and, more specifically, how students learn science. 1. If students' initial knowledge is not engaged, they may fail to grasp the new concepts and information that are taught and may distort the new information to make it fit their prior experience. 2. This idea of learning with understanding has two parts: (1) factual knowledge *must* be placed in a conceptual framework (a big idea or a set of big ideas) organized in ways that enable students to use and apply that

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			knowledge to make predictions, solve problems, explain new situations, and so forth; and (2) multiple representations that are rich in science ideas and details give concepts meaning. 3. This idea helps students monitor their developing understandings, engaging them in reflecting on their learning experiences, their changing ideas, and their remaining questions and musings.
10:40–12:00 80 min **Content Deepening: Variation in Traits** Slides 40–69	**Purpose** • Determine participants' previous science-content knowledge related to traits, trait variation, and the levels of diversity in life. • Deepen participants' understandings of shared traits and trait variation among individuals within and across different species. • Explore how similarities and differences in traits across different species can be used to organize individual organisms into groups. **Content** • Biologists study diversity and variation across many levels of life. • *Traits* are features or characteristics of an organism that may be visible or hidden. • The traits of individuals of the same kind of plant or animal may or may not vary within a		**Display Slide 40.** Content Deepening: Variation in Traits (Less than 1 min) **Note:** Throughout this content deepening phase, refer as needed to Variation in Plants and Animals and Variation in Traits: Content Background Document and Variation in Traits: Learning Goals for Students and Teachers. a. "Now let's begin our content deepening work on variation in traits."
			**Display Slide 41.** Unit Central Question (Less than 1 min) a. Introduce participants to the unit central question that students will answer in the Variation in Traits lesson sequence. b. "Today we'll explore some key science ideas that will help us answer this central question." c. "Write this question in your notebooks and draw a double-lined box around it." **Note:** Copying the unit central question into their

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	species. • Traits help biologists identify related groups of organisms. • The traits of organisms include physical traits, molecular traits, behavioral traits, chemical pathways, and developmental pathways. • A *species* is a group of individuals that can mate and produce fertile offspring under natural conditions. • Shared traits help biologists define groups of organisms related by common ancestry. • One reason groups of organisms share so many features is common ancestry. • Common ancestry explains why organisms have many shared features that give the impression they're closely related. **What Participants Do** • Explore the definition of a trait. • Identify examples of traits and variations among painted lady butterflies • Identify shared traits among groups of organisms related by common ancestry. • Examine four different species, list their traits, and categorize them.		notebooks will reinforce an important practice participants should follow with their students.
		Content Deepening Focus Questions 1. How do traits of living things help us understand how they're grouped and related? 2. Why are trait variations important for the survival of living things? 3. How can we represent patterns of trait variation among individuals of a species?	**Display Slide 42.** Content Deepening Focus Questions (Less than 1 min) a. Read the focus questions on the slide. b. Ask participants to write the first question in their science notebooks.
		Thinking about Differences What comes to mind when you hear the word *diversity* or *variation*?  	**Display Slide 43.** Thinking about Differences (1 min) a. "What do you think of when you hear words like *diversity* or *variation*? Let's hear some of your ideas." **Note:** This elicit question is designed to uncover participants' initial ideas. Don't try to correct their ideas at this point or lead them to the right answers. b. As participants share their ideas, record them on chart paper.

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• Learn how biologists organize living organisms into groups based on the presence or absence of certain traits.
• Assign organisms to related groups and make a claim stating why each organism belongs in a particular group.
• Identify traits that differ among species of organisms and explain how trait variations might affect survival.
• Link activities to the NGSS performance expectations for 3rd grade.

Videos
• The Life Cycle of Painted Lady Butterflies (YouTube video)

Handouts in PD Binder
• 1.6 Traits and Groups (1 per pair)

Supplies
• Science notebooks
• Chart paper and markers

PD Resources
• STeLLA strategies booklet
• RESPeCT lesson plans binder

Resources in Lesson Plans Binder
Resources section:
• Content background document
Pretabs section:
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<td>Display Slide 44. Traits and Trait Variation in Butterflies (5 min)

a. “As you watch a video clip about the life cycle of painted lady butterflies, look for examples of traits and trait variations in the butterflies and record your observations in your notebooks.”
b. Show the YouTube video from the beginning to segment 4:27.
c. Invite one or two participants to share their observations of butterfly traits and variations with the group.
Observations:
• Some traits that vary are the size and shape of the caterpillars, the timing of the silk-button formation, and the timing of butterflies emerging from the chrysalis.</td>
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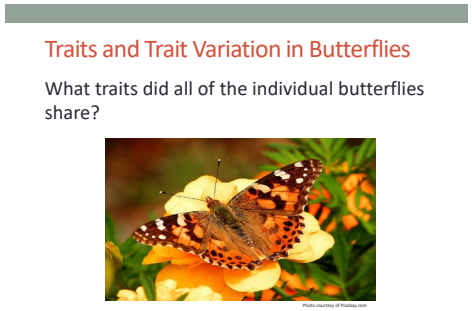
<td> 
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<td>Display Slide 45. Traits and Trait Variation in Butterflies (Less than 1 min)

a. “What traits did all of the individual butterflies in the video share?”
Possible responses:
• The number of legs
• The number of body segments
• The number of eyes
• The life cycle
• The basic pattern of colors in the same life stages.</td>
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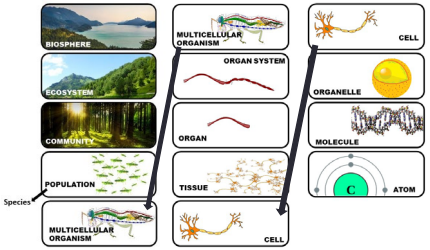
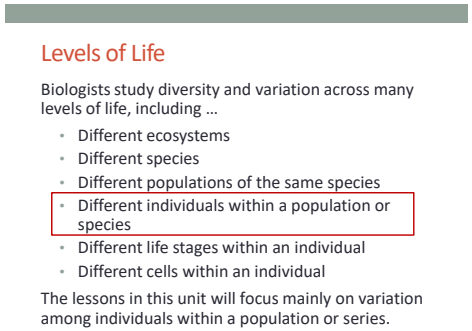
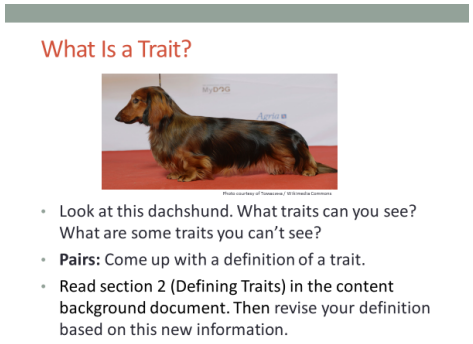
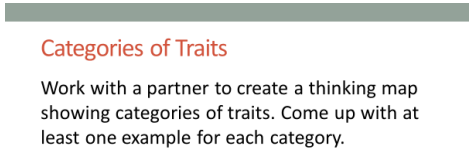
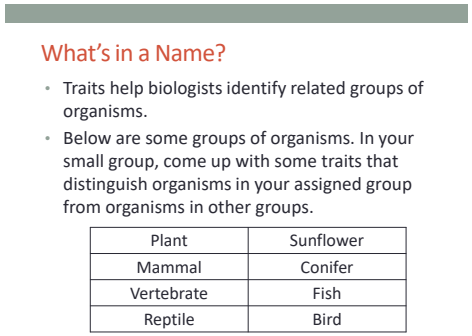
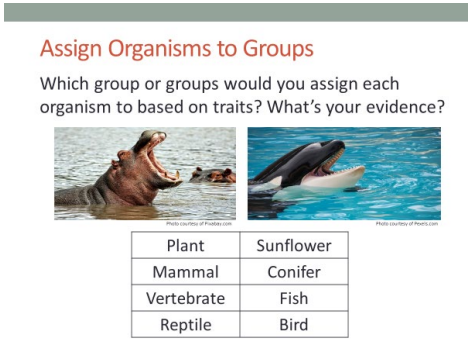
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	• Variation in Traits: Learning Goals for Students and Teachers	Levels of Life In the video clip, we identified trait variations among individual butterflies, but life has many levels of organization. What do you think the phrase "levels of life" means?	**Display Slide 46.** Levels of Life (1 min) **Note:** This slide marks a transition into a discussion of trait variation at different levels of life. a. "In the video clip, we identified a several trait variations among *individual* butterflies, but life has many levels of organization." b. "What do you think the phrase "levels of life" means?" c. Invite a few participants to share their initial ideas.
		Levels of Life  	**Display Slide 47.** Levels of Life (1 min) a. "Biologists study life at various levels of organization. Let's briefly review the levels of life on the slide." b. Walk participants through the various levels of life on the slide, but don't dwell on the details or differences between levels at this point. c. "Variations can be observed at all of these levels, with the exception of the biosphere, since it's unlikely we'll find other biospheres in the universe." d. "Each higher level of life may have properties that aren't necessarily predictable from lower levels. For example, cells may have certain functions and accomplish things that we wouldn't necessarily be able to predict based on knowing which organelles and molecules make up the cells."

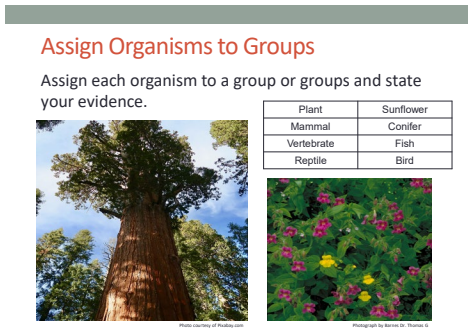
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 48.** Levels of Life (Less than 1 min) a. "Biologists study diversity and variation across many levels of life, such as across different ecosystems, species, populations within a species, individuals within a population or species, life stages within an individual, and cells within an individual." b. Emphasize that the lessons in the Variation in Traits unit will focus mainly on variation among individuals within a population or species.
			**Display Slide 49.** What Is a Trait? (8 min) a. "Look at this photo of a dachshund. What traits do you see? What are some traits you can't see?" b. As participants share their observations, record five or six traits on chart paper. c. **Individuals:** Ask participants to come up with a concise working definition of a trait and write it in their notebooks. d. **Whole group:** Invite a few participants to share their definitions with the group. As time allows, ask probe questions, such as "What do you mean when you say …?" "Can you define this more precisely?" and "Can you elaborate on that idea?" e. After the discussion, have participants locate the content background document in their lesson plans binders and read the section titled "Defining Traits." Then give them a minute or two to revise their definitions based on this information. Their revisions should be in their own words.

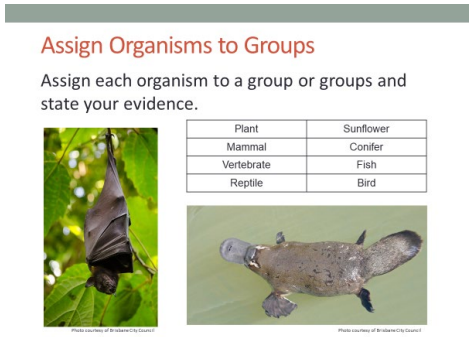
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			f. Emphasize from the reading that traits are features or characteristics of organisms that may be visible or hidden. They aren't just physical features; they can also be behaviors, molecular characteristics like DNA, chemical pathways, or developmental pathways.
			**Display Slide 50.** Categories of Traits (6 min) a. **Pairs (3 min):** "Now I'd like you to work with an elbow partner to create a thinking map showing categories of traits. Come up with at least one example for each category. Your examples may include traits of dachshunds and other kinds of organisms." b. **Whole-group discussion (3 min):** "What categories of traits and examples did you come up with?" **Note:** Ideally, pairs should come up with most or all of the following categories of traits and cite at least one example for each category : • External physical traits (e.g., fur color, eye color, hair length) • Internal physical traits (e.g., brain size, bone structure) • Behavioral traits (e.g., mother feeding offspring with milk) • Molecular traits (e.g., DNA) • Developmental pathways (e.g., stages of butterfly life) • Chemical pathways (e.g., how food is broken down and used)

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 51.** Identifying and Categorizing Traits (7 min) **Note:** Hide the photographs during the synonym discussion. Then reveal one photo at a time in the following order: (1) dolphin, (2) tardigrade (water bear), (3) *Staphylococcus aureus* bacteria, and (4) human beings. Don't reveal the next organism in the sequence until participants have listed traits for the current organism. a. "What synonyms can you think of for the word *trait*? Let's try to come up with three or four." b. Write the synonyms on the board; then ask participants which ones their students are most likely to use. c. Next, reveal one photograph at a time (see note above) and ask participants to come up with three traits for each of the following organisms. Also share the notes of interest. • A dolphin • A tardigrade or water bear. (**Note:** These amazing organisms can survive in temperatures between −458 ºF to about 300 ºF, and they can live 30 years without food or water.) • A bacteria called *Staphylococcus aureus*. (**Note:** Some forms of this bacteria are resistant to antibiotics [methicillin-resistant *Staphylococcus aureus*] and cause outbreaks in schools and hospitals. Biologists categorize bacteria using common traits, such as the kinds of foods they eat and the chemicals they break down.)

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			• Human beings d. List the organisms on chart paper and record the traits participants come up with. e. "Now let's try to categorize these traits using the categories we listed earlier: physical traits, behavioral traits, molecular traits, developmental pathways, or chemical pathways."
			**Display Slide 52.** What's in a Name? (6 min) a. "Traits help biologists identify related groups of organisms like the ones on this slide. Let's see if we can identify traits that distinguish each of these groups from other groups of organisms." b. **Small groups (3 min):** Have participants divide up into small groups of two or three. Then assign each pair or threesome one group of organisms on the slide to investigate. To find information about their assigned organism, participants may use a search engine on their smartphones. Direct them to come up with a list of traits that distinguish their group of organisms from other groups on the chart. c. **Whole-group discussion (3 min):** Invite a few participants to share the traits they listed for their assigned group of organisms. Ask probe questions to find out why they think these traits distinguish their group of organisms from other groups.

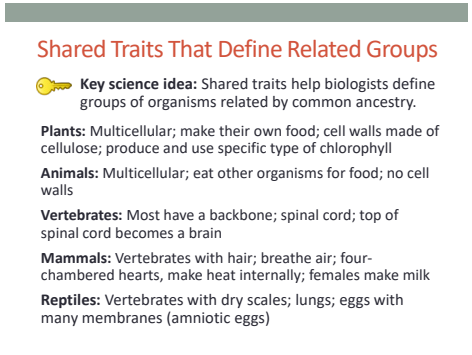
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 53.** Assign Organisms to Groups (5 min) **Note:** Initially, display only the questions at the top of the slide. a. "Next, we'll use our knowledge of traits to assign different organisms to groups." b. Reveal the image of the hippo and the chart of organisms. c. "Look at the organism chart on the slide and think about where you would place the hippo based on specific traits. Which group would be the most specific, or least inclusive? What evidence supports your decision?" d. Next, reveal the image of the orca whale and ask participants to assign the organism to the least inclusive group on the chart based on specific traits. Make sure participants back up their answers with evidence. e. Highlight the traits that hippos and the orcas have in common. Then ask, "What are some differences between these organisms? How might these differences help the two species live in their environment?" **Ideal responses:** • *Similarities:* Hippos and whales are both mammals. This means they're vertebrates with hair, they breathe air and have four-chambered hearts, they make heat internally, and females make milk. Both hippos and whales are large and heavy and have very little hair. Interestingly, they're closely related in evolutionary history. • *Differences:*

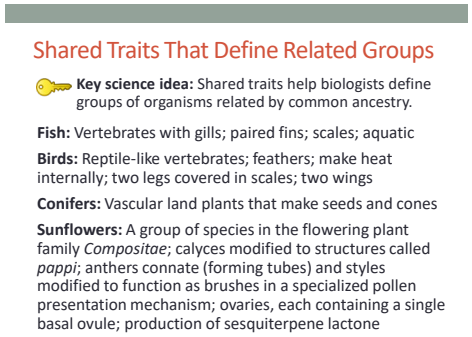
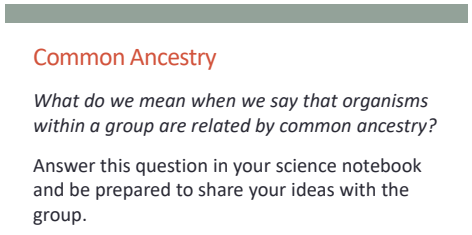
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			• Whales live in a water environment, while hippos live on land, although they also spend quite a bit of time walking or floating in water (but not swimming). • Hippos have legs (for walking and running); whales have fins (for swimming). • Hippos are herbivores that eats plants, whereas whales are carnivores that eat fish, seals, sharks, and other organisms. • Hippos have smaller teeth for grinding food and larger teeth for cutting food; whales use their teeth only for cutting food, and they swallow smaller fish whole. • The coloring of hippos and orcas is quite different. Orcas are black and white, while hippos are bluish gray or black with pink skin around the eyes and ears and on the belly. • Orcas form pods and are highly social, while hippos aren't social at all.
			**Display Slide 54.** Assign Organisms to Groups (4 min) **Note:** Initially, display only the instructions and chart at the top of the slide and the image of the sequoia tree. a. Ask participants to assign the sequoia tree to the most specific (least inclusive) group based on traits and include their evidence. b. Next display the image of the monkeyflower bush and ask participants to assign the organism to the most specific (least inclusive) group based on traits. Make sure they support their choices with evidence. c. Highlight the traits these plants have in common.

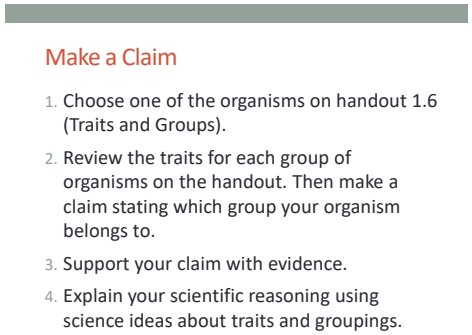
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			Then ask, "What are some differences between sequoias and monkeyflower bushes? How might these differences help the two species live in their environment?" **Ideal responses:** • *Similarities:* Both the sequoia tree and the monkeyflower bush are plants. This means they're multicellular, make their own food, have cell walls made of cellulose, and produce and use a specific type of molecule called *chlorophyll* for photosynthesis. • *Differences:* Sequoia trees are conifers, which have needles instead of leaves and produce pine cones. They also don't lose their needles in winter. Monkeyflower bushes aren't conifers. They're also much smaller than sequoias and produce colorful flowers.
			**Display Slide 55.** Assign Organisms to Groups (4 min) **Note:** Initially, display only the instructions and chart at the top of the slide and the platypus photo. a. Ask participants to assign the platypus to the most specific (least inclusive) group based on traits and include their evidence. b. Next display the photo of the bat and have participants assign the organism to the most specific (least inclusive) group based on traits. Make sure they support their choices with evidence. c. Highlight the traits these animals have in common. Then ask, "What are some differences between platypuses and bats? How might these

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

			differences help the two species live in their environment?"
			
			Ideal responses:
			• *Similarities:* Both platypuses and bats are mammals. This means they're vertebrates with hair, they breathe air and have four-chambered hearts, they make heat internally, and females make milk.
			• *Differences:*
			  • Platypuses are semiaquatic; bats aren't.
			  • Platypuses eat insect larvae, worms, and shrimp; bats primarily eat insects, as well as fruits, flower nectar, and blood.
			  • Platypuses are egg-laying mammals; bats deliver their offspring.
			  • Platypuses have legs; bats have webbed wings.
			  • Platypuses live only in Australia and Tasmania; bats are present throughout most of the world.

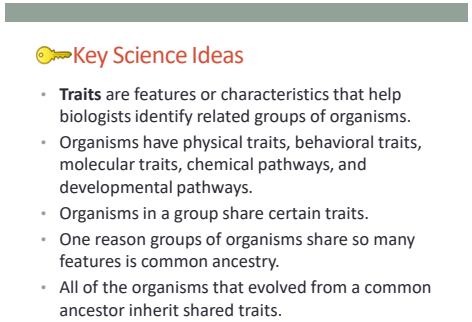
			**Display Slide 56.** Shared Traits That Define Related Groups (Less than 1 min) a. "This slide and the next list some of the shared traits that define related groups of organisms." b. Instead of reading all of the traits, list two traits and then highlight the key science idea: *Shared traits help biologists define groups of organisms related by common ancestry.*

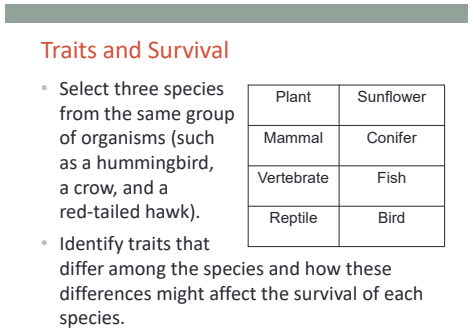
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 57.** Shared Traits That Define Related Groups (Less than 1 min) a. List two of the traits on the slide and note that some traits become quite specialized in sunflowers. b. Then highlight the key science idea again: *Shared traits help biologists define groups of organisms related by common ancestry.*
			**Display Slide 58.** Common Ancestry (2 min) a. "What do you think we mean when we say that organisms within a group are related by common ancestry?" b. As participants share their ideas, record them on chart paper. c. **Emphasize:** "Common ancestry explains why organisms have many shared features that give the impression they're closely related." **Note:** During this discussion, make sure participants understand that heredity and evolutionary relationships are involved.

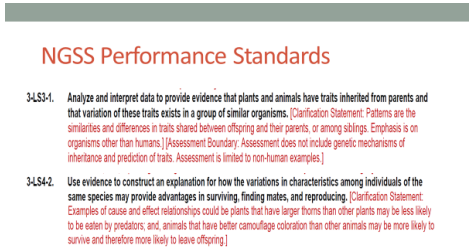
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 59.** Make a Claim (10 min) **Note:** Participants may use available resources, such as the STeLLA strategies booklet, for this activity. a. "For this next activity, you'll work with a partner to develop a claim stating which group you think an organism belongs to and supporting your claim with evidence and reasoning." b. Have participants pair up; then give each pair a copy of handout 1.6 (Traits and Groups). c. **Pairs:** Review the instructions on the slide and handout. Then answer any questions before pairs begin working on the tasks. d. **Whole group:** Invite pairs to share their claims, evidence, and reasoning. Ask challenge questions as needed, such as "Can you use science ideas we've been talking about to further support your claim?" Encourage other participants to agree or disagree, add on, or ask questions. e. Emphasize that developing an explanation by making a claim and supporting it with evidence and reasoning is an important skill in the NGSS and Common Core and is one of the Student Thinking Lens strategies they'll explore in more detail later in the PD program. For now, note that one of the most difficult parts of developing an explanation is linking the claim to scientific reasoning and the underlying science ideas. For example, the scientific reasoning that explains why dolphins are mammals is that all mammals at one point in time shared a common ancestor. This common ancestor must have had traits (such as having hair and a four-chambered heart,

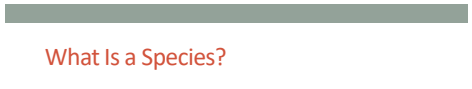
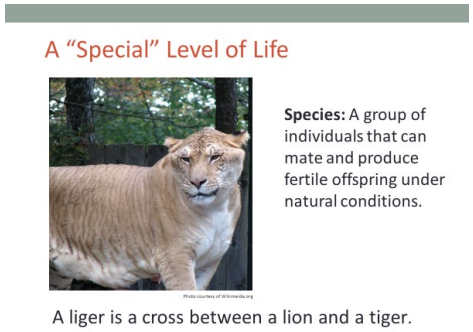
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process

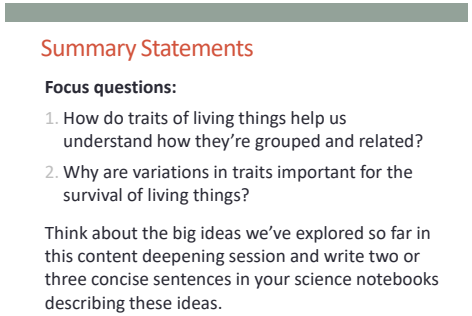
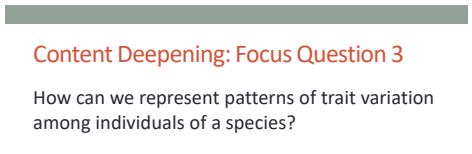
			breathing air, generating heat, and making milk) that it passed on to the groups that evolved from it. This reasoning relates to one of the teacher learning goals for this session: One reason groups of organisms share so many features is common ancestry.
			
			Ideal responses:
			• *Question 2 (least inclusive group):*
			  • Dolphin: mammal
			  • Lamprey: vertebrate (**Note:** The lamprey is interesting because it's classified as a vertebrate but lacks a true backbone. Instead, it has a similar structure made out of cartilage.)
			  • Snail: Animal
			  • Penguin: Bird
			• *Questions 3 and 4 (sample claim, evidence, and reasoning):*
			  • I claim that the penguin is a bird. My evidence is that penguins have the following traits of birds: They have vertebrae, feathers, two legs covered in scales, and two wings, and they make heat internally. My reasoning is that scientists put organisms into groups that share certain traits. Scientists believe that these traits have been passed down to them through common ancestors. Penguins have the same traits and the same ancestors as other organisms in the birds group. They aren't mammals because they don't share common ancestors or the traits of mammals, such as having hair or making milk.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 60.** Reflect: Content Deepening Focus Question 1 (3 min) a. Review the focus question on the slide. b. **Individuals (1 min):** Have participants answer this question in their science notebooks. c. **Whole group:** Invite one or two participants to share their answers and reasoning with the group.
			**Display Slide 61.** Key Science Ideas (Less than 1 min) a. Highlight the key science ideas on the slide.
			**Display Slide 62.** Content Deepening: Focus Question 2 (Less than 1 min) a. Read the focus question on the slide. b. Ask participants to write the question in their science notebooks.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 63.** Traits and Survival (7 min) **Note:** Don't spend too much time on this activity, since participants should understand the reasoning involved. To stay within the allotted time, you may need to reduce the number of species participants examine. a. "The purpose of this next activity is to set the stage for understanding the origins of traits in different species." b. Direct participants to pair up for this activity. c. **Pairs:** "Select three species from the groups of organisms listed on the slide. For example, you might choose a hummingbird, a crow, and a red-tailed hawk. Identify traits that differ among the species and describe how these differences might affect the survival of each organism. For instance, you might describe differences in the beaks, feet, and body size among the hummingbird, crow, and red-tailed hawk. Then describe how these trait variations might help each species survive in its environment. For example, the hawk is an active predator with a sharp, hooked beak. This trait enables the hawk to tear apart its prey, giving it a survival advantage. d. **Whole group:** Invite one pair of participants to share their descriptions and explanations with the group.

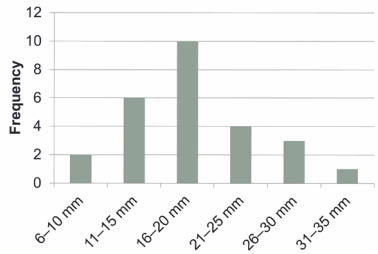
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 64.** Reflect: Content Deepening Focus Question 2 (3 min) a. Review the focus question on the slide. b. **Individuals:** Have participants answer the question in their science notebooks, supporting their ideas with evidence from the activity they just completed. c. **Whole group:** Invite one or two participants to share their explanations and evidence with the group.
			**Display Slide 65.** NGSS Performance Expectations (Less than 1 min) a. Highlight the NGSS performance standards on the slide. b. Emphasize that the focus is on variation among offspring and their parents, as well as within species.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 66.** What Is a Species? (Less than 1 min) a. "How would you define the word *species*?" b. As participants share their ideas, record them on chart paper.
			**Display Slide 67.** Defining a Species (Less than 1 min) a. How many species do you see on the slide? **Note:** Participants should identify two species: lion and tiger. b. Read the definition on the slide and indicate that this is a common definition of a species.
			**Display Slide 68.** A "Special" Level of Life (Less than 1 min) a. "The animal on this slide is called a *liger*, which is a cross between a lion and a tiger. Ligers don't exist naturally in the wild but are the result of crossbreeding practices. Due to crossbreeding, ligers often have birth defects and die prematurely." b. "Based on this evidence, do you still think lions

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			and tigers represent two different species?" c. Emphasize the words "under natural conditions" in the definition of species. Note that under natural conditions, lions and tigers don't overlap, so it's reasonable to classify them as two different species. However, defining species can be very difficult, especially since the common definition doesn't apply to special groups of organisms like bacteria or ligers.
			**Display Slide 69.** Let's Summarize! (3 min) a. Revisit the focus questions on the slide. b. **Individuals:** "Think about the big ideas we've explored so far in this content deepening session and write two or three concise sentences in your notebooks describing these ideas." c. **Whole group:** Invite one or two participants to share their sentences with the group.
12:00–12:45 45 min	**LUNCH**		
12:45–2:10 85 min (Includes 10-min break) **Content Deepening (Continued)**	**Purpose** • Explore patterns of trait variation within a species and how evidence of these patterns can be represented. **Content** • Patterns of trait variation among individuals of a species are represented in different ways and can be recorded on		**Display Slide 70.** Content Deepening: Focus Question 3 (3 min) a. Read the focus question on the slide. b. **Individuals:** Ask participants to write the focus question in their science notebooks and jot down their initial ideas. c. **Whole group:** "What ideas do you have for ways we can *represent* patterns of trait variation in a

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
Slides 70–79	frequency distribution tables and histograms. **What Participants Do** • Investigate trait-variation patterns by collecting and analyzing data for a trait that can be measured in 10–20 individual plants of the same species. • Demonstrate trait-variation patterns within a plant species using data from the investigation to create a histogram and a frequency distribution table. **Handouts in PD Binder** • 1.7 Celebrate Variation! **Supplies** • Science notebooks • Chart paper and markers • Rulers **PD Resources** • RESPeCT lesson plans binder **Resources in Lesson Plans Binder** *Resources section:* • Common Student Ideas about Variation in Traits		species?" d. "To gather information that will help us answer this question, we'll explore trait variation within a species of plant."
		Celebrate Variation! 1. Work with a partner to identify about 15 or 20 individual plants of the **same species** and a trait you would like to measure. Examples of traits you could measure: • The length of the longest stem on 10 rosemary plants • The length of the biggest leaf on 15 rose stems • The height of the flower on 20 dandelions • The length of 20 different pea pods 2. Measure this trait for every individual in your sample population. Then record the data on the Plant Species Measurement table in your handout.	**Display Slide 71.** Celebrate Variation! (20 min) a. "To find trait-variation patterns among individuals of a species, we need to work like scientists. This means collecting data on a specific trait from a sample population and then recording the data on a table. That's what we'll do next." b. Walk participants through the steps on the slide; then distribute handout 1.7 (Celebrate Variation!). Have participants record their data on the Plant Species Measurements table in their handouts. **Option to save time:** To save time, instead of having participants collect their data outside, bring in samples of the same kind of fruit, vegetable, or plant (e.g., 20 bananas, 20 carrots, 20 green beans) for participants to measure.
		Create a Histogram 1. Determine the range in your sample by finding the difference between the largest and smallest measurement. 2. Divide the resulting range into 4 to 6 intervals. 3. Count the number of measurements that fall into each interval and record this data on the frequency distribution table in your handout (page 2). 4. Use the data in your frequency distribution table to create a histogram (bar graph) on your handout that illustrates the results. (See the sample histogram on page 1.)	**Display Slide 72.** Create a Histogram (15 min) a. "Now that you and your partner have collected and recorded your data, let's go over the steps for creating a histogram." b. Walk participants through the steps on the slide. Then display the sample frequency distribution table and histogram on the next two slides. **Note:** As pairs work on their histograms, be available to answer questions and give direction

<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>as needed.
c. After participants have created their histograms, ask them to copy them onto chart paper and then display all the histograms for participants to see.</td></tr>
<tr><td></td><td></td><td>Sample Frequency Distribution Table
<table><tr><th>Length Range</th><th>Number of Individuals in That Range</th></tr><tr><td>6–10 mm</td><td>2</td></tr><tr><td>11–15 mm</td><td>6</td></tr><tr><td>16–20 mm</td><td>10</td></tr><tr><td>21–25 mm</td><td>4</td></tr><tr><td>26–30 mm</td><td>3</td></tr><tr><td>31–35 mm</td><td>1</td></tr></table></td><td>Display Slide 73. Sample Frequency Distribution Table (Less than 1 min)

a. Show participants the sample frequency distribution table and note that it also appears in their handouts.</td></tr>
<tr><td></td><td></td><td>Sample Histogram
 
</td><td>Display Slide 74. Sample Histogram (Less than 1 min)

a. Show participants this sample histogram and note that it also appears in their handouts. Highlight the information that should appear on the x- and y-axes.</td></tr>
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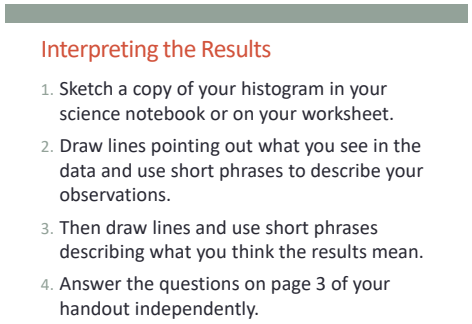
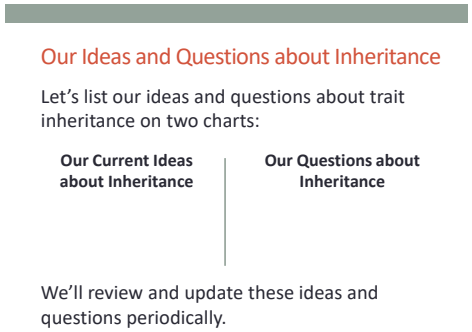
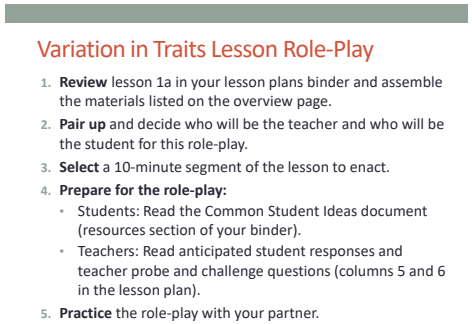
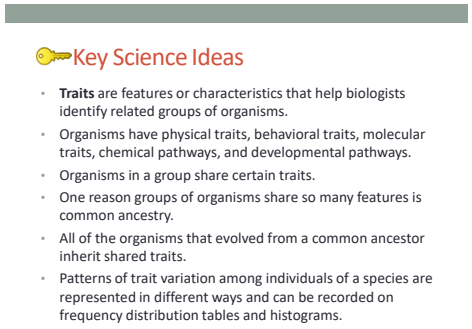
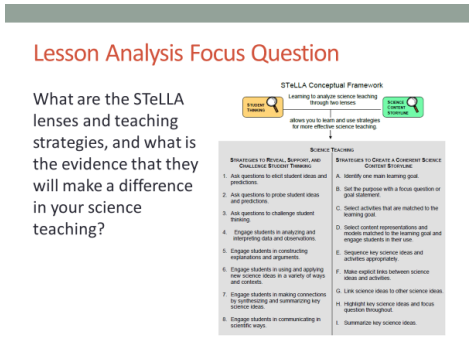
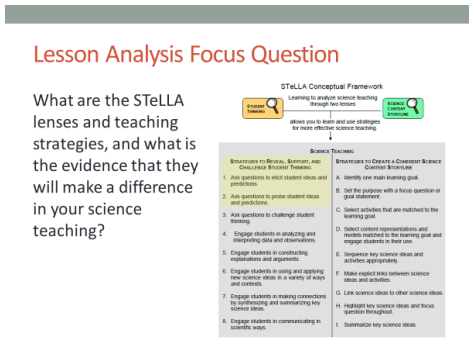
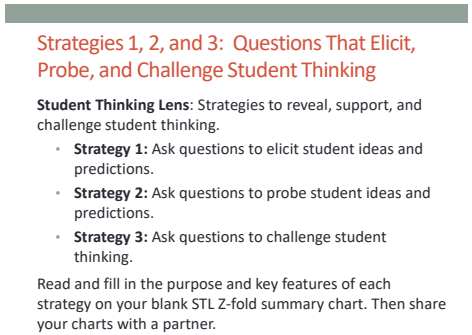
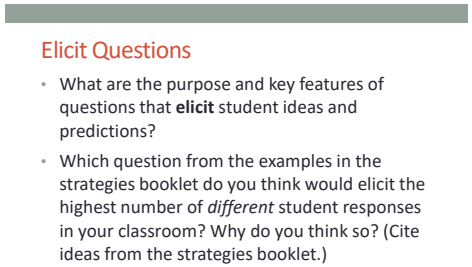
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 75.** Interpreting the Results (7 min) a. Have participants complete the first three steps on the slide. Then have a brief group discussion about their observations and explanations. b. During this discussion, keep participants focused on what they see in the data (observations of patterns) and what they think the results mean (inferences). Use probe questions to clarify their thinking as needed. c. Highlight that a common trait-variation pattern is a bell-shaped curve that scientists call *continuous variation*. Later in the session, participants will contrast this trait-variation pattern with another pattern. d. "What would the bar graph look like if the trait in our sample showed no variation?" **Note:** Participants should recognize that the bar graph would have only one bar. This foreshadows what students will do in lesson 1. e. "Now I'd like you to answer the questions on page 3 of your handouts, using what you already know about traits. Work on this task independently."

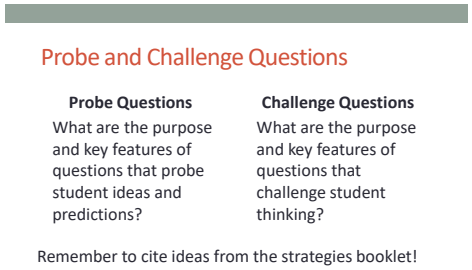
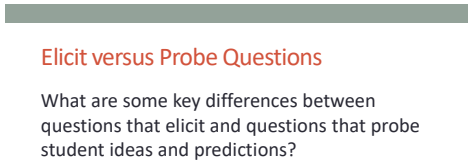
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 76.** Our Ideas and Questions about Inheritance (4 min) a. "Let's list our ideas and questions about trait inheritance on two charts so we can review and update them during our content deepening sessions this week." b. "What do you think accounts for the differences in traits among individuals of the same species? Which types of traits are inherited, and what role might the environment play in some of the differences among individuals?" **Note:** Keep this discussion brief.
			**Display Slide 77.** Variation in Traits Lesson Role-Play (20 min) a. Ask participants to locate lesson 1a in their lesson plans binders. b. Orient participants to key features of the lesson plan, including the overview page, the lesson outline, and the different phases and columns in the main lesson plan. Highlight the unit central question and lesson focus question on the overview page, the materials list, and other information they'll need for the role-play, including where to find the anticipated student responses (column 5) and possible probe and challenge questions (column 6) in the main lesson plan. c. Also show participants where to locate the

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			Common Student Ideas document in the resources section of their lesson plans binders. d. Emphasize that the lesson plans are meant to be used only as a *guide* to help teachers prepare for a lesson, not as a script to follow. These idealized plans demonstrate how the lessons *might* be implemented using embedded STeLLA strategies. e. Share any important lessons you may have learned from teaching the lesson yourself. f. **Pairs:** Review the steps on the slide and have participants pair up to complete the tasks. Make sure teachers and students know what they should read to prepare for the role-play. g. Give pairs adequate time to prepare for and act out their role-plays. h. "Tomorrow, you'll switch roles and act out another lesson."
			**Display Slide 78.** Reflect: Content Deepening Focus Question 3 (5 min) a. Review the focus question on the slide. b. **Individuals:** Ask participants to reflect on the question and record their current ideas in their science notebooks. c. **Whole group:** Invite one or two participants to share their ideas with the group.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 79.** Key Science Ideas (Less than 1 min) a. Review the key science ideas on the slide.
2:00–2:10 10 min	**BREAK**		
2:10–3:00 50 min **STL Strategies: Elicit, Probe, and Challenge Questions** Slides 80–86	**Purpose** • Begin to develop shared understandings of the Student Thinking Lens (STL) and STeLLA strategies 1, 2, and 3 (elicit, probe, and challenge questions). **Content** • Participants are introduced to the purposes and key features of Student Thinking Lens strategies 1, 2, and 3 (elicit, probe, and challenge questions). This is the first step in learning about these strategies. Learning will continue on day 2 when participants watch video footage of these strategies in action.		**Display Slide 80.** Lesson Analysis Focus Question (1 min) a. Read the focus question on the slide. b. "The visual on this slide tells us a little about the first part of our focus question: What are the STeLLA lenses and teaching strategies? As you can see, there are eight specific science teaching strategies to support the Student Thinking Lens." c. **Acknowledge:** "I know you have existing frameworks (ideas and language) regarding teaching and learning, and I expect you'll continuously draw from them throughout the Summer Institute."

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	• Elicit questions are designed to reveal a variety of student ideas, misconceptions, and experiences before they learn new content. • Probe questions follow up on something a student has already said to find out more. • Challenge questions are designed to push students toward more-scientific understandings by making new connections and changing their thinking. **What Participants Do** • Read about STeLLA strategies 1, 2, and 3 and write summaries on their blank STL Z-fold summary charts. • Chart and discuss the purposes and key features of strategies 1, 2, and 3. • Discuss key similarities and differences among the three strategies. **Supplies** • Chart paper and markers **PD Resources** • STeLLA strategies booklet • STL Z-fold summary chart (blank copy in front pocket of PD binder)		**Display Slide 81.** Lesson Analysis Focus Question (1 min) a. "Today we'll begin learning about three of the Student Thinking Lens teaching strategies." b. Read the strategies highlighted on the slide. c. "These three types of questions will help reveal, support, and challenge student thinking." d. **Emphasize:** "Even though we're studying the strategies this summer, you'll better understand them as you start trying them out in your teaching next fall."
			**Display Slide 82.** Strategies 1, 2, and 3: Questions That Elicit, Probe, and Challenge Student Thinking (20 min) a. Orient participants to the STeLLA strategies booklet. Forecast that you'll come back to this resource repeatedly to ensure consistent use of ideas, meaning, and language that match the STeLLA conceptual framework. b. **Individuals:** Have participants read about all three strategies and write on their blank STL Z-fold summary charts the purpose(s) and key features of each strategy. State that in the future, they'll do this kind of reading and writing as homework. c. **Pairs:** Have participants pair up and share their Z-fold summary charts. Encourage them to provide evidence from the readings to support their ideas and ask each other questions consistent with the norms for working together,

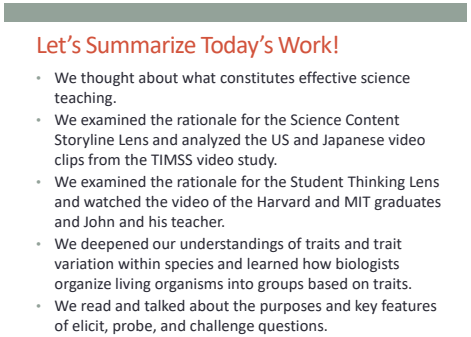
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			such as “Where did you find that?” or “I interpreted that differently.”
			**Display Slide 83.** Elicit Questions (5 min) a. As a group, discuss the purpose and key features of questions that elicit student ideas and predictions. Write these features on chart paper and hang the chart where it can be referenced later. b. Sample chart: **Key Ideas about Elicit Questions** **Purpose:** To reveal student ideas, predictions, misconceptions, and experiences *before* they learn about the content. **Key features:** • Asked anytime, but often at the beginning of a lesson • Phrased in everyday language that students can understand even before studying the related content • Addressed to multiple students (usually the whole class) • Reveals a variety of student ideas • Useful to teachers in adapting instruction • Useful to students so they see that others have different ideas • Can be a prediction • Can set up a discrepant event

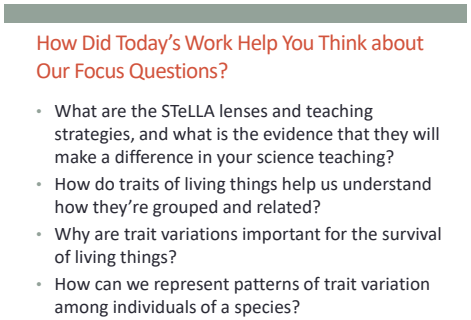
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 84.** Probe and Challenge Questions (13 min) a. **Small groups (5 min):** Split participants into two groups—one group for probe questions and one group for challenge questions. Have each group create a chart of the purpose and key features of the assigned strategy *from the STeLLA strategies booklet* (not from experience). b. **Whole group (8 min):** Share the charts with the entire group. Encourage participants to add to, delete from, and modify them as needed to ensure they're accurate and match the language in the strategies booklet.
			**Display Slide 85.** Elicit versus Probe Questions (5 min) a. **Turn and Talk:** "Discuss this question with an elbow partner." b. **Whole-group share-out:** Invite participants to share their ideas with the group. **Key ideas about elicit questions versus probe questions:** • Elicit questions are addressed to the whole class; probe questions are addressed to individual students. • Elicit questions are used before students have studied a concept; probe questions can be asked at any time. • Elicit questions start a discussion; probe questions follow up on something a student has

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			already said.
		Elicit/Probe Questions versus Challenge Questions What are some key differences between questions that elicit and probe student ideas and predictions and questions that challenge student thinking?	**Display Slide 86.** Elicit/Probe Questions versus Challenge Questions (5 min) a. **Turn and Talk:** "Discuss this question with your elbow partner." b. **Whole-group share-out:** Invite participants to share their ideas with the group. **Key ideas about elicit/probe questions versus challenge questions:** • Elicit and probe questions focus on understanding students' existing ideas rather than trying to change students' thinking. • In contrast, challenge questions are designed to push students' thinking toward more-scientific understandings and support them in changing their thinking.
3:00–3:30 30 min **Wrap-Up: Summary, Homework, and Reflections** Slides 87–91	**Purpose** • Summarize and reflect on key ideas from today's learning and foreshadow what will be addressed tomorrow and later in the week. **What Participants Do** • Review the lesson plans binder. • Summarize today's learning and discuss the focus questions. • Go over directions for an extended homework assignment related to the	The RESPeCT Lesson Plans Binder **What comes before the lessons?** • Scope and sequence • Learning goals • California NGSS • Student pretest/posttest • Features analysis chart • Working with English language learners (ELLs) in science **Overview of lesson format and structure:** • Lesson overview • Lesson outline • Detailed lesson plan	**Display Slide 87.** The RESPeCT Lesson Plans Binder (5 min) a. **Foreshadow:** "In a moment, we'll review the details of a homework assignment related to the lesson plans you'll be teaching in the upcoming school year." b. "But before we look at the assignment, let's review the organization and contents of the lesson plans binder." c. Use the slide to guide participants through the binder contents.

<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>Variation in Traits lesson plans (content area 1).
• Write reflections on today's session.

Handouts in PD Binder
• 1.8 Extended Homework: RESPeCT Lesson Plan Analysis
• 1.9 Daily Reflections—Day 1

PD Resources
• RESPeCT lesson plans binder</td><td></td><td></td></tr>
<tr><td></td><td></td><td> 
</td><td>Display Slide 88. Let's Summarize Today's Work! (5 min)

a. Remind participants of the various activities they've been involved in today.
b. Foreshadow: Let participants know that you're going to ask them to reflect on what they've learned from these activities.</td></tr>
<tr><td></td><td></td><td> 
</td><td>Display Slide 89. How Did Today's Work Help You Think about Our Focus Questions? (10 min)

Note: If time is running short, you may want to skip the Turn and Talk or the entire slide.
a. Turn and Talk: "Discuss these questions with an elbow partner."
b. Whole-group share-out: Invite participants to share their ideas with the group.</td></tr>
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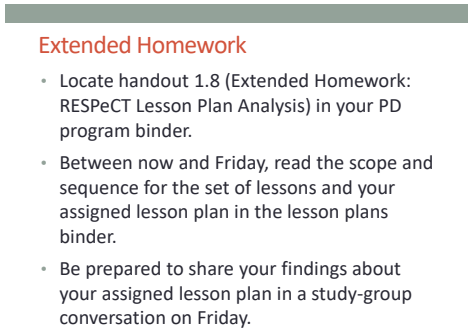
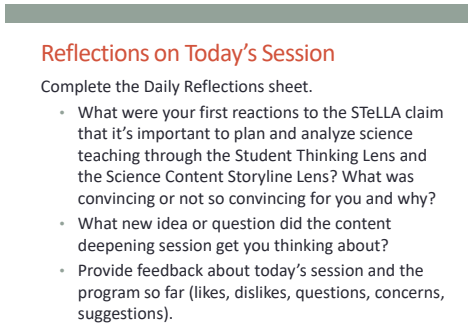
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 90.** Extended Homework (5 min) a. Assign each participant one of the lessons in the Variation in Traits lesson-plan sequence. There are seven 2-part lessons in this content area. Each teacher should take responsibility for one 2-part lesson. That is, Teacher 1 will study lessons 1a and 1b; Teacher 2 will study lessons 2a and 2b; and so forth. b. If the study group is small, figure out who will be assigned an extra lesson (or when you, as the PD leader, will cover any extra lessons). c. If the study group is large, assign lessons to more than one teacher later in the sequence. d. Go over the homework sheet (handout 1.8) with participants. If time allows, have them read the assignment sheet before discussing.
			**Display Slide 91.** Reflections on Today's Session (5 min) a. Review the questions on the Daily Reflections sheet (handout 1.9). b. Ask participants to think about these questions and write down their reflections.