RESPeCT Summer Institute Professional Development Leader Guide (PDLG)

Grade Level	1	**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**	Sound

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 can we tell if something is making a sound? • How does sound travel from a soundmaker to our ears?
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 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. • Sound is produced when objects vibrate very quickly back and forth, causing the air around them to vibrate. These vibrations or air disturbances create sound waves. • Sound waves begin at the source of a sound and travel in all directions away from the source. • When sound waves reach our ears, our eardrums vibrate, and our brains interpret these vibrations as sound.

Preparation	**Materials**	**Videos**
Daily Setup Tasks • Check that video clips are correctly linked to PowerPoint (PPT) slides. • Set up PowerPoint. • Make sure video clips play correctly with good sound. • Arrange furniture and food. • Arrange participant materials. • Put up posters and charts. **Day-1 Setup Tasks** • Arrange participant materials on tables in	**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) • 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	• 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 Content deepening: • *What Is Sound?* YouTube video (25 seconds); https://www.youtube.com/watch?v=27a26e2CnuM

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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.
- Assemble science notebooks and materials.
- Prepare charts for the agenda, focus questions, and norms.
- Review the activities for Sound lessons 1b, 2a, 3, and 6a in the lesson plans binders as needed.
- Content deepening:
  - Read sections 1–4 of the content background document.
  - Preview the YouTube video clips *What Is Sound?* and *Longitudinal Waves Using a Slinky*. Make sure the links are working correctly.
  - Assemble several kazoos using cardboard toilet-paper rolls (with a hole punched in the side of each), wax paper, and rubber bands. (See the assembly instructions in Sound lesson 6a.)
  - Assemble a soundmaker using a small plastic container and a rubber band. Place the rubber band around the container so that it stretches across the opening. (See the instructions in Sound lesson 1b.)

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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 Soundmakers
- 1.7 Sound on the Move (from Sound lesson 3)
- 1.8 Extended Homework: RESPeCT Lesson Plan Analysis
- 1.9 Daily Reflections—Day 1

Handouts in RESPeCT Lesson Plans Binder

- 6.1 The Ear (from Sound lesson 6a)

Supplies

- Science notebooks
- Chart paper and markers
- Lesson materials kit
- For content deepening:
  - Tuning fork (for demonstration)
  - 1 extra-long Slinky
  - Several homemade kazoos (from Sound lesson 6a)
  - Rubber bands
  - Small plastic containers (preferably a square measuring cup)
  - Cluckers (from Sound lesson 2a)
    - 1 clear-plastic cup (9 oz) with a hole in the bottom
    - 18" of string
    - 2 small paperclips or toothpicks
    - Small piece of sponge

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

- *Longitudinal Waves Using a Slinky* YouTube video (1:24); https://www.youtube.com/watch?v=GIkeGBXqWW0

• Assemble one clucker for demonstration purposes. (See the assembly instructions in Sound lesson 2a.)	*Resources section:* • Sound Content Background Document • Common Student Ideas about Sound *Pretabs section:* • Sound: 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: Sound**	• Deepen participants' science-content understandings of sound and how sound is produced and received by conducting investigations from the Sound lessons.
12:00–12:45 45 min	**LUNCH**	
12:45–2:10 85 min (Includes 10-min break)	**Content Deepening (Continued)**	• Deepen participants' science-content knowledge of sound waves and how they travel through the air to the ear. • Illustrate what constitutes a good soundmaker and sound receiver using components from the Sound lessons.
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.

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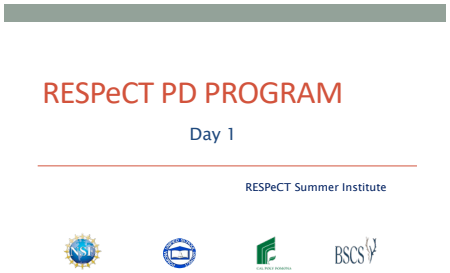
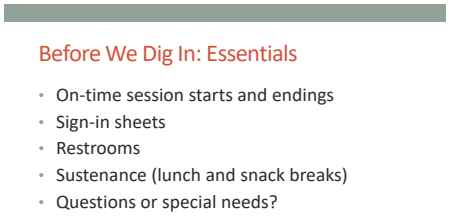
DAY 1

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
	  • The 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.

			**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.

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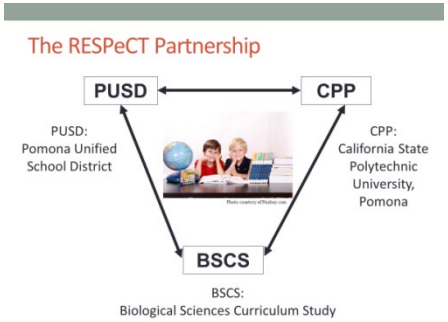
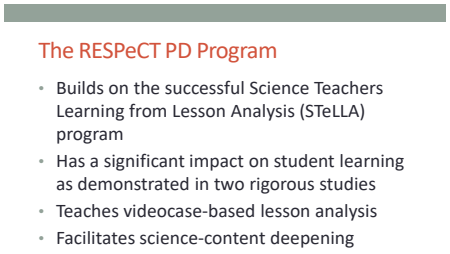
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 4.** The RESPeCT Partnership (Approximately 1 min) a. The original RESPeCT partners included the following: • **Cal Poly:** science, science education, and mathematics faculty, as well the Center for Excellence 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 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.

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PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		The RESPeCT PD Program Extends the STeLLA approach by • Addressing grade-level standards in Next Generation Science Standards (NGSS) • Incorporating Common Core English language arts (ELA) and math standards • Addressing more explicitly the needs of English language learners (ELLs) • Addressing all grade levels, K–6	**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.
		Goals of the RESPeCT PD Program • Deepen teachers' science-content knowledge and knowledge of effective science teaching. • Develop teachers' analytical skills to improve lesson-plan development and the teaching of science. • Support teachers in the practical use of new knowledge and analytical skills in their classrooms. • Improve students' science learning. • Achieve sustainability by eventually reaching all K–6 teachers.	**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.
		Summer Institute Study-Group Leaders Grade [Insert grade level here] • [Insert leader names here] • [Insert leader names here]	**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.

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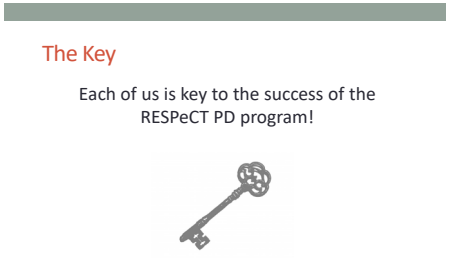
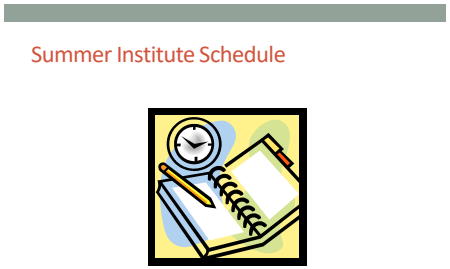
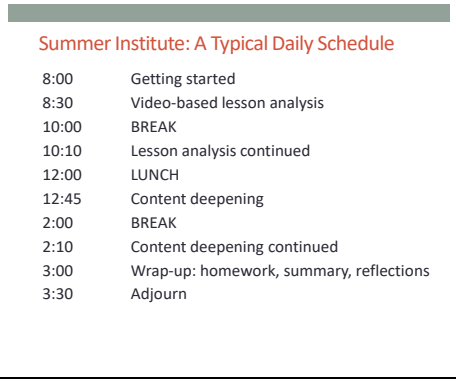
			**Display Slide 9.** The Key (Approximately 1 min) a. Many people are involved in organizing, planning, and leading this program, but the teacher-participants are the key to its success.
			**Display Slide 10.** Summer Institute Schedule **Note:** This is a transition slide.
			**Display Slide 11.** 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.

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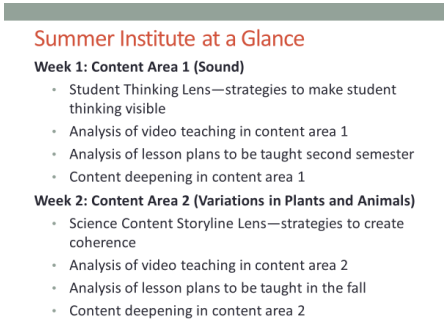
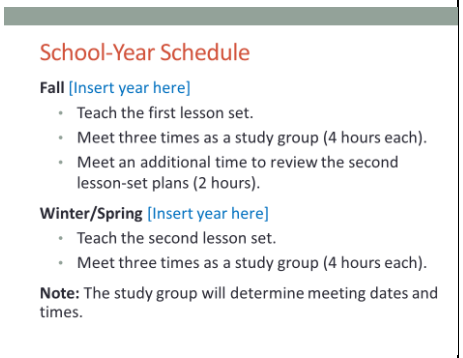
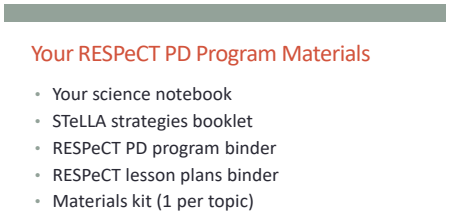
			**Display Slide 12.** Summer Institute at a Glance (Approximately 1 min) a. During the Summer Institute, each grade level will focus on two content areas, with one week devoted to each area. Participants will deepen their science-content knowledge, study lesson plans in each content area, and analyze 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.”
			**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.”

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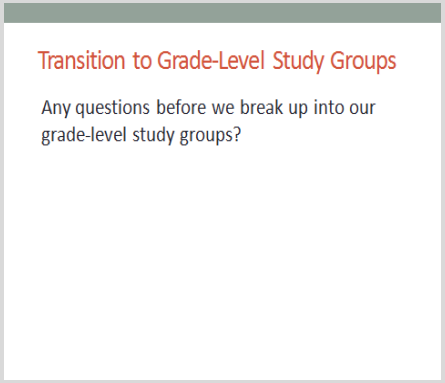
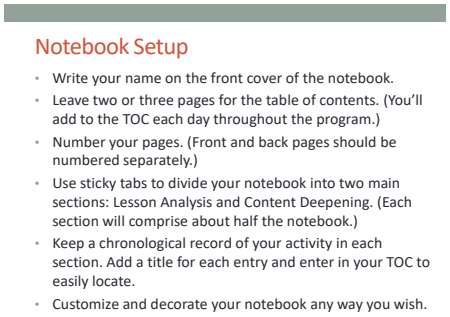
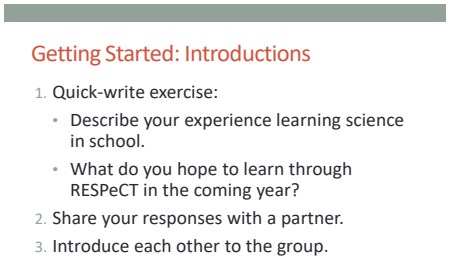
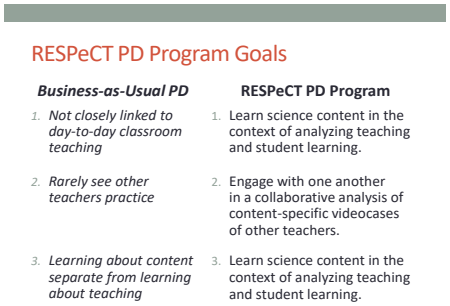
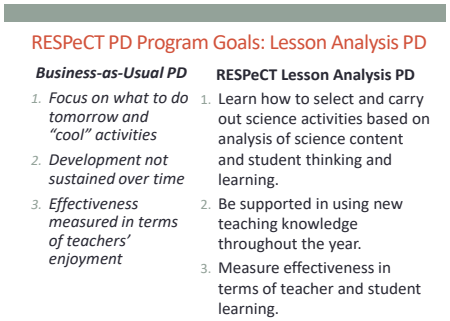
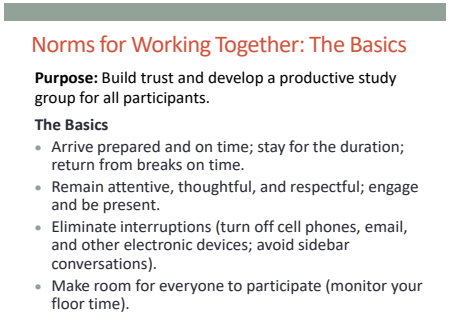
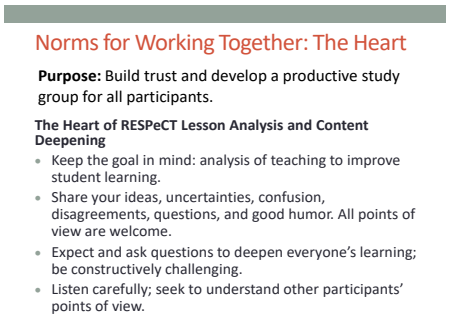
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
8:25–8:30 5 min **Transition** Slide 15	**Transition to Grade-Level Study-Group Settings**		**Display Slide 15.** Transition to Grade-Level Study Groups (5 min) a. "Any questions before we head to our grade-level study groups?" 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: 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		**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 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,

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

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

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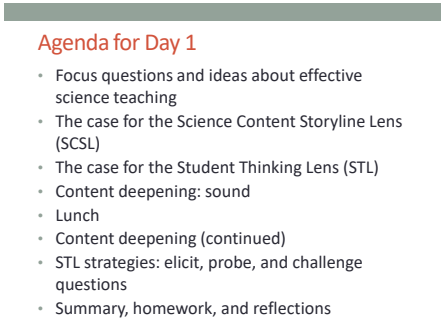
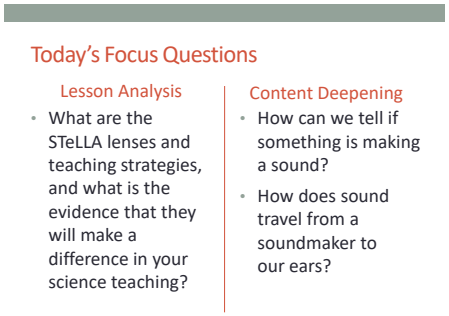
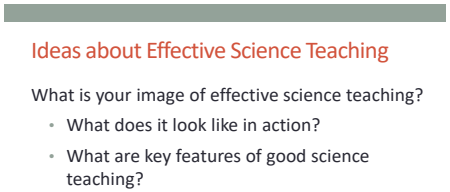
			**Display Slide 22.** Agenda for Day 1 (Less than 1 min) a. Talk through the agenda for the day.
			**Display Slide 23.** Today's Focus Questions (1 min) a. "Each day we're going to have at least one lesson analysis focus question and one content deepening focus question. These are today's focus questions." b. Read the focus questions on the slide.
			**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

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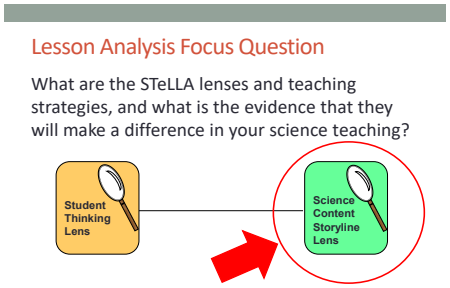
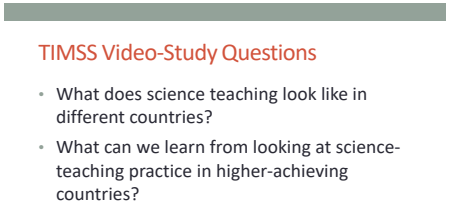
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			other modifications."
9:20–10:10 50 min (Includes 10-min break) **The Case for the Science Content Storyline Lens (SCSL)** Slides 25–34	**Purpose** • Draw from the TIMSS video study to build the case for the Science Content 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** • 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		**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."
			**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.

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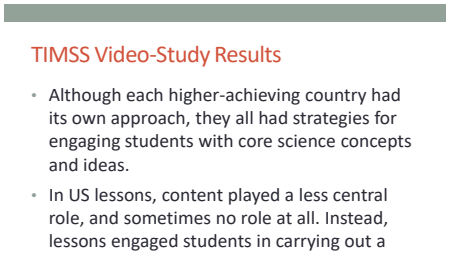
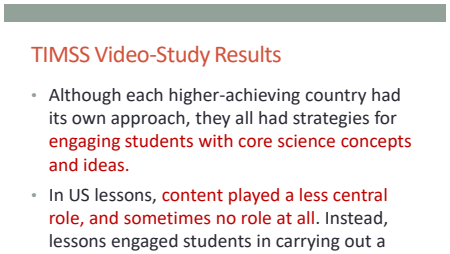
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	• Video Clip 1.2, TIMSS Japan Lesson 1 **Handouts in PD Binder** • 1.2 Transcript for Video Clip 1.1 • 1.3 Transcript for Video Clip 1.2 • 1.4 TIMSS *Educational Leadership* article		**Display Slide 27.** TIMSS Video-Study 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."
			**Display Slide 28.** TIMSS Video-Study Results (2 min) a. "The TIMSS video study showed these results."
			**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.

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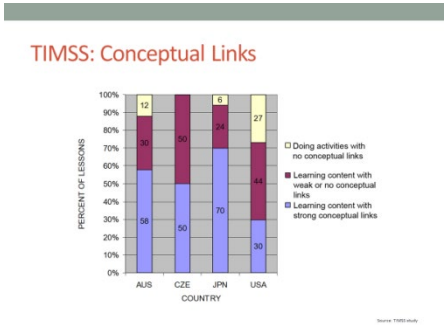
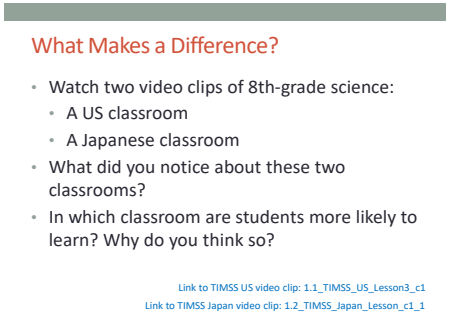
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 30.** TIMSS: Conceptual Links (3 min) a. **Ask:** "What do you notice from this graph? What do you make of this data?" b. **Emphasize:** "In the US, more than a quarter of the lessons had no science content; 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:** "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.

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

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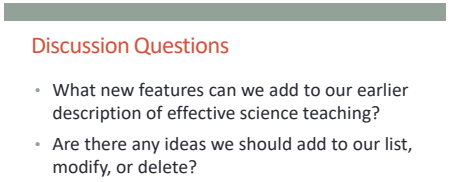
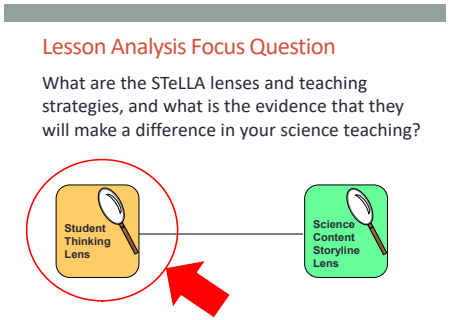
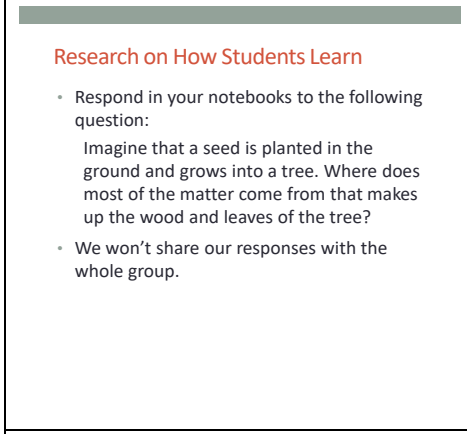
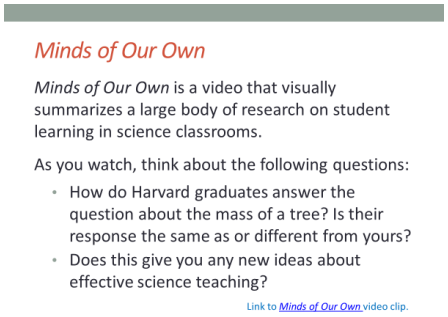
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			Note: Participants may be critical of both classrooms because student thinking isn't made visible. This is true, but bring their focus back to the science content and storyline. They should see a clear distinction between 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 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**		
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		**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."

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	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. **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		**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.
			**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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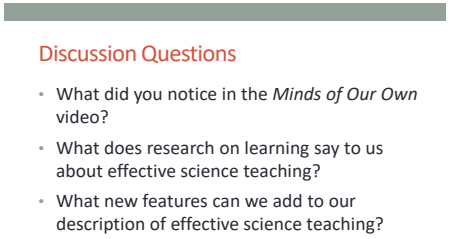
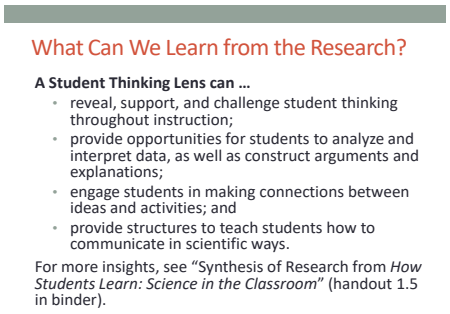
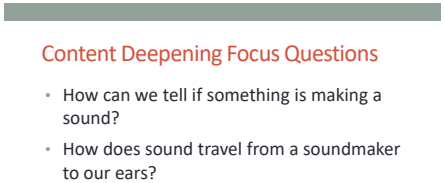
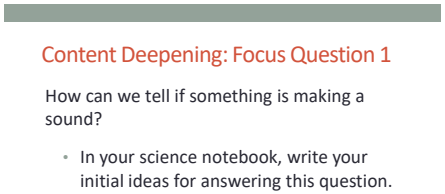
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	question. • Discuss ideas about research on student thinking addressed in the video. • Review a chart of participant ideas about effective science teaching in light of this research. **Posters and Charts** • Effective Science 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		**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 ideas to emphasize:** Research shows that we not only need to engage students in more thinking and sensemaking, but we also need to 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

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			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 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: Sound** Slides 40–61	**Purpose** • Deepen participants' science-content understandings of sound and how sound is produced and received by conducting investigations from the Sound lessons. **Content** • Objects must vibrate to produce sounds.		**Display Slide 40.** Content Deepening: Sound (Less than 1 min) a. "Now let's begin our content deepening session on sound." **Note:** Throughout this content deepening phase, refer as needed to the Sound Content Background Document, Common Student Ideas about Sound, and the learning goals for students and teachers.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	• We hear sound when a vibrating object causes the air around it to vibrate. These vibrations create sound waves that move in all directions from the soundmaker. When the vibrating air reaches our eardrums, it makes them vibrate, and we hear sound. • We can tell if something is making a sound because it vibrates and we can hear the sound. We may also be able to see and feel the vibrations. **What Participants Do** • Explore key science ideas behind the Sound lessons. • Consider how sound is produced in variety of soundmakers and which senses they would use to detect evidence of sound in each soundmaker. • Read about sound in the content background document. • Make predictions about how sound moves. • Think about the four ingredients of sound, how sound waves (vibrations) move from a source to their ears, and how their brains interpret these vibrations as sound. **Handouts in PD Binder** • 1.6 Soundmakers • 1.7 Sound on the Move **Supplies** • Science notebooks		**Display Slide 41.** Content Deepening Focus Questions (2 min) a. "Today's content deepening work will focus on how sound is produced, how it travels from a soundmaker to our ears, and how it's received or heard." b. Introduce the focus questions on the slide. c. "The science ideas we learn about in this session will help us answer these questions." d. Have participants write the focus questions in their science notebooks and draw a box around each one. This will reinforce the practice they'll follow with students. Make sure they leave space below each question to write a response.
			**Display Slide 42.** Content Deepening: Focus Question 1 (6 min) a. **Individuals:** Ask participants to write down their initial ideas for answering the first focus question. b. **Whole group:** Invite participants to share their ideas with the group. Record participants' ideas on chart paper during this share-out. Highlight any ideas that refer to objects vibrating to make sounds and/or how these vibrations may be seen or felt in addition to hearing the sounds. c. Ask probe questions to clarify participants' ideas and make their thinking visible. Examples: • "Can you say more about that?" • "What do you mean by …?" d. Emphasize the following key ideas: • Objects must vibrate to produce sounds. • These vibrations travel as sound waves to our ears, and we hear or perceive them as

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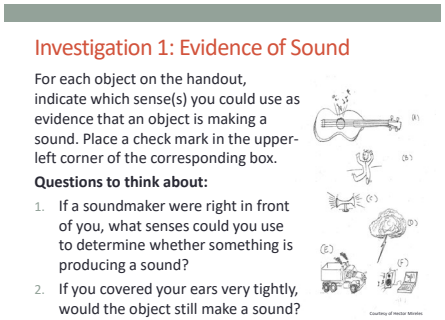
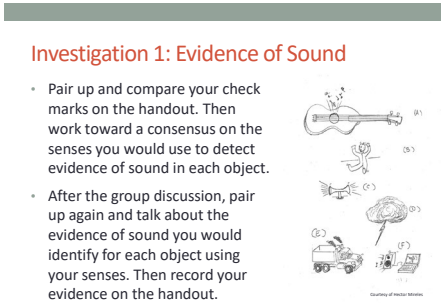
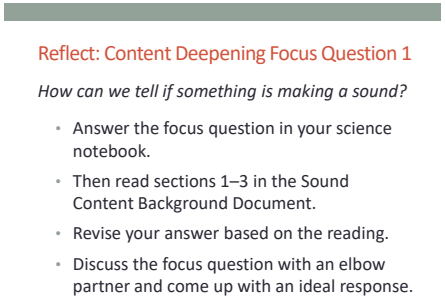
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	• Chart paper and markers • Tuning fork **PD Resources** • RESPeCT lesson plans binder **Resources in Lesson Plans Binder** *Resources section:* • Content background document • Common Student Ideas *Pretabs section:* • Sound: Learning Goals for Students and Teachers		sound.
			**Display Slide 43.** Investigation 1: Evidence of Sound (6 min) a. Distribute handout 1.6 (Soundmakers) and introduce the different types of soundmakers: • A guitar string that has been plucked • A baby crying • A blaring horn • A clap of thunder from a lightning bolt • A diesel-truck's engine • A loudspeaker connected to a laptop b. "For each scenario on your handout, think about how sound is produced and how you might detect evidence of sound in each soundmaker using your senses of hearing, sight, and touch." c. "Then for each object, place a small check mark in the upper-left corner of the corresponding box or boxes to indicate which sense or senses you could use as evidence that the object is producing a sound. Make sure to leave plenty of space to record your evidence later." d. "As you consider each soundmaker, think about the two questions on the slide. The second question is an especially interesting one to ponder." **Key science ideas:** • Objects must vibrate to make sounds. • In addition to hearing a sound, we may be able to see and/or hear a soundmaker vibrating.

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

			**Display Slide 44.** Investigation 1: Evidence of Sound (20 min)
			
			a. **Pairs:** Have participants pair up with an elbow partner and compare which senses they checked off for each soundmaker on their handouts. Direct them to work toward a consensus on the senses they would use to detect evidence of sound or vibrations in each object.
			
			b. **Whole group:** Display the handout on a document reader and ask participants which senses they selected for each object on their handouts. Work toward a consensus. For example:
			• Objects I can **hear** vibrate:
			  • A blaring horn
			  • A clap of thunder from a lightning bolt
			• Objects I can **see** vibrate:
			  • A guitar string
			  • A loudspeaker
			• Objects I can **feel** vibrate:
			  • A baby crying
			  • A loudspeaker
			  • A diesel-truck's engine
			
			c. **Pairs:** Next, have participants pair up again with the same partners and talk about the evidence of sound they would identify for each object using their senses. If participants are struggling, ask elicit and probe questions to generate the correct response for the first object:
			• My evidence of sound for the plucked guitar string is that I can **see** the string vibrate.
			
			d. **Individuals:** Based on the pairs work, have participants record their evidence of sound for each object on their handouts.
			
			e. **Whole group:** Invite participants to share their evidence of sound for each object on the

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			handout. Ask probe questions to clarify participants' thinking (e.g., "Can you say more about that?" "What do you mean by …?"). Highlight ideas about objects vibrating to produce sounds and how these vibrations may be seen or felt in addition to hearing the sounds. **Note:** In each scenario, the object must be vibrating to make a sound. **Evidence of sound/vibrations:** 1. A guitar string that has been plucked • **Evidence:** The string vibrates. • I would be able to **hear**, **see**, and **feel** the string vibrate. 2. A baby crying • **Evidence:** The baby's vocal cords vibrate. • I would **feel** the baby's vocal cords vibrating if I touched the baby's throat. 3. A blaring horn • **Evidence:** The air vibrates when pressurized air is force through a hole. • I would **hear** the sound. I might also **feel** the horn vibrate if I were next to it. 4. A clap of thunder from a lightning bolt • **Evidence:** The air vibrates when the lightning causes sudden heating. • I would **hear** the sound of thunder. 5. A diesel-truck's engine • **Evidence:** The engine vibrates when the cylinders fire. • A diesel engine always vibrates a little. If I leaned on the truck, I would **hear** and **feel** the engine vibrate. 6. A loudspeaker connected to a laptop • **Evidence:** The speaker vibrates when the laptop sends an electrical signal. • I would **feel** the speaker vibrate if I touched it. I might also be able to **hear** and **see** it vibrate.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 45.** Reflect: Content Deepening Focus Question 1 (10 min) a. Review the focus question on the slide and ask participants to answer the question in their science notebooks. b. **Individuals:** Next, have participants silently read sections 1–3 in the Sound Content Background Document (lesson plans binder). Then ask them to revise their answers to the focus question based upon what they learned from the reading. c. **Pairs:** Ask participants to discuss their answers with an elbow partner and reach a consensus on an ideal response to the focus question. **Ideal response:** Other than hearing the sound, you can tell that something is making a sound because it vibrates. You may also be able to see and feel the vibrations. d. **Whole group:** Invite pairs to share their ideal responses with the group. Ask probe questions to clarify participants' ideas and make their thinking visible (e.g., "Can you say more about that?" "What do you mean by …"?). e. Have participants turn to the overview page of Sound lesson 1a in their lesson plans binders and read the ideal student response to the focus question. f. Remind participants that an object must vibrate to make a sound.

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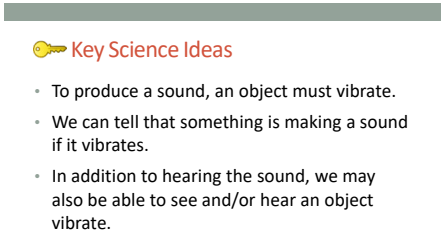
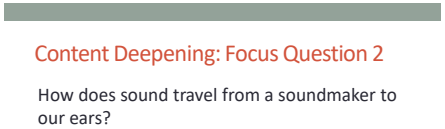
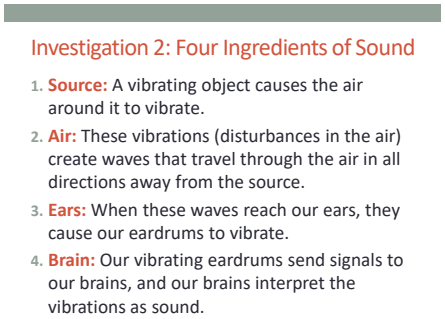
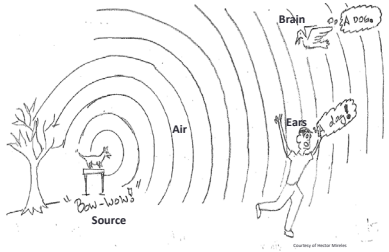
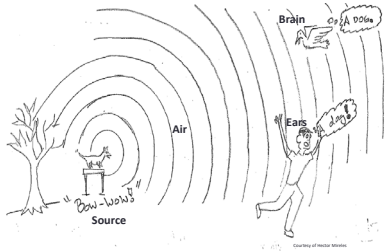
			**Display Slide 46.** Key Science Ideas (1 min) a. Highlight the key science ideas on the slide that answer the first content deepening focus question. b. Emphasize that ideas and evidence from the investigation helped to shape the answer to this question. c. Ask participants, "Does everyone agree that these key ideas answer our focus question? Would you like to add or revise anything?"
			**Display Slide 47.** Content Deepening: Focus Question 2 (Less than 1 min) a. Review the focus question on the slide. b. "Next, we'll investigate how sound moves from a vibrating object to our ears."
	Purpose • Illustrate the four ingredients of sound and how sound moves. • Deepen participants understandings of how sound moves from the source to the ear via sound waves and how the brain interprets vibrations as sound. **Content** • The four ingredients of sound are a source, air, ears, and a		**Display Slide 48.** Investigation 2: Four Ingredients of Sound (1 min) a. Introduce the four ingredients of sound on the slide: the source of the sound, air, ears, and brain. b. "Next, we'll examine these four ingredients in a real-life scenario."

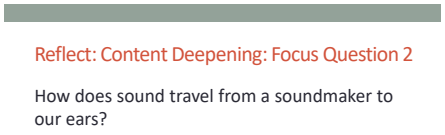
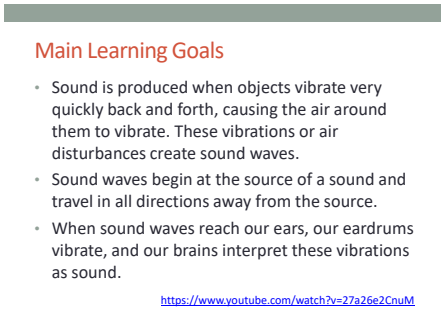
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	brain. • An object must vibrate to make a sound. These vibrations cause the air around the object to vibrate, and the vibrations move through the air in all directions away from the soundmaker. • Sound travels in waves through the air. When these waves or vibrations reach our ears, they make our eardrums vibrate. These vibrations produce electrical signals that travel to the brain, and our brains interpret the signals as sound. • Sound doesn't stop moving when it's detected.		
		Investigation 2: Four Ingredients of Sound  	**Display Slide 49.** Investigation 2: Four Ingredients of Sound (20 min) a. Highlight the four ingredients of sound on the slide. b. "When a dog barks, its vocal chords vibrate and cause the air around it to vibrate. We represent sound as circles that move away from the source and get bigger as they travel outward. These vibrations travel on waves to our ears, and our brains interpret the vibrations as a barking sound. We'll talk about this in more detail later." c. Distribute handout 1.7 (Sound on the Move) and go over the directions. Then make a sound with a tuning fork by tapping it on your hand or the bottom of your shoe. (Don't tap the tuning fork on a hard surface, since that might damage it.) d. Ask participants, "Based on what you've learned so far about the four ingredients of sound, how do you think the sound from this tuning fork moves to your ears?" e. **Pairs:** Have participants pair up with an elbow partner and talk about where they think the sound will move. Challenge participants to think about how sound travels and then compare their ideas to the diagram on the slide. f. **Individuals:** After pairs have shared their ideas, have participants write their predictions on the handout and draw circles (waves) showing where they think the sound from the tuning fork will move. g. **Whole group:** Invite a few participants to share their predictions and reasoning with the group. h. Note that these are only predictions, and that

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			you'll revisit them later in the session.
		Investigation 2: Four Ingredients of Sound 	**Display Slide 50.** Investigation 2: Four Ingredients of Sound (10 min) a. "Next, we'll explore some key science ideas about how sound moves from a source to our ears." b. **Source:** "Anything that vibrates causes the air around it to vibrate. In the slide diagram, the source of the vibrations is the dog, or more precisely, the vocal chords inside the dog. If you hugged this dog while it was barking, you'd be able to feel its vocal tract vibrating." **Key ideas to emphasize:** • All sounds originate at the vibration (oscillator). This causes a pressure disturbance in the air (or water) around the vibrating object. • The sound can be heard if the vibrating object oscillates higher than 20 times a minute—or 20 hertz (Hz), which is a very low hum—*but* no higher than 20,000 times per minute—or 20 kilohertz (kHz), which is a very high-pitched sound like scratching a chalkboard. • Sounds are unique if they have a resonator that chooses a few frequencies over the others. • Dogs make different dog sounds because each breed has a unique physiology. A dachshund, for example, sounds different from a German shepherd because of resonance. • It takes energy to sustain a vibration. For example, we get tired if we talk or sing for long periods of time. c. **Air:** "Sound (vibrations) travels through the air in the form of waves."

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			Key ideas to emphasize: • The vibrating source causes air-pressure disturbances that propagate through the air as *pressure waves*. • Sound waves travel away from the source in all directions, just like waves moving away from a pebble tossed into a pond. • Sound must travel through a medium, such as air or water. There can be no sound wave without a medium. • Sound waves cause vibrations (disturbances) in the air to travel in all directions. The air stays where it is; only the vibrations travel through the air. • Sound waves are a way of transporting a little bit of energy. d. Ask probe and challenge questions to elicit the following key ideas from participants about where the sound waves in the slide diagram can go. The sound waves in the diagram can … • travel to empty spaces, which means that nobody receives that portion of the disturbance; • reach the man's ears, which means that two ears receive a portion of the disturbance; • reach the bird's ears, which means that two more ears receive another portion of the disturbance; or • reach the tree on the other side of the dog, which means the tree receives yet another portion of the disturbance. e. **Ears:** "If the sound waves reach your eardrums, they will vibrate at the same frequency as the vibrations of the original oscillator." **Key ideas to emphasize:** • Sound is a pressure wave, so it can make a very light object move when the pressure

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

			wave reaches it.
			• Eardrums vibrate when pressure waves hit them.
			• Eardrums vibrate in response to very, very small changes in air pressure.
			  • We can perceive a change in air pressure when we ride an elevator up to a higher floor in a building.
			  • We can feel a change in air pressure when we descend rapidly in an airplane.
			  • The greater the change in pressure, the louder the sound is.
			  • We have two ears that help us determine the source of a sound. This protected our ancestors from predators!
			• Less of the sound wave reaches our eardrums the farther away we are from the source of a sound. This makes the sound softer.
			
			f. **Brain:** "When sound waves reach our ears, they make our eardrums vibrate. These vibrations produce electrical signals that travel to our brains, and our brains interpret these signals as sound."
			
			Key ideas to emphasize:
			
			• Our brains remember exactly what a dog sounds like and interpret the electrical signals accordingly. A different set of amplifying parts of an animal will be identified as a different animal.
			• Each person makes a unique sound, which is why babies can recognize their parents' voices.
			• Our brains tell us which ear is receiving more sound waves, and that helps us determine where a sound is coming from.
			• We each have a keen recognition of combined tones (e.g., music).
			• If a sound reaches a nonliving thing or a living thing without a brain (like a tree), the object

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			perceives no sound.
			**Display Slide 51.** Reflect: Content Deepening Focus Question 2 (3 min) a. Review the focus question on the slide. b. **Individuals:** "Think about what you've learned so far about how sound moves from a soundmaker to our ears. Then jot down your ideas for answering this question in your science notebooks." c. "At the end of our content deepening session, you'll have an opportunity to revise your answers."
12:00–12:45 45 min	**LUNCH**		
12:45–2:10 85 min (Includes 10-min break) **Content Deepening (Continued)** Slides 52–61	**Purpose** • Deepen participants' science-content knowledge of sound waves and how they travel through the air to the ear. • Illustrate what constitutes a good soundmaker and sound receiver using components from the Sound lessons. **Content** • Sound is produced when objects vibrate very quickly back and forth, causing the air around them to vibrate. These		**Display Slide 52.** Main Learning Goals (2 min) a. Read the main learning goals on the slide. b. "Next, we'll watch a short video clip on sound waves. Then we'll drive home these learning goals by exploring more about how sound is produced and how sound waves move through the air to our eardrums." c. Show the YouTube video *What Is Sound?* d. Highlight key ideas about sound waves from the video clip. Ask participants if they have any questions or comments.

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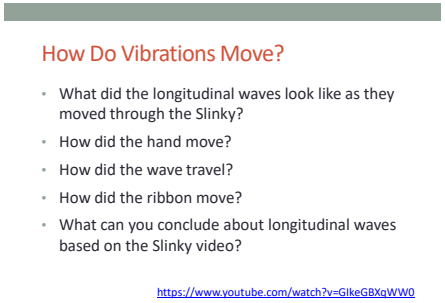
	vibrations or air disturbances create sound waves. • Sound waves begin at the source of a sound and travel in all directions away from the source. • When sound waves reach our ears, our eardrums vibrate, and our brains interpret these vibrations as sound. • The human ear is a good sound receiver because (1) it has a large opening or auricle to receive an incoming sound wave; (2) it has a resonant space that prefers one dominant frequency; and (3) it has a tympanic membrane (eardrum) that's free to vibrate. • As a good sound producer, an oscillator must (1) be free to vibrate, and (2) must produce vibrations at the rate of 20–20,000 Hz so the human ear can hear the sound. • As a good sound producer, a resonator must (1) have a large volume of air near an oscillator, and (2) have a dominant frequency that will be amplified louder than other frequencies. **What Participants Do** • Watch a YouTube video showing how sound waves move through the air. • Watch a video clip of longitudinal waves moving through a Slinky. • Observe a Slinky demonstration		**Display Slide 53.** How Do Vibrations Move? (25 min) a. Introduce the questions on the slide and have participants copy them into their notebooks. b. Show the YouTube video *Longitudinal Waves Using a Slinky*. **Note:** You may want to replay the video a few times so that participants can look more closely at various parts of the model and take notes to help them answer the questions on the slide. c. **Individuals:** After the video demonstration, have participants answer the slide questions in their notebooks. As needed, replay the video clip and ask probe and challenge questions to support participants as they work through each question. d. Next, conduct your own Slinky demonstration. Ask a volunteer to hold one end of the Slinky as you quickly move it forward and backward with your hand. e. Ask the volunteer the following questions during the demonstration: • "Am I pushing your hand or the Slinky?" • "So how come you can feel the vibrations in your hand?" f. After the demonstration, ask participants the following questions: • Where did the vibrations start? • What moved down the Slinky? • Can you describe how the vibrations moved down the Slinky? • Can you relate this to the ribbon in the video clip? g. **Individuals:** Have participants read section 4 in the content background document. Then ask

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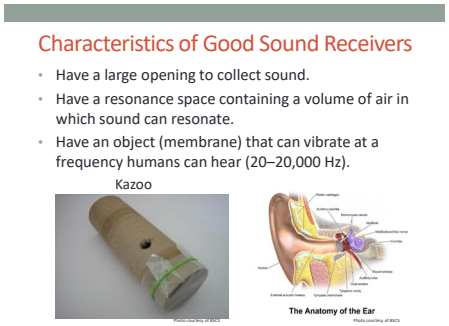
	and answer questions about longitudinal waves. • Read about sound, vibrations, and sound waves in the content background document. • Use kazoos to simulate how human ears receive sound. • Explore similarities between kazoos and human ears and investigate what makes a good sound receiver. • Explore how different objects produce sound and learn about what makes a good sound producer. • Build their own soundmakers (cluckers) and use them to investigate how sound energy creates motion. **Videos** • *What Is Sound?* (YouTube video) • *Longitudinal Waves Using a Slinky* (YouTube video) **Handouts in Lesson Plans Binder** • 6.1 The Ear (from Sound lesson 6a) **Supplies** • Slinky • Kazoos • Small plastic container • Rubber band • Tuning fork • Cluckers • Grains of rice		them to revise their responses to the slide questions based on the ideas presented in the reading. h. **Whole group:** Invite participants to share their revised answers with the group. Encourage participants to listen carefully to one another's ideas and be ready to agree or disagree, add their own ideas, and ask questions.
			**Display Slide 54.** Characteristics of Good Sound Receivers (3 min) a. Have participants locate lesson handout 6.1 (The Ear) in their lesson plans binders and refer to them as needed as you walk them through the information on the slide. b. "Both of the objects on this slide are good sound receivers. The tree in the earlier diagram wasn't a good sound receiver because it didn't do anything with the sound waves that reached it." **Note:** You might want to show the diagram on slide 49 again. Point out the sound waves that moved from the dog to the tree and note that the sound waves enter the tree, but the tree isn't able to perceive them because it doesn't have an eardrum to transmit signals or a brain to translate them into sound. c. "The human ear and a homemade kazoo are good sound receivers for three important reasons: 1. "They each have a large opening that can catch or collect a portion of the incoming sound wave. In a human ear, this opening is the outer ear or *auricle*, and in the kazoo, it's the end of the tube without the wax paper. 2. "Both the human ear and the kazoo have a resonance space containing a volume of air in which sound can resonate. This space prefers one dominant frequency. The

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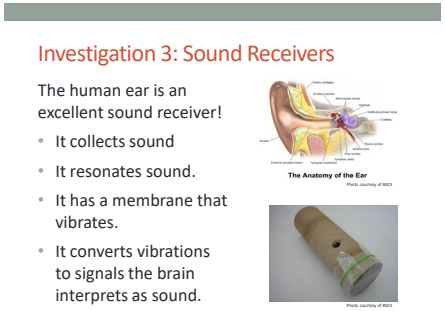
			resonance space in the human ear is called the *external acoustic meatus* or *ear canal*. The resonance space in the kazoo is just past the opening. 3. "The human ear and the kazoo also have an object that vibrates. The human ear has a tympanic membrane or eardrum that vibrates at a frequency humans can hear (20–20,000 Hz). The kazoo has wax paper attached to one end that simulates an eardrum." d. Point out that when sound waves or vibrations reach the eardrum, the eardrum vibrates. These vibrations are converted to electrical signals or impulses that the auditory nerve transports to the brain. The brain then interprets these signals as sound, such as music or a barking dog!
			**Display Slide 55.** Investigation 3: Sound Receivers (8 min) a. "The human ear is an excellent sound receiver! It collects and resonates sound, it has a tympanic membrane or eardrum that can vibrate, and it converts these vibrations to signals the brain can interpret as sound." b. To illustrate how the human ear receives sound, distribute homemade kazoos to several volunteers. c. Direct the volunteers to put the open end of the cardboard rolls against their mouths and make a sound like an owl. Then ask participants to describe what they hear. d. Next, direct the volunteers to hum into their kazoos. Then ask participants to describe what they hear. e. Following the demonstration, ask participants, "How are kazoos and human ears similar? How

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			are they different?" f. Probe and challenge participants' thinking to highlight the key ideas on the slide.
		Characteristics of Good Soundmakers 1. Oscillators: • Must be free to vibrate • Should vibrate at a rate of 20–20,000 Hz for the human ear to hear it 2. Resonators: • Must have a large volume of air (resonance space) near an oscillator • Must have one frequency with a greater amplification than other frequencies	**Display Slide 56.** Characteristics of Good Soundmakers (1 min) a. Read through the information on the slide and highlight the characteristics of good soundmakers. b. Note that a musical sound or note has a few strong frequencies that we can hum along with. Noise, on the other hand, has an infinite number of frequencies that resonate at the same time. Rushing air causes noise and sounds like "shshshshshsh." c. "We'll talk more about the distinctions between musical sound and noise in a later content deepening session."
		Investigation 4: Soundmakers A plastic container with a rubber band across the opening is one example of a good soundmaker. 1. The rubber band is an **oscillator**. It's bound to the container, but it's free to vibrate. 2. The measuring cup is a **resonator**. It has resonance space (a volume of air) near the oscillator and "sings" to one or two strong frequencies. 3. Together, they produce a musical sound! 	**Display Slide 57.** Investigation 4: Soundmakers (10 min) a. "We used kazoos to simulate how the human ear receives sound. Now let's investigate how sound is produced." b. Introduce the plastic container with a rubber band stretched across the opening. c. Make a sound by plucking the rubber band with your finger (see image on slide). Then ask participants to share their observations. Did they see the soundmaker vibrate? What did they hear? d. Next, have a volunteer stretch the rubber band around his or her fingers and try to match the tension of the rubber band around the container. Then ask another volunteer to make a sound by

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			plucking the rubber band. e. After this demonstration, ask participants to share their observations. Did they see the soundmaker vibrate? What did they hear? Did the volunteer feel the rubber band vibrate? f. Then have participants compare the two soundmakers. Ask, "What is the difference between a rubber band vibrating around fingers and a rubber band vibrating around a plastic container?" g. Emphasize the key points on the slide that explain what makes the plastic container and rubber band a good soundmaker. h. Next, make a sound with the tuning fork. • First, strike the tuning fork against your knee, and hold it up in the air. Ask participants what they hear. (The tuning fork will vibrate, but participants will find it hard to hear.) • Next, strike the tuning fork against your knee and hold it upright on a file cabinet, a table, or any large, firm object. Ask participants what they hear. (The tuning fork will resonate the sound.) i. "Think about the sound the tuning fork produced each time it vibrated. The first time, it was hard to hear, but the second time, we could hear the sound clearly. Why do you think the tuning fork was such a poor soundmaker the first time and such a good soundmaker the second time?"

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		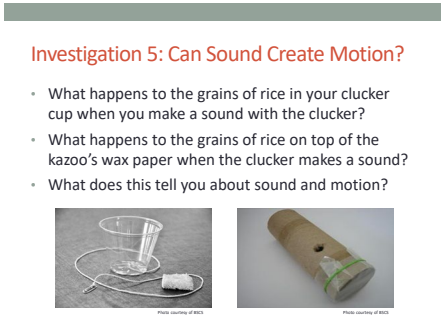	**Display Slide 58.** Investigation 5: Can Sound Create Motion? (20 min) a. "We just saw that the tuning fork with an amplifier allowed the sound to resonate and travel in all directions from the soundmaker. Next, we'll see whether the energy of sound can create motion." b. Show participants a clucker (from lesson 2a) and demonstrate how it works. c. "Now I'd like you to make your own cluckers and see if they can make grains of rice move." d. Distribute the materials for the cluckers; then walk participants through assembling them. e. After participants assemble their cluckers, have them place several grains of rice in their cups and make a sound with their cluckers. Then ask participants what happens to the grains of rice. f. "Now let's see if the grains of rice move if I place them on top of the wax paper covering one end of a kazoo and then make a sound with the clucker." **Note:** To make sure everyone sees the wax paper vibrating, you may want to use a document camera to magnify the surface of the kazoo. Alternatively, you could repeat the demonstration several times. g. Following the demonstration, invite participants to share their observations. Challenge participants to make connections between the wax paper vibrating and their eardrums vibrating. h. Emphasize that the wax paper on the kazoo illustrates what happens when sound waves or vibrations from a soundmaker travel through the air and reach their eardrums. i. "So just as sound waves from the clucker caused the wax paper to vibrate, which in turn made the

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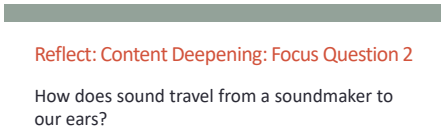
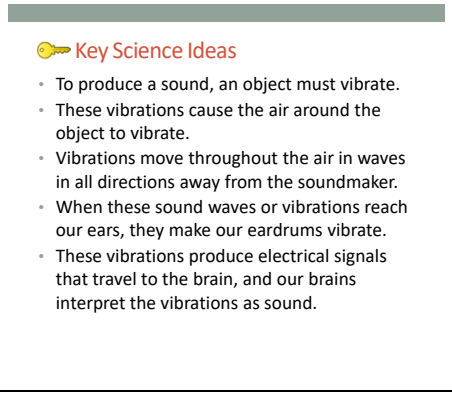
			rice grains on the paper jump around, sound waves cause our eardrums to vibrate."
			**Display Slide 59.** Reflect: Content Deepening Focus Question 2 (6 min) a. Review the focus question on the slide. b. **Individuals:** Ask participants to reflect on what they learned about sound and motion during the content deepening session and then revise their previous answers. Remind them to support their ideas with evidence from today's investigations. c. **Whole group:** Invite a few participants to share their ideas and evidence with the group. d. Following this discussion, revisit the first focus question, *How can we tell if something is making a sound?* and ask participants to share any new insights they've gained from today's content deepening work. e. Discuss the predictions participants made earlier about where the sound from the tuning fork would move (handout 1.7, Sound on the Move). Ask whether their predictions match the results of today's investigations.
			**Display Slide 60.** Key Science Ideas (Less than 1 min) a. Highlight the key science ideas on the slide that answer the second content deepening focus question. b. Emphasize that ideas and evidence from the investigations helped to shape the answer to this question. c. Ask participants, "Does everyone agree that these key ideas answer our focus question?

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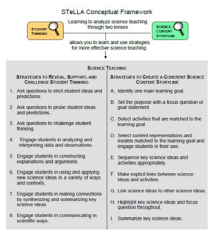
			Would you like to add or revise anything?"
		Homework • Review section 4 in the content background document. • Read Sound: Learning Goals for Students and Teachers in your lesson plans binder (pretabs section).	**Display Slide 61.** Homework (Less than 1 min) a. "To prepare for our next session, please review section 4 in the content background document and read the learning goals for students and teachers in your lesson plans binders." b. Have participants copy the homework assignment into their science notebooks.
2:00–2:10 10 min	**BREAK**		
2:10–3:00 50 min **STL Strategies: Elicit, Probe, and Challenge Questions** Slides 62–68	**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	Lesson Analysis Focus Question What are the STeLLA lenses and teaching strategies, and what is the evidence that they will make a difference in your science teaching? 	**Display Slide 62.** 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."

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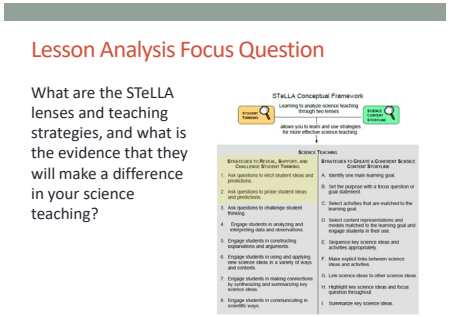
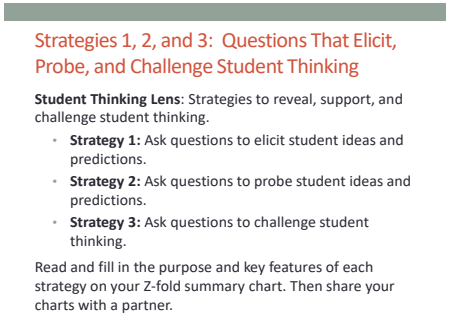
	in learning about these strategies. Learning will continue on day 2 when participants watch video footage of these strategies in action. • Elicit questions are designed to reveal a variety of student ideas, misconceptions, and experiences before they learn new content. • Probe questions follow up on 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 63.** 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 64.** 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, such as "Where did you find that?" or "I interpreted that differently."

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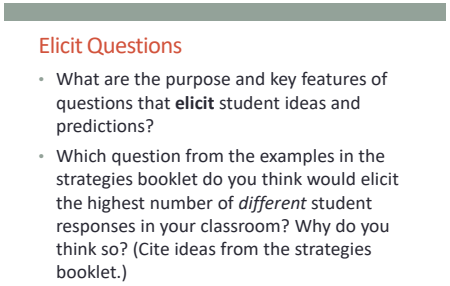
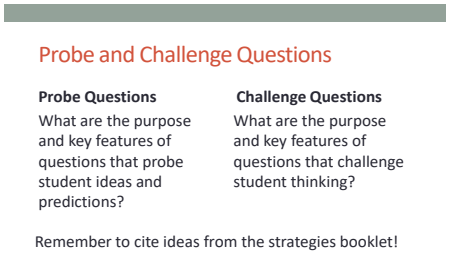
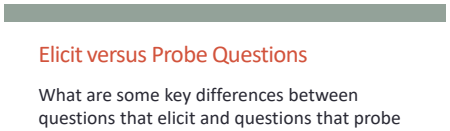
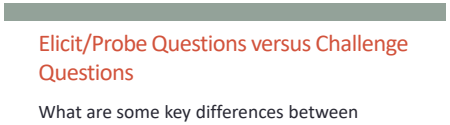
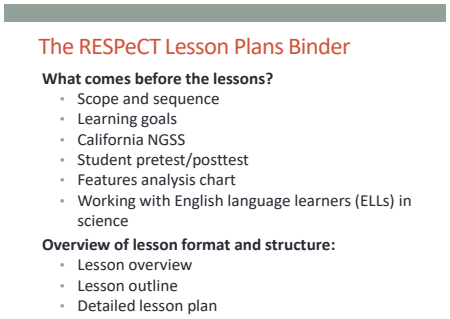
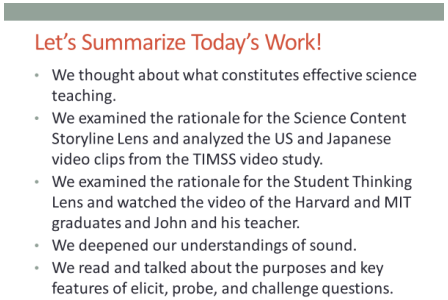
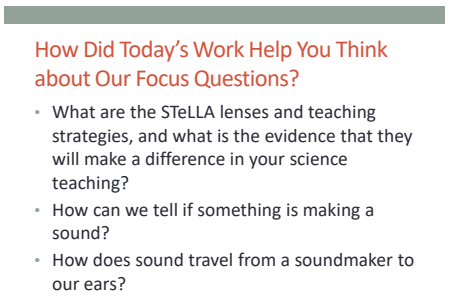
			**Display Slide 65.** Elicit Questions (5 min) a. As a group, discuss the purpose and key features of questions that elicit student ideas and predictions. Write these features on chart paper and hang the chart where it can be referenced later. b. Sample chart: **Key Ideas about Elicit Questions** **Purpose:** To reveal students' 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
			**Display Slide 66.** 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

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			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 67.** 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 already said.
			**Display Slide 68.** 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

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			understandings and support them in changing their thinking.
3:00–3:30 30 min **Wrap-Up: Summary, Homework, and Reflections** Slides 69–73	**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 Sound 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		**Display Slide 69.** 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.
			**Display Slide 70.** 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.
			**Display Slide 71.** 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.

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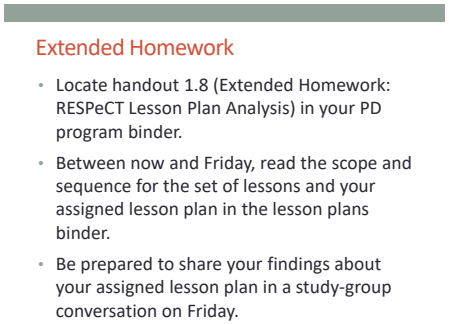
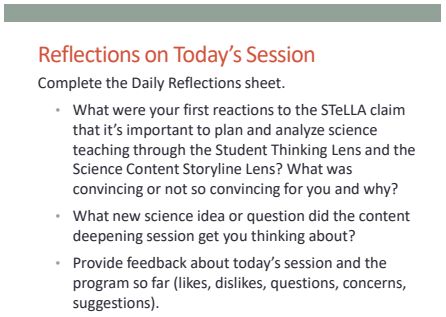
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 72.** Extended Homework (5 min) a. Assign each participant one of the lessons in the Sound lesson-plan sequence. In this content area, six of the lessons have two parts (a and b), and lesson 3 has one part. Each teacher should take responsibility for one 2-part lesson, and one teacher should be responsible for lesson 3. So Teacher 1 will study lessons 1a and 1b; Teacher 2 will study lessons 2a and 2b; Teacher 3 will study lesson 3, Teacher 4 will study lesson 4a and 4b, 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 73.** 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.