RESPeCT Summer Institute Professional Development Leader Guide (PDLG)

Grade Level	3	Day	5	STeLLA Strategy	Science Content Storyline Lens (SCSL) Strategy A: Identify One Main Learning Goal	Subject Matter Focus	Forces

Focus Questions	• What is the Science Content Storyline Lens (SCSL)? • Why is one main learning goal essential for science content storyline coherence? • What makes something start to move? • How can we draw the forces pushing or pulling an object when we can't see them?
Main Learning Goals	Participants will understand the following: • Research from the TIMSS Video Study of Science Teaching emphasizes the importance of creating science content storylines that support students in making links between classroom activities and science ideas. • The SCS Lens and strategies empower teachers to think in new ways about planning and teaching science lessons. • Identifying and focusing on one main learning goal in a lesson is an important strategy for creating a coherent science content storyline. • A *force* is a push or pull that involves an interaction between two objects and causes a change in an object's motion. • Arrows can be used to represent the forces acting on an object. Arrows begin at the center of an object and point in the direction of the respective forces. • A *net force* is the sum of all of the forces acting on an object. • A change in an object's motion in the same direction as the net force is called *acceleration*. • Weight refers to the pull of gravity on an object toward Earth's center. • When one object is resting on another object, the object underneath exerts an upward force called the *normal force*. This force keeps the two touching objects separated from each other.

Preparation	Materials	Videos

Daily Setup Tasks
• Check that video clips are correctly linked to PowerPoint (PPT) slides.
• Set up PowerPoint.
• Make sure video clips play correctly with good sound.
• Arrange furniture and food.
• Arrange participant materials.
• Put up posters and charts.
 	
Planning and Preparation Tasks
• Study the PDLG, PowerPoint slides (PPTs), video clips, and handouts. Make changes to PPTs if needed.
	Posters and Charts
	• STeLLA Framework and Strategies poster
	• Day-5 Agenda (chart)
	• Norms for Working Together (chart)
	• Day-5 Focus Questions (chart)
	• Effective Science Teaching chart (from day 1)
	• Strategy charts from days 1–4 (STL strategies 1–6)
	• Parking Lot poster
	
	Handouts in RESPeCT PD Binder Front Pocket
	• Z-fold summary chart: Science Content Storyline Lens Strategies (blank)
		• Video clips from one Forces lesson:
		  • Video Clip 5.1: Torres classroom (beginning of lesson); 5.1_mspcp_gr.3 .forces_torres_L2_c1-2
		  • Video Clip 5.2: Torres classroom (during lesson); 5.2_mspcp_gr.3 .forces_torres_L2_c3
		  • Video Clip 5.3: Torres classroom (end of lesson); 5.3_mspcp_gr.3.forces _torres_L2_c4

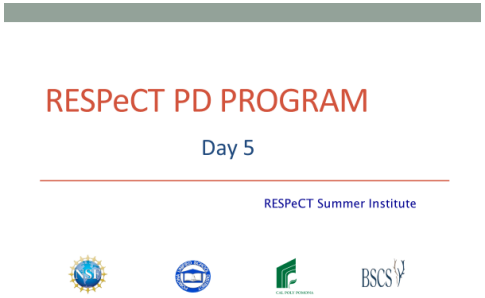
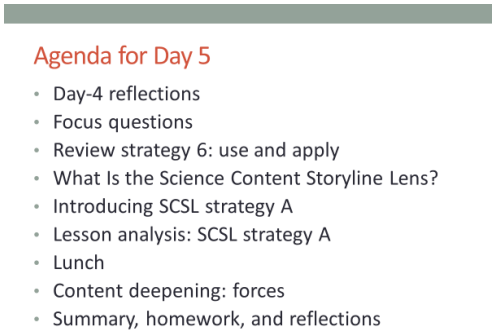
• Review the reflections from day 4 and create a summary slide.
• Watch video clips and anticipate participant responses.
• Prepare charts for the day's agenda and focus questions.
• Review the activities for Forces lessons 1a/b and 2a/b in the lesson plans binder.
• Content deepening:
  • Read sections 4 (Net Forces) and 5 (Tracking Changes in Motion with Cartoons) in the content background document.
	Handouts in RESPeCT PD Binder, Day 5
	• 5.1 Analysis Guide A: Identifying One Main Learning Goal (2 copies)
	• 5.2 Practice Identifying One Main Learning Goal
	• 5.3 Transcript for Video Clip 5.1
	• 5.4 Transcript for Video Clip 5.2
	• 5.5 Transcript for Video Clip 5.3
	• 5.6 Tree Map (from Forces lesson 1a)
	• 5.7 What Are the Forces? (from Forces lesson 2b)
	• 5.8 Weight (The Force of Gravity)
	• 5.9 Net Forces: Train, Airplane, and Dandelion
	• 5.10 Net Force and Acceleration: Apple-and-Car Scenario
	• 5.11 Net Force and Acceleration: Falling-Car Challenge
	• 5.12 Net Force and Acceleration: Shopping-Cart Challenge
	• 5.13 Extended Homework: RESPeCT Lesson Plan Analysis
	• 5.14 Daily Reflections—Day 5
	Handouts in RESPeCT Lesson Plans Binder
	• 1.2 Forces (from Forces lesson 1b)
	PD Leader Masters, Days 5–8
	• PD Leader Master: Practice Identifying One Main Learning Goal (Answer Key)
	Supplies
	• Science notebooks
	• Chart paper and markers
	• Black and red pencils (for drawing vectors)
	• For content deepening investigations from Forces lessons 1a/b (1 per group):
	  • Tray
	  • Paddleballs
	  • Rubber balls
	  • Toy cars
	  • Blocks
	• For content deepening investigations from Forces	

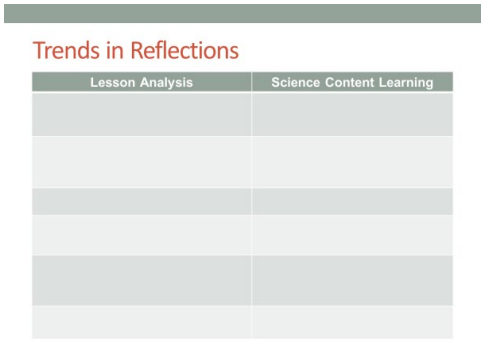
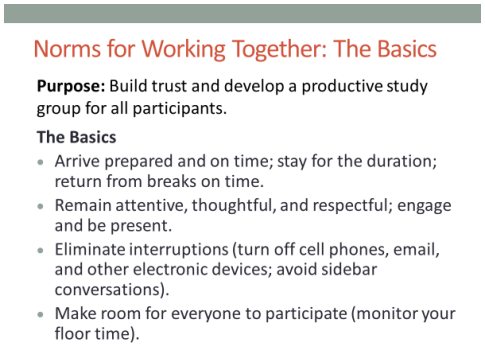
	lessons 2a/b: • Rolling cart • Foam arrows of different lengths (2 short, 2 medium, 2 long) • Toy cars (1 per pair) • Paper arrows of different lengths (2 short, 2 medium, 2 long) **PD Resources** • STeLLA strategies booklet • RESPeCT PD program binder • RESPeCT lesson plans binder **Resources in Lesson Plans Binder** *Resources section:* • Forces and Motion: Content Background Document • Common Student Ideas about Forces and Motion	

DAY 5 SESSION OUTLINE

Time	Activities	Purpose
8:00–8:25 25 min	**Getting Started: Housekeeping, Agenda, Day-4 Reflections, Norms, Focus Questions**	• Build community by sharing participants' reflections from day 4. • Set the stage for a day of learning.
8:25–8:40 15 min	**Review of Strategy 6: Use and Apply**	• Review STL strategy 6 (use and apply) and deepen participants' understandings of this strategy and the Variation in Traits lesson content.
8:40–8:55 15 min	**What Is the Science Content Storyline Lens (SCSL)?**	• Help participants develop strong initial understandings of the Science Content Storyline Lens.
8:55–10:10 75 min (Includes 10-min break)	**Introducing SCSL Strategy A**	• Clarify and deepen participants' understandings of SCSL strategy A: Identify one main learning goal. • Clarify the distinctions between science ideas, student ideas, and main learning goals.
10:10–12:00 110 min	**Lesson Analysis: SCSL Strategy A**	• Use lesson analysis of classroom videos to better understand SCSL strategy A. • Deepen participants' science-content knowledge of forces through lesson analysis.
12:00–12:45 45 min	**LUNCH**	
12:45–3:10 145 min (Includes 10-min break)	**Content Deepening: Forces**	• Deepen participants' understandings of science ideas about forces and motion by conducting investigations from Forces lessons 1a/b and 2a/b. • Expand participants' science-content knowledge of forces and motion related to teacher learning goals by exploring the concepts of weight/gravity, normal force, net force, and acceleration.
3:10–3:30 20 min	**Wrap-Up: Summary, Homework, and Reflections**	• Summarize and reflect on key ideas from today's learning, including the Science Content Storyline Lens, STeLLA strategy A, and the Forces science content.

DAY 5

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
8:00–8:25 25 min **Getting Started** Slides 1–8	**Purpose** • Build community by sharing participants' reflections from day 4. • Set the stage for a day of learning. **What Participants Do** • Review the day's agenda. • Discuss the reflections from day 4. • Review and discuss progress on the RESPeCT program norms. • Read the focus questions for day 5. **Posters and Charts** • STeLLA Framework and Strategies poster • Day-5 Agenda (chart) • Norms for Working Together (chart) • Day-5 Focus Questions (chart)		**Display Slide 1.** RESPeCT PD Program (5 min) a. Take care of any housekeeping issues.
			**Display Slide 2.** Agenda for Day 5 (2 min) a. Talk through the agenda for the day.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 3.** Trends in Reflections (5 min) a. Give participants time to review your feedback on their reflections from day 4 and offer reactions, comments, or follow-up questions.
			**Display Slide 4.** Norms for Working Together: The Basics (5 min) a. Review the norms as a group. b. **Ask:** "Any comments or suggested changes? How are we doing with applying these norms?"

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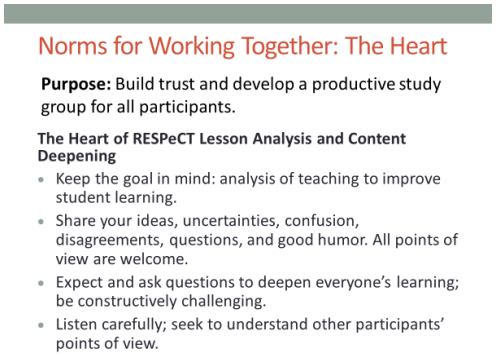
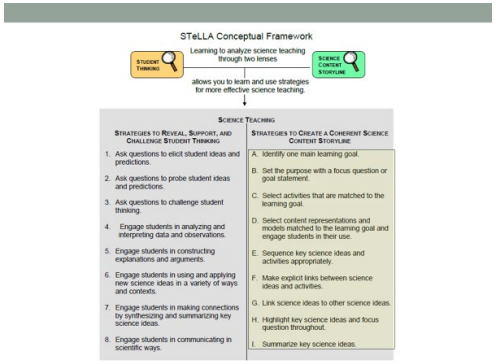
			**Display Slide 5.** Norms for Working Together: The Heart (5 min) a. Review these norms as a group. b. **Ask:** "Any comments or suggested changes? Which of these norms do you think we could get better at applying individually and as a group?" c. **Remind participants:** "These norms will become increasingly important during the Summer Institute and throughout the academic year as we analyze one another's classroom videos and learn together."
			**Display Slide 6.** STeLLA Conceptual Framework (1 min) a. **Transition:** This slide marks the transition from the STL strategies to the Science Content Storyline Lens strategies. b. "Throughout the PD program, we'll continue learning about the Student Thinking Lens (STL) strategies, but today we'll transition to the Science Content Storyline Lens strategies." c. Highlight the SCSL strategies on the slide.

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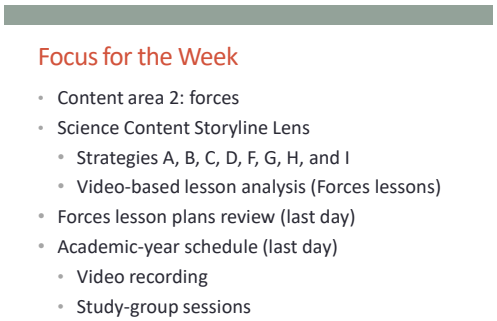
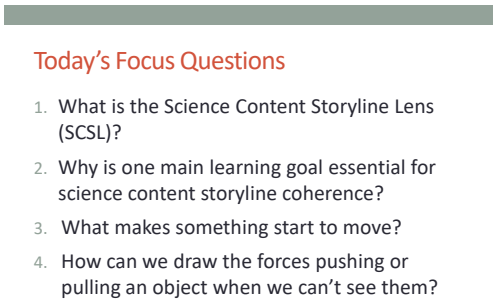
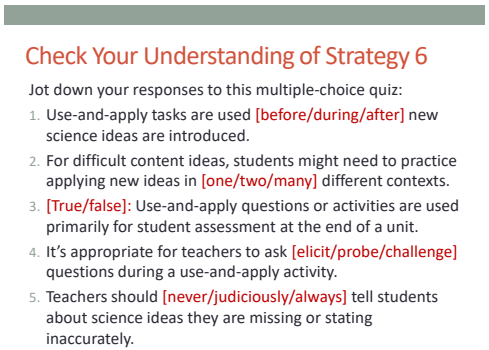
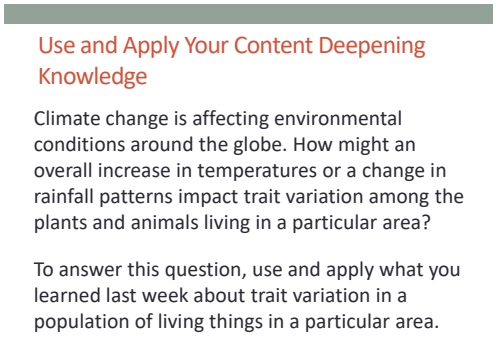
			**Display Slide 7.** Focus for the Week (1 min) a. "This week we'll focus on a new content area: forces. We'll also examine the Science Content Storyline Lens strategies and the Forces lessons you'll be teaching in the fall, analyze video clips of those lessons, and deepen your science-content knowledge related to the lesson plans." b. "On the last day of the RESPeCT PD program, we'll review the lesson plans and the schedule for the academic year." c. "You may notice that we skip strategy E: Sequence key science ideas and activities appropriately. This strategy will be addressed during the school year as you teach the STeLLA lesson plans and analyze how they're sequenced within each lesson and across lessons."
			**Display Slide 8.** Today's Focus Questions (1 min) a. Introduce the focus questions that will guide today's session.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
8:25–8:40 15 min **Review of Strategy 6: Use and Apply** Slides 9–10	**Purpose** • Review STL strategy 6 (use and apply) and deepen participants' understandings of this strategy and the Variation in Traits lesson content. **Content** • STL strategy 6 engages students in using and applying new science ideas in a variety of ways and contexts. **What Participants Do** • Take a multiple-choice quiz to check their understanding of STL strategy 6. • Work on a scenario that engages them in using and applying strategy 6 and the Variation in Traits lesson content. **Supplies** • Science notebooks		**Display Slide 9.** Check Your Understanding of Strategy 6 (7 min) **Note:** Display this slide only if it wasn't used on day 4. a. "To check your understanding of STL strategy 6, jot down your responses to this multiple-choice quiz in your science notebooks." b. Have participants discuss their answers either in pairs or as a group. (If time is short, just read the answers aloud.) **Answer key:** a. After b. Many c. False d. Challenge (and probe) e. Judiciously (defined as "good or discriminating judgment; wise, sensible, or well advised")
			**Display Slide 10.** Use and Apply Your Content Deepening Knowledge (8 min) a. **Turn and Talk (4 min):** "Discuss the use-and-apply question on the slide with a partner, and be ready to share your ideas with the group." **Note:** Alternatively, you might want to divide the group in half and have one group consider possible changes in plant traits and the other group consider possible changes in animal traits. b. **Whole-group share-out (4 min):** "What ideas do you have for answering this question?" **Note:** One of the main learning goals of the

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			Variations in Traits lesson sequence is recognizing that changing environmental conditions can impact trait variation in a population of living things. Climate change is currently impacting environmental conditions in a variety of ways across the globe. This use-and-apply question specifically relates climate change to an increase in temperatures or a change in rainfall (more or less) in an area. **Ideal responses:** There are many possible responses to the use-and-apply questions, but each should include logical reasoning that suggests a plant or animal would have a greater chance of surviving and passing on its characteristics to the next generation. **Changes in plant traits:** • Plants with smaller leaves might lose less moisture in higher temperatures than plants with larger leaves, so they might have a greater chance of surviving and producing seeds. • Plants with leaf surfaces that are slightly waxy or hairy might hold moisture better than plants without such protection. Plants with these characteristics might have a greater chance of surviving and reproducing in higher temperatures. **Changes in animal traits:** • A population of animals that currently have very thick fur might change over time and grow less fur or shorter fur if overheating caused death among animals with the thickest fur prior to reproducing. • If greater changes in climate cause an area to receive less rainfall, individuals that retain moisture rather than sweating profusely may have a survival advantage. • As in the example of Darwin's finches, if there is less rainfall, plants may produce seeds with harder shells. Birds with longer beaks might have

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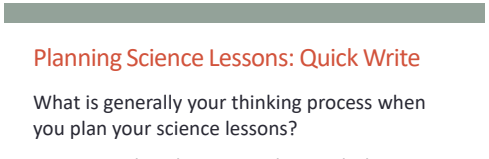
			a greater ability to crack the harder shells and would have a survival advantage because they're able to access this food supply. Over time, beak length within this population may increase.
8:40–8:55 15 min **What Is the Science Content Storyline Lens (SCSL)?** Slides 11–13	**Purpose** • Help participants develop strong initial understandings of the Science Content Storyline Lens. **Content** • A science content storyline brings coherence within and across science lessons. **What Participants Do** • Write about and discuss their typical process of planning science lessons. • Discuss their reading about the definition of a science content storyline. • Review and discuss the TIMSS (Trends in Mathematics and Science Study) research basis for the Science Content Storyline Lens. **Posters and Charts** • STeLLA Framework and Strategies poster **PD Resources** • STeLLA strategies booklet		**Display Slide 11.** Planning Science Lessons: Quick Write (6 min) **Note:** This activity is a lead-in for thinking about specific SCSL strategies. When planning science lessons, are participants thinking primarily about (1) SCSL issues, such as learning goals, (2) student misconceptions (an STL issue), which is a great start but doesn't include SCSL strategies, or (3) activities and/or classroom management and timing issues? a. **Individuals:** Direct participants to take 2–3 minutes to write down the key things they think about when planning science lessons. b. **Whole group:** Ask participants to share their reflections with the group. c. **Tell participants:** "The Science Content Storyline Lens strategies should provide some new or additional ways of thinking about planning your science lessons."

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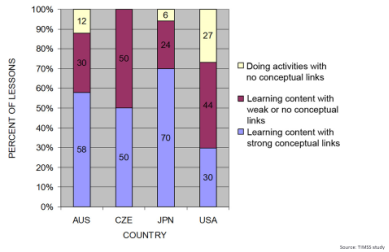
		Lesson Analysis: Focus Question 1 What is the Science Content Storyline Lens (SCSL)? • What is a science content storyline, and why is it important? • What is challenging about developing a science content storyline?	**Display Slide 12.** Lesson Analysis: Focus Question 1 (7 min) a. **Small groups:** Direct half the group to focus on the first bulleted question on the slide, and the other half to focus on the second. Allow groups 2 minutes to think about their assigned questions as they review "Introduction to the Science Content Storyline Lens" in the STeLLA strategies booklet. b. **Whole group:** Have each group share their ideas and responses for these questions. c. As you listen to participants, make sure that what they're saying is consistent with the strategies booklet. If you aren't sure they're interpreting the text accurately, ask them to identify the specific text they're drawing from.
		The TIMSS Video Study Findings and the Science Content Storyline Lens  	**Display Slide 13.** The TIMSS Video Study Findings and the Science Content Storyline Lens (2 min) a. Emphasize the research basis for the Science Content Storyline Lens and its importance. Remind participants that the data on the slide was presented on day 1 of the PD program. b. **Ask:** "What does this graph reveal about US science lessons compared with higher-achieving countries?" **Ideal response:** According to the study, US

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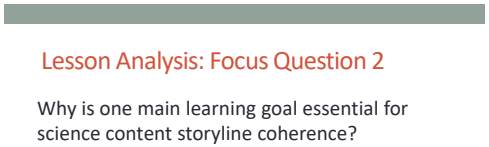
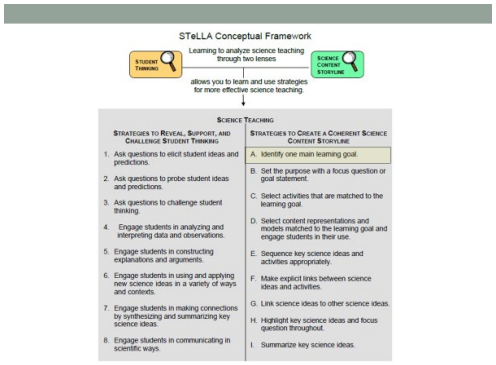
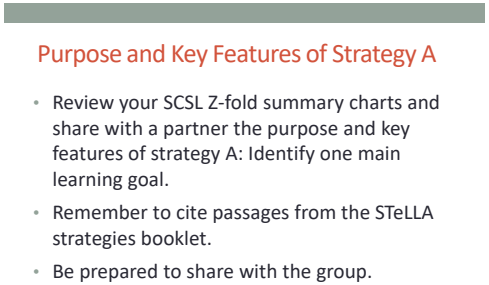
			science lessons didn't do as well linking science ideas to lesson activities; in fact, many lessons were activity focused and included significantly fewer science ideas compared to other countries. c. **Summarize:** Point to strategies F and G on the STeLLA strategies poster: Make explicit links between science ideas and activities (strategy F) and link science ideas to other science ideas (strategy G). These strategies and the idea of a Science Content Storyline Lens grew out of the TIMSS research findings. d. "Today we'll begin our study of the Science Content Storyline Lens, with a focus on strategy A: Identify one main learning goal."
8:55–10:10 75 min (Includes 10-min break) **Introducing SCSL Strategy A** Slides 14–23	**Purpose** • Clarify and deepen participants' understandings of SCSL strategy A: Identify one main learning goal. • Clarify the distinctions between science ideas, student ideas, and main learning goals. **Content** • A main learning goal is a big idea that students are expected to learn and take away from a lesson or series of lessons. Everything in the lesson supports the development of this one main learning goal.		**Display Slide 14.** Lesson Analysis: Focus Question 2 (Less than 1 min) a. Read the focus question on the slide.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	What Participants Do • Make a chart highlighting the purpose and key features of SCSL strategy A. • Review the differences and relationships among student ideas, science ideas, and main learning goals. • Practice identifying student ideas and science ideas in a written list. • Practice identifying strong main learning goals using the analysis guide for strategy A. **Handouts in PD Binder** • 5.1 Analysis Guide A • 5.2 Practice Identifying One Main Learning Goal **PD Leader Masters** • PD Leader Master: Practice Identifying One Main Learning Goal (Answer Key) **Supplies** • Chart paper and markers **PD Resources** • STeLLA strategies booklet • SCSL Z-fold summary chart (blank copy in front pocket of PD binder) **Resources in Lesson Plans Binder** *Resources section:* • Content background document • Common Student Ideas		**Display Slide 15.** STeLLA Conceptual Framework (1 min) a. "Now let's dig into SCSL strategy A!" b. "As you can see, strategy A is the first of nine Science Content Storyline Lens strategies. It appears first because it's the foundation on which all the other SCSL strategies are built. This will become clearer as we delve into the other strategies and see how important it is that each of them is matched to the lesson's main learning goal."
			**Display Slide 16.** Purpose and Key Features of Strategy A (25 min) a. **Pairs:** "Share with a partner what you wrote on your Science Content Storyline Lens Z-fold summary chart about the purpose and key features of strategy A." b. **Whole group:** Have one or two participant volunteers lead the group in creating a chart that describes the purpose and key features of strategy A. c. **Transition:** "Next, we'll review the difference between a science idea and the main learning goal of a lesson. Then you'll practice identifying

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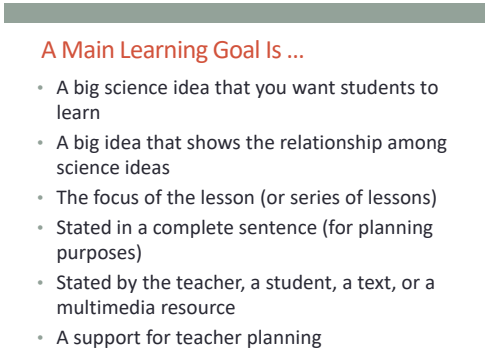
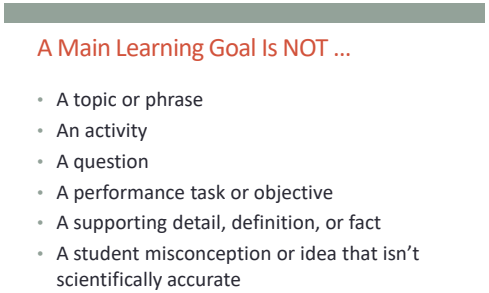
			and clarifying this distinction."
			**Display Slide 17.** A Main Learning Goal Is … (1 min) a. "This slide lists some key ideas about the definition of a main learning goal." b. Read through the ideas. c. **Emphasize:** "Notice the parenthetical reference to 'lessons' in the third bullet point. Each lesson should have only one main learning goal, but you might need two or more lessons to help students accomplish a difficult goal. So it's often necessary to spend more than one lesson on a specific learning goal."
			**Display Slide 18.** A Main Learning Goal Is NOT … (1 min) a. Review what is **not** considered a main learning goal.

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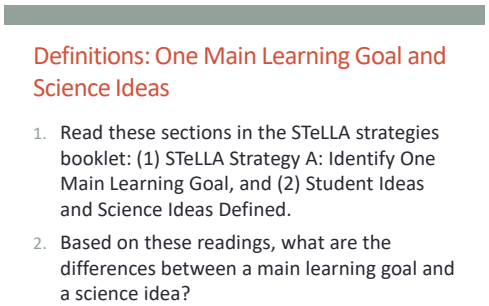
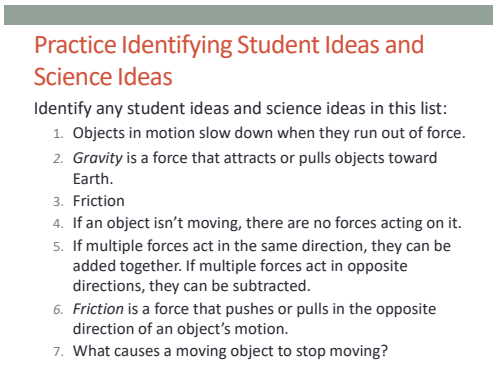
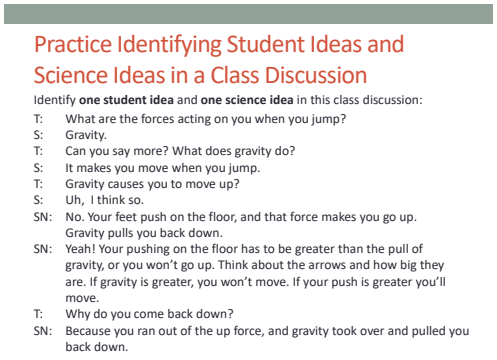
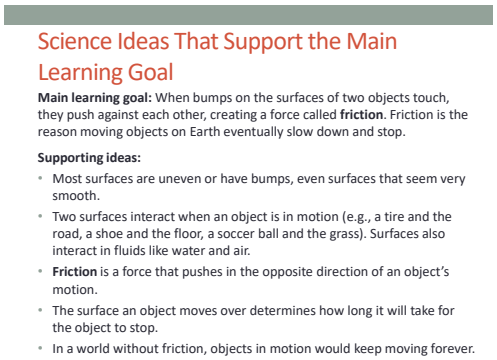
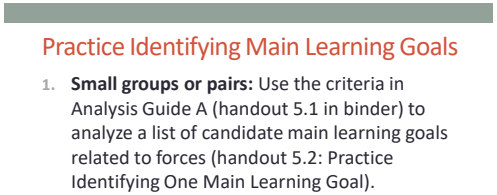
			**Display Slide 19.** Definitions: One Main Learning Goal and Science Ideas (10 min) a. Have participants locate these two readings in the strategies booklet: (1) STeLLA Strategy A: Identify One Main Learning Goal, and (2) Student Ideas and Science Ideas Defined. b. "After you read these sections in the strategies booklet, we'll discuss the differences between a science idea and a main learning goal." c. **Individuals (3 min):** Give participants time to read the specified sections in the strategies booklet. d. **Whole group (7 min):** Discuss the question on the slide. e. **Emphasize:** "While you might incorporate several science ideas that support the main learning goal of a lesson, be careful not to plan an 'all about' lesson with too many different science ideas that will likely come across to students as a bunch of disconnected facts to be memorized."
			**Display Slide 20.** Practice Identifying Student Ideas and Science Ideas (5 min) a. "Next, we'll practice identifying student ideas and science ideas just to make sure you understand the way we're defining these terms." **Note:** As needed, refer participants to the section in the strategies booklet where student ideas are defined (Student Ideas and Science Ideas Defined). b. **Individuals:** "First, identify examples of **science**

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			ideas on the slide. If you need help, refer to the document in your lesson plans binders titled Common Student Ideas about Forces and Motion. Then identify examples of **student ideas** on the slide." c. **Whole group:** Discuss participants' responses and the correct answers (see answer key). **Answer key:** 1. Student idea (common but incorrect) 2. Science idea (complete sentence and scientifically accurate) 3. Neither a science idea nor a student idea (a topic, not a complete idea) 4. Student idea (common but incorrect) 5. Science idea (complete sentence and scientifically accurate) 6. Science idea (complete sentence and scientifically accurate) 7. Neither a science idea nor a student idea (a topic, not a complete idea)
			**Display Slide 21.** Practice Identifying Student Ideas and Science Ideas in a Class Discussion (5 min) a. "It's a little trickier to recognize student ideas and science ideas in class discussions because students sometimes give only one- or two-word answers to teacher questions. But if you link the teacher's question with a student's response, you can sometimes find a science idea or a student idea." **Note:** In the RESPeCT PD program, we encourage students to speak in complete sentences as much as possible.

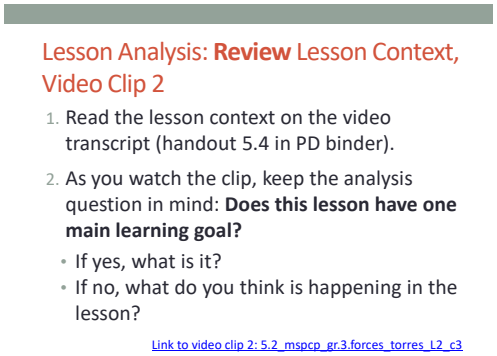
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process

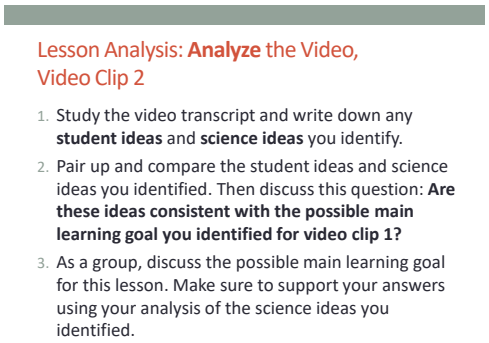
			b. "Let's practice linking the teacher's question with student responses in the sample discussion on the slide."
			
			c. **Pairs:** "Work with a partner to see if you can identify one student idea and one science idea in this discussion."
			
			d. **Whole-group share-out:** Have participants share the ideas they identified in the sample discussion. Then review the answers (see answer key).
			
			e. **Emphasize:** "Here's some food for thought: To make student thinking more visible, why not require students to speak in complete sentences during classroom discussions about science ideas?"
			
			Answer key:
			• *Student ideas/misconceptions:*
			  • Gravity (a word, not an idea)
			  • Gravity makes you move up when you jump.
			  • When you run out of the up force, gravity takes over and pulls you back down.
			• *Science ideas:*
			  • The force that pushes you up when you jump comes from your feet pushing on the floor.
			  • When you jump, gravity pulls you back down.
			  • To leave the ground when you jump, the force of your feet pushing on the floor must be greater than the pull of gravity.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 22.** Science Ideas That Support the Main Learning Goal (6 min) a. Display **only** the main learning goal on the slide. b. **Pairs:** "Work with a partner to come up with two or three science ideas that might support the development of this main learning goal. Use the content background document and the Common Student Ideas chart as resources." c. **Whole group:** Have pairs share the supporting science ideas they came up with. d. Next, reveal the list of possible supporting science ideas one by one on the slide and compare them with participants' ideas. e. **Highlight:** "Some of these supporting science ideas could also be a lesson's main learning goal."
			**Display Slide 23.** Practice Identifying Main Learning Goals (10 min) a. Direct participants to locate handout 5.1 (Analysis Guide A: Identifying One Main Learning Goal) and handout 5.2 (Practice Identifying One Main Learning Goal) in their PD program binders. b. **Small groups/pairs:** Have participants form small groups or pairs and use the criteria from Analysis Guide A to analyze the list of possible learning goals on handout 5.2. c. Direct participants to write yes or no on the

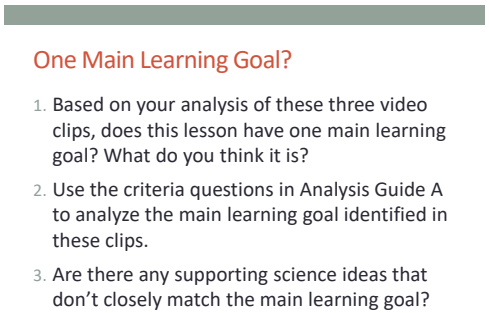
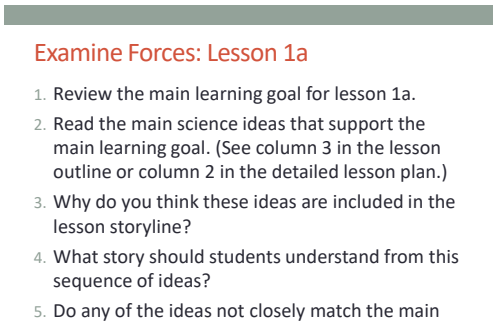
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			handout to indicate whether the statement is or is not a good candidate for a lesson's main learning goal. Then have them state the reason for each assessment using criteria from the analysis guide. d. **Whole-group share-out:** Have participants share and discuss their selections. e. Be sure to highlight what distinguishes a main learning goal from supporting science ideas, topics, phrases, activities, or questions. f. Also use this discussion to clarify science content. **Answer key:** See PD Leader Master: Practice Identifying One Main Learning Goal (Answer Key).
10:00–10:10 10 min	**BREAK**		
10:10–12:00 110 min **Lesson Analysis: SCSL Strategy A** Slides 24–32	**Purpose** • Use lesson analysis of classroom videos to better understand SCSL strategy A. • Deepen participants' science-content knowledge of forces through lesson analysis. **Content** • Using one main learning goal brings coherence within and across lessons. • A main learning goal is a big idea that students are expected to learn and take away from a lesson or	Lesson Analysis: Strategy A Next, we'll watch a sequence of three video clips from the same lesson on forces. **Analysis question for all three clips:** Does this lesson have one main learning goal? **Follow-up questions:** • If yes, what is it? • If no, what do you think is happening in the lesson?	**Display Slide 24.** Lesson Analysis: Strategy A (1 min) a. Make sure participants understand that they will be viewing a sequence of three video clips from the same Forces lesson. b. "For each set of three clips, we'll answer the analysis question, *Does this lesson have one main learning goal?*" c. "If the answer is yes, what is the learning goal? If no, why do you think that's the case? What do you think is happening in the lesson?"

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	series of lessons. Everything in the lesson supports the development of this one main learning goal. **What Participants Do** • Watch a sequence of three video clips from one lesson. Analyze the science ideas in each clip and determine whether they're organized to support one main learning goal. • Use the criteria in Analysis Guide A to determine the quality of the main learning goal identified for this lesson. • Examine a Forces lesson plan to see how the main learning goal and supporting science ideas are identified. **Videos** • Video Clip 5.1, Torres classroom (beginning of lesson) • Video Clip 5.2, Torres classroom (during the lesson) • Video Clip 5.3, Torres classroom (end of lesson) **Handouts in PD Binder** • 5.1 Analysis Guide A • 5.3 Transcript for Video Clip 5.1 • 5.4 Transcript for Video Clip 5.2 • 5.5 Transcript for Video Clip 5.3 **Supplies** • Science notebooks • Chart paper and markers	Lesson Analysis: **Review** Lesson Context, Video Clip 1 1. Read the lesson context on the video transcript (handout 5.3 in PD program binder). 2. As you watch the clip, keep the analysis question in mind: **Does this lesson have one main learning goal?** • If yes, what is it? • If no, what do you think is happening in the lesson? Link to video clip 1: 5.1_mspcp_gr.3.forces_torres_L2_c1-2	**Display Slide 25.** Lesson Analysis: Review Lesson Context, Video Clip 1 (5 min) a. Have participants read the lesson context at the top of the video transcript (handout 5.3 in PD program binder). (Less than 1 min) b. Read the information on the slide. (Less than 1 min) c. Show the video clip. (4 min)
		Lesson Analysis: **Analyze** the Video, Video Clip 1 1. Study the video transcript and write down any **science ideas** the students and/or the teacher put on the table. 2. Pair up and compare the science ideas you identified. Then discuss the analysis question: **Does this lesson have one main learning goal?** • If yes, what is it? • If no, what do you think is happening in the lesson? 3. As a group, discuss what the main learning goal might be. Support your answers using your analysis of the science ideas you identified.	**Display Slide 26.** Lesson Analysis: Analyze the Video, Video Clip 1 (25 min) a. Before participants analyze the video transcript, remind them of these key points: (1 min) • A science idea is a full-sentence idea that students could take away as something they learned during the lesson. • Science ideas are sometimes identified by linking the teacher's question with the student's response. b. **Individuals (8 min):** "Study the video transcript and write in your notebooks any science ideas you identify in the discussion." c. **Pairs (5 min):** "Pair up and compare the science ideas you identified in the transcript. Then

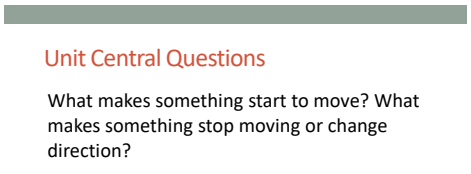
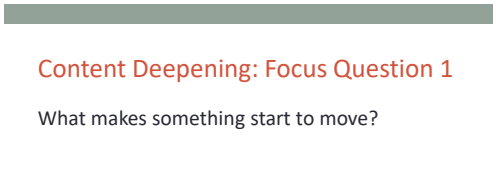
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	PD Resources • RESPeCT lesson plans binder		discuss the questions on the slide." d. **Whole group (11 min):** Have participants share what they think might be the main learning goal of this lesson, using their analyses of the science ideas they identified to support their suggestions. e. List the possible learning goals on chart paper. f. Let participants know they'll revisit this list of possible main learning goals for the lesson after they watch the remaining video clips.
			**Display Slide 27.** Lesson Analysis: Review Lesson Context, Video Clip 2 (5 min) a. Have participants read the lesson context at the top of the video transcript (handout 5.4 in PD binder). (Less than 1 min) b. Review the instructions on the slide. (Less than 1 min) c. Show the video clip. (4 min)

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 28.** Lesson Analysis: Analyze the Video, Video Clip 2 (25 Min) a. Review the definitions of a science idea and a student idea. Remind participants that students can express correct science ideas and inaccurate student ideas at the same time. (1 min) b. **Individuals (8 min):** "Study the video transcript and write in your notebooks any student ideas and science ideas you identify." c. **Pairs (5 min):** "Pair up and compare the student ideas and science ideas you identified in the transcript. Then discuss the question on the slide." d. **Whole group (11 min):** Have participants share what they think might be the main learning goal of this lesson, using their analyses of the science ideas they identified to support their suggestions. e. List the possible learning goals on chart paper. f. Let participants know they'll revisit this list of possible main learning goals for the lesson after they watch one more video clip.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Lesson Analysis: **Review** Lesson Context, Video Clip 3 1. Read the lesson context on the video transcript (handout 5.5 in PD binder). 2. As you watch the clip, keep the analysis question in mind: **Does this lesson have one main learning goal?** • If yes, what is it? • If no, what do you think is happening in the lesson? Link to video clip 3: 5.3_mspcp_gr.3.forces_torres_L2_c4	**Display Slide 29.** Lesson Analysis: Review Lesson Context, Video Clip 3 (5 min) a. Have participants read the lesson context at the top of the video transcript (handout 5.5 in PD binder). (Less than 1 min) b. Review the instructions on the slide. (Less than 1 min) c. Show the video clip. (4 min)
		Lesson Analysis: **Analyze** the Video, Video Clip 3 1. Study the video transcript and write down any **student ideas** and **science ideas** you identify. 2. Pair up and compare the student ideas and science ideas you identified. Then discuss this question: **Are these ideas consistent with the possible main learning goal you identified for clips 1 and 2?** 3. As a group, discuss the possible main learning goal for this lesson. Make sure to support your answers using your analysis of the science ideas you identified.	**Display Slide 30.** Lesson Analysis: Analyze the Video, Video Clip 3 (24 min) a. **Individuals (8 min):** "Study the video transcript and write in your notebooks any student ideas and science ideas you identify." b. **Pairs (5 min):** "Pair up and compare the student ideas and science ideas you identified on the transcript. Then discuss the questions on the slide." c. **Whole group (11 min):** Have participants share what they think might be the main learning goal of this lesson, using their analyses of the science ideas they identified to support their suggestions. d. List the science ideas and possible learning goals on chart paper. e. **Ask:** "Did the three video clips develop coherence across the lesson or include too many ideas that didn't support the main learning goal?"

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 31.** One Main Learning Goal? (15 min) a. **Whole group:** Discuss the first question on the slide and reach a consensus on the main learning goal for the lesson. b. **Pairs:** Have participants work in pairs to answer the criteria questions in Analysis Guide A for the main learning goal they agreed upon for this lesson. Also have them identify any supporting science ideas that don't closely match the main learning goal. c. **Whole group:** Discuss participants' responses to the questions in Analysis Guide A and the final question on the slide.
			**Display Slide 32.** Examine Forces: Lesson 1a (5 min) **Note:** This slide is **optional** if time is running short. It's designed to help participants see how the lesson plans are written to highlight the main learning goal and science ideas that support the main learning goal. a. Have participants look at Forces lesson 1a in their lesson plans binders and compare the main learning goal with the goal they came up with in their analyses of the Torres video clips. It should be a pretty close match.

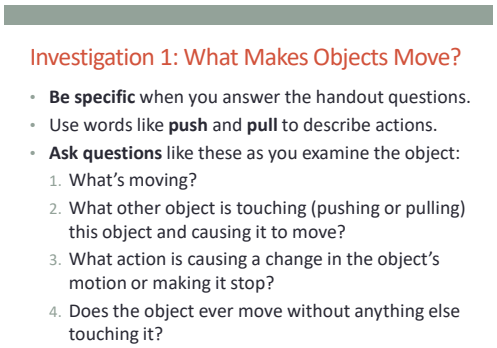
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			b. Show participants how to find the main science ideas for the lesson in the lesson plans binder—column 3 of the lesson outline (How the Science Content Storyline Develops) or column 2 of the detailed lesson plan under the Main Science Idea(s) heading. All of these ideas should support the main learning goal. c. Discuss the questions on the slide. **Note:** All of the key science ideas in the lesson outline should closely match the main learning goal.
12:00–12:45 45 min	**LUNCH**		
12:45–3:10 145 min (Includes 10-min break) **Content Deepening: Forces** Slides 33–81	**Purpose** • Deepen participants' understandings of science ideas about forces and motion by conducting investigations from Forces lessons 1a/b and 2a/b. • Expand participants' science-content knowledge of forces and motion related to teacher learning goals by exploring the concepts of weight/gravity, normal forces, net force, and acceleration. **Content** • A *force* is a push or pull that involves an interaction between two objects and causes a change in an object's motion. • Arrows can be used to represent the forces acting on an object. Arrows begin at the center of an object and point in the direction of the		**Display Slide 33.** Content Deepening: Forces (Less than 1 min) a. "Now let's begin the content deepening phase on forces." **Note:** Throughout this content deepening phase, refer as needed to the content background document and Common Student Ideas about Forces and Motion.

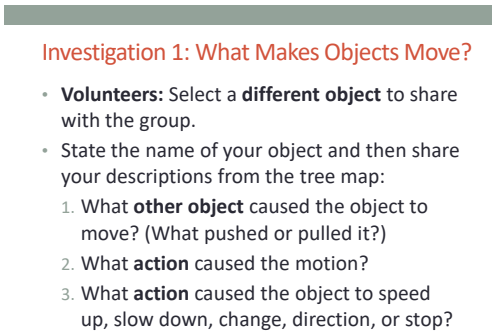
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	respective forces. • A *net force* is the sum of all of the forces acting on an object. • A change in an object's motion in the same direction as the net force is called *acceleration.* • Weight refers to the pull of gravity on an object toward Earth's center. • When one object is resting on another object, the object underneath exerts an upward-pushing force called the *normal force*. This force keeps the two touching objects separated from each other. **What Participants Do** • Explore the pushing and pulling actions that cause various objects to move. • Complete a tree map describing those actions. • Read an essay on forces. • Draw pictures showing what makes an object start moving, change speed or direction, or stop moving. • Exert different forces on a shopping cart and represent the strength and direction of the forces using arrows of varying lengths. • Complete a handout describing what happens when equal and unequal forces are exerted on a toy car. • Learn about contact and noncontact forces. • Conduct an investigation of normal force using their fists and desk		**Display Slide 34.** Unit Central Questions (Less than 1 min) a. Introduce the unit central questions on the slide. b. **Emphasize:** "These questions will guide student thinking throughout the Forces unit."
			**Display Slide 35.** Content Deepening: Focus Question 1 (Less than 1 min) a. "Our first content deepening focus question is from Forces lessons 1a and b." b. Read the question on the slide. c. Ask participants to write the question in their science notebooks and draw a box around it. This will reinforce a process they'll follow with students in the actual lessons.

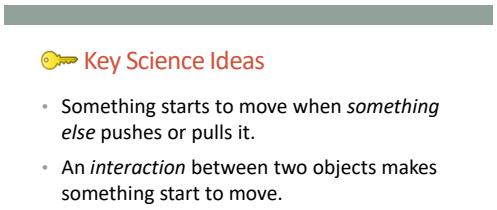
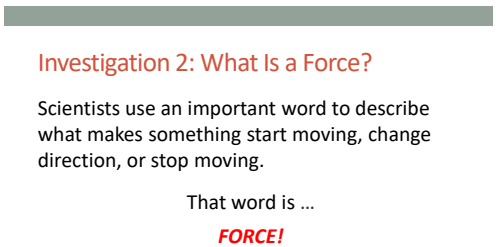
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	surfaces. • Complete worksheets using vectors to illustrate the forces acting on various objects, as well as changes in their motion. • Estimate net force and the direction of the net force and acceleration for various objects. **Handouts in PD Binder** • 5.6 Tree Map (from Forces lesson 1a) • 5.7 What Are the Forces? (from Forces lesson 2b) • 5.8 Weight (The Force of Gravity) • 5.9 Net Forces: Train, Airplane, and Dandelion • 5.10 Net Force and Acceleration: Apple-and-Car Scenario • 5.11 Net Force and Acceleration: Falling-Car Challenge • 5.12 Net Force and Acceleration: Shopping-Cart Challenge **Handouts in Lesson Plans Binder** • 1.2 Forces (from Forces lesson 1b) **Supplies** • Science notebooks • Chart paper and markers • Black and red pencils (for drawing vectors) • For content deepening (from Forces lessons 1a/b) (1 per group): • Paddle balls	Investigation 1: What Makes Objects Move? What do you think can make this cart start moving?  Photo courtesy of Cal Poly Pomona	**Display Slide 36.** Investigation 1: What Makes Objects Move? (Less than 1 min) a. Draw participants' attention to the shopping cart on the slide. b. Ask, "What do you think can make this cart start to move?" c. Elicit a variety of ideas and record them on chart paper.

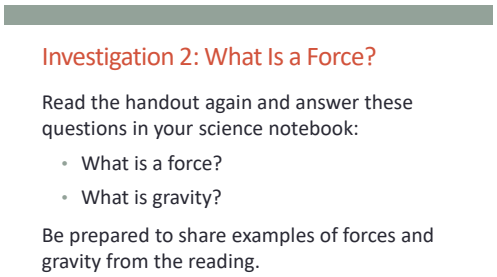
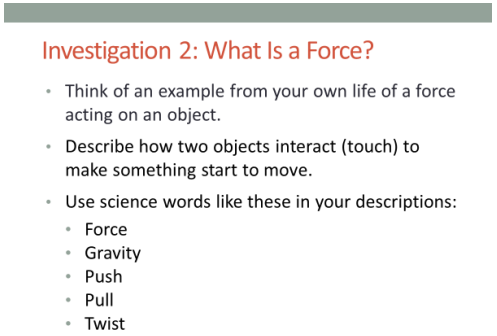
		Investigation 1: What Makes Objects Move?
		
		Directions for each group member:
		1. Choose an object on the tray to investigate.
		2. Explore different ways to make the object move.
		3. On the tree map, circle the name of the object you're investigating. Then answer these questions using action words like **push** and **pull**:
		  • What **other object** caused the object to move?
		  • What **action** caused the motion?
		  • What **action** caused the object to speed up, slow down, change direction, or stop?
			Display Slide 37. Investigation 1: What Makes Objects Move? (4 min)
			
			a. "Let's explore what makes other familiar objects move."
			b. Divide participants into small groups and give each group a tray of objects (paddle ball, rubber ball, toy car, block).
			c. Distribute handout 5.6 (Tree Map) and go over the instructions. Then highlight each of the questions participants will need to answer as they explore their objects.
			d. Read the directions on the slide.

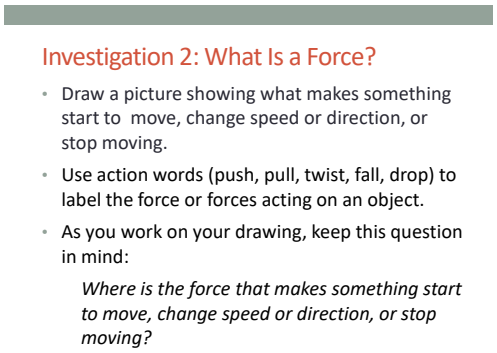
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process

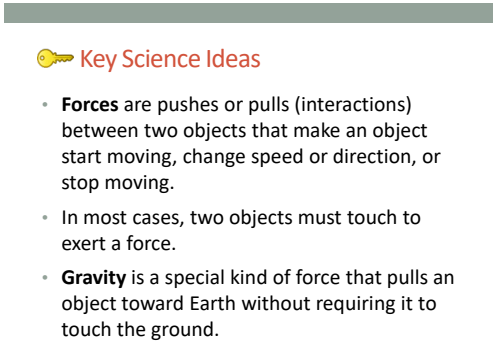
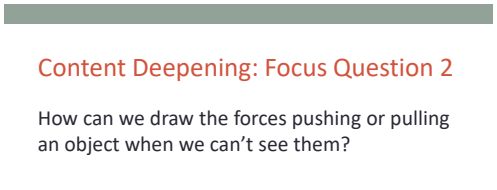
	• Rubber balls
	• Toy cars
	• Blocks
	• For content deepening (from Forces lessons 2a/b):
	  • Rolling cart
	  • Foam arrows of different lengths (2 short, 2 medium, 2 long)
	  • Toy cars (1 per pair)
	  • Paper arrows of different lengths (2 short, 2 medium, 2 long)
	
	PD Resources
	• RESPeCT lesson plans binder
	
	Resources in Lesson Plans Binder
	Resources section:
	• Content background document
	• Common Student Ideas
			**Display Slide 38.** Investigation 1: What Makes Objects Move? (6 min)
			
			a. Review the guidelines on the slide.
			
			b. Direct small groups to begin their investigations and complete their tree maps. Encourage participants to explore as many of the objects on the tray as time allows.

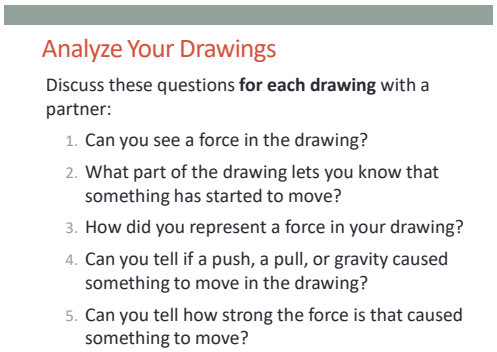
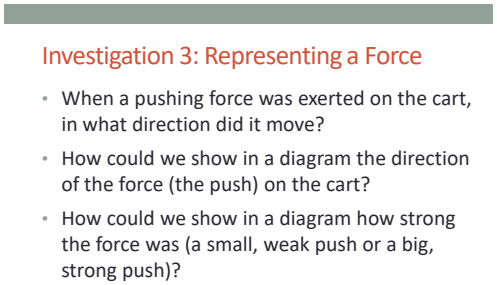
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 39.** Investigation 1: What Makes Objects Move? (3 min) a. "Next, let's have a couple of volunteers select a different object to share with the group. When it's your turn to share, state the name of your object and then share your descriptions from the tree map. Each of you will have 1 minute for your presentation." b. Use the following example as a model: • My object is the **cart**. • **My hand** (the other object) caused the cart to start moving. • **Pushing the cart** (the action) caused the motion. • **Pulling the cart** (action) with **my hand** (other object) made it **change direction**.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 40.** Key Science Ideas (Less than 1 min) a. Review the key science ideas on the slide.
			**Display Slide 41.** Investigation 2: What Is a Force? (Less than 1 min) a. "Scientists use the word *force* to describe what makes objects start moving, speed up, slow down, change direction, or stop moving." b. "To learn more about what forces are, let's read a brief essay from lesson 1b."

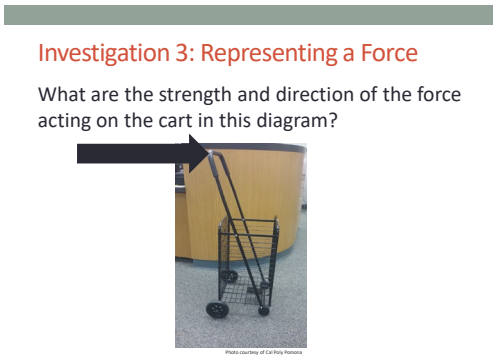
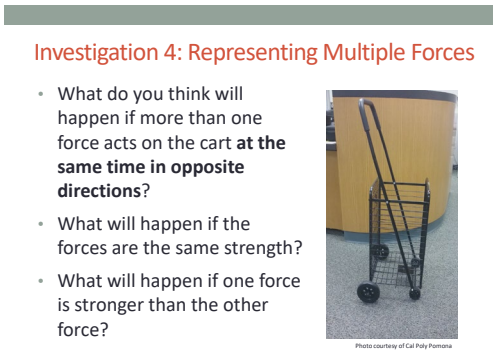
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 42.** Investigation 2: What Is a Force? (3 min) a. **Individuals:** Ask participants to locate handout 1.2 (Forces) in their lesson plans binders, read it silently, and answer the questions on the slide in their science notebooks. b. **Whole group:** Invite participants to share their definitions and examples with the group. Record their ideas on chart paper. **Key science ideas:** • *Forces* are pushes or pulls (interactions) between two objects that make an object start moving, change speed or direction, or stop moving. • In most cases, two objects must touch to exert a force. • *Gravity* is a special kind of force that pulls an object toward Earth without requiring it to touch the ground.
			**Display Slide 43.** Investigation 2: What Is a Force? (2 min) a. Read the instructions on the slide. b. Invite participants to share their examples and descriptions with the group.

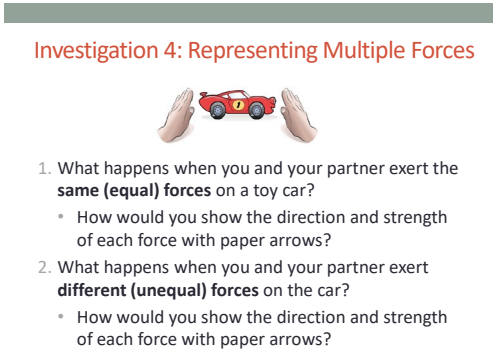
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 44.** Investigation 2: What Is a Force? (4 min) a. **Individuals:** "To illustrate key science ideas about motion and forces that we've investigated so far, draw a picture in your science notebooks showing what makes something start to move, change speed or direction, or stop moving. You may use an example from our investigations, from the handouts, or from your own life." b. "Make sure to label your drawings using action words that show the force or forces acting on an object. As you work on your drawings, ask yourself, *Where is the force that makes something start to move, change speed or direction, or stop moving?*" c. **Whole group:** Invite one or two participants to share their drawings with the group.
			**Display Slide 45.** Reflect: Content Deepening Focus Question 1 (3 min) a. Review the focus question on the slide. b. **Individuals:** Ask participants to answer the question in their science notebooks using science ideas and evidence from the previous investigations. c. **Whole-group:** Invite one or two participants to briefly share their responses with the group.

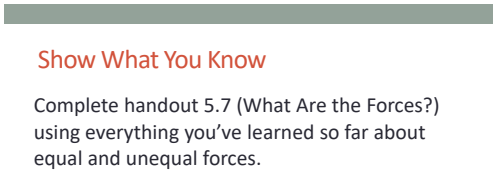
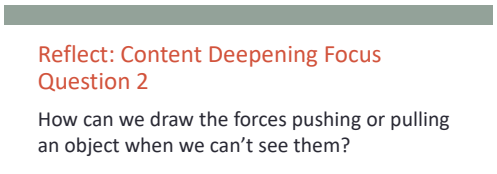
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 46.** Key Science Ideas (Less than 1 min) a. Review the key science ideas on the slide.
			**Display Slide 47.** Content Deepening: Focus Question 2 (Less than 1 min) a. "Our second content deepening focus question is from Forces lessons 2a and b." b. Read the question on the slide. c. Ask participants to write the question in their science notebooks and draw a box around it.

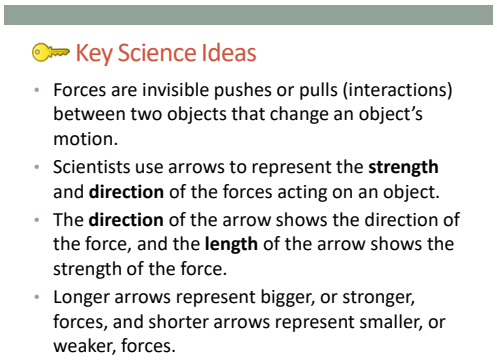
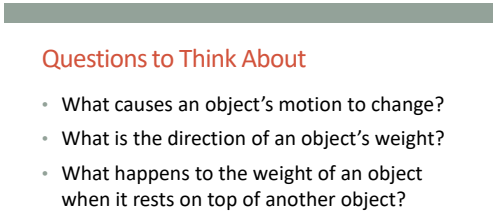
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 48.** Analyze Your Drawings (5 min) **Note:** You can skip this slide if time is running short. a. **Pairs:** "Before we begin our next investigation, I'd like you to pair up with an elbow partner and discuss your drawings from the previous investigation. Use the discussion questions on the slide to analyze each of your drawings."
			**Display Slide 49.** Investigation 3: Representing a Force (3 min) a. Position the rolling cart where everyone can see it. b. Ask a volunteer to come up and exert a pushing force on the cart. c. Discuss the questions on the slide as a group and record on chart paper participants' ideas for the second and third questions. **Note:** If no one mentions using arrows to represent the strength of a force, add it to the list of ideas. d. Emphasize that arrows can be used to represent both the strength and direction of the forces acting on an object.

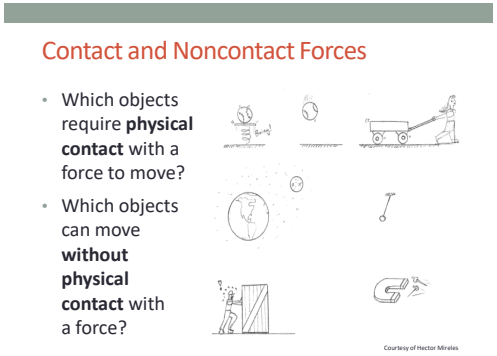
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Investigation 3: Representing a Force **Volunteer 1:** Exert a pushing or pulling force on the cart. **Volunteer 2:** Select a foam arrow to represent both the **strength** and **direction** of the force acting on the cart.  Photo courtesy of Cal Poly Pomona	**Display Slide 50.** Investigation 3: Representing a Force (4 min) **Note:** Make sure the foam arrows of different lengths are available for this activity. a. "Let's use foam arrows to represent the strength and direction of a pushing or pulling force acting on our rolling cart." b. "I'll need two volunteers for this demonstration. One volunteer will exert a pushing or pulling force on the cart, and the other volunteers will select one of the foam arrows to represent *both* the direction and strength of the force acting on the cart. As you watch the demonstration, think about whether the foam arrow accurately represents both the strength and direction of the force. Be prepared to share your observations with the group." c. Select two volunteers and have one of them push or pull the cart. Then ask the second volunteer to select an arrow and describe the direction and strength of the force. d. Following the demonstration, invite participants to share their observations. Ask, "Do you agree or disagree with the length of arrow selected to represent the force on the cart? Why?"

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 51.** Investigation 3: Representing a Force (Less than 1 min) a. "What are the strength and direction of the force acting on the cart in this diagram? How do you know?" b. Participants should observe that based on the length and direction of the arrow in the diagram, the force acting on the cart is pushing it to the right with a medium-sized strength.
			**Display Slide 52.** Investigation 4: Representing Multiple Forces (5 min) a. Read the questions on the slide. b. **Pairs (1 min):** Ask participants to share their predictions and reasoning with an elbow partner. c. **Whole group (1 min):** Invite a few participants to share their predictions and reasoning with the group. d. "Now let's test our predictions!" e. Select two volunteers to demonstrate multiple forces acting on the cart at the same time. First, ask both volunteers to exert forces of *equal* (the same) strength on the cart in opposite directions. Then have them exert forces of *unequal* strength in opposite directions. f. Following the demonstrations, invite participants to share their observations. g. Ask, "Did your predictions match what actually happened?"

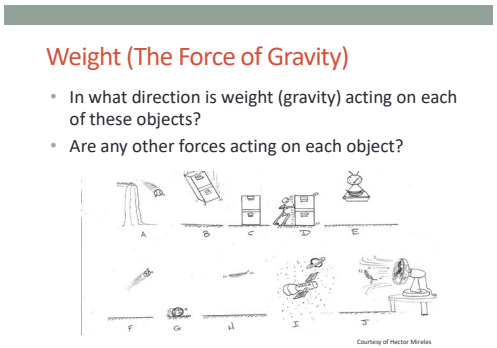
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			Key science ideas: • When forces of equal strength are exerted on an object in opposite directions, the object won't move. • When forces of unequal strength are exerted on an object in opposite directions, the object will move in the direction the stronger force is pushing.
			**Display Slide 53.** Investigation 4: Representing Multiple Forces (9 min) a. "Next, we'll investigate what happens when more than one force is exerted on a toy car at the same time in opposite directions." b. Have participants pair up; then give each pair a toy car. c. First, direct pairs to apply the same or equal forces on the car at the same time in opposite directions. **Note:** Make sure participants apply each force from opposite ends of the car. d. Then ask, "How would you show the direction and strength of each force with paper arrows?" e. Invite one pair of participants to demonstrate equal forces acting on the car using the paper arrows. Ask participants whether they agree or disagree with the representation or have observations to add. f. Next, direct pairs to apply different or unequal forces on the car at the same time in different directions. Partners should decide who will exert a gentle force and who will exert a stronger force. g. Then ask, "How would you show the direction and

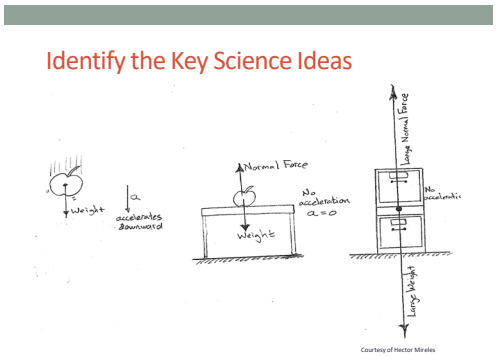
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			strength of each force with paper arrows?" h. Invite one pair of participants to demonstrate the forces acting on the car using the paper arrows. Ask participants whether they agree or disagree with the representation or have observations to add.
			**Display Slide 54.** Show What You Know (5 min) a. Distribute handout 5.7 (What Are the Forces?) and read through the instructions. b. **Individuals:** "To show what you know about equal and unequal forces, complete this handout by drawing arrows to represent the force or forces acting on the toy car in each scenario and recording a description of what happens." c. **Whole group:** Briefly discuss what happens when equal and unequal forces act on the toy car.
			**Display Slide 55.** Reflect: Content Deepening Focus Question 2 (4 min) a. Review the focus question on the slide. b. **Individuals:** Ask participants to answer the question in their science notebooks using what they learned during the previous investigations. c. **Whole group:** Invite participants to share their ideas with the group.

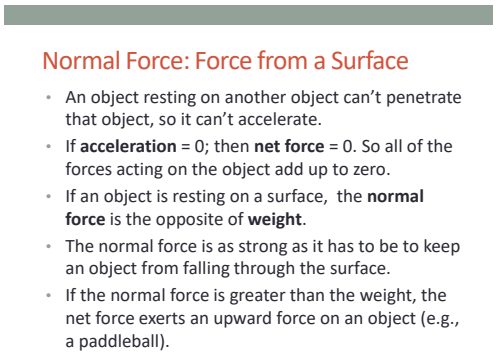
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 56.** Key Science Ideas (Less than 1 min) a. Review the key science ideas on the slide.
	10-MINUTE BREAK		
			**Display Slide 57.** Questions to Think About (Less than 1 min) a. Read the questions on the slide. b. "We'll explore these questions as we continue deepening our understandings of forces and motion in the next part of our content deepening session."

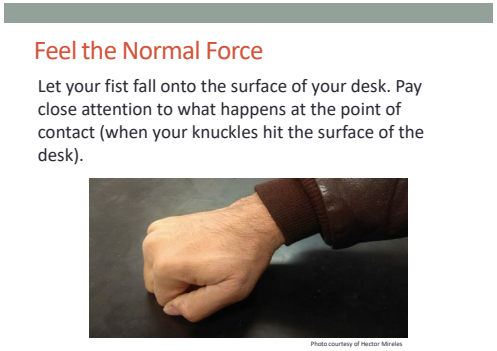
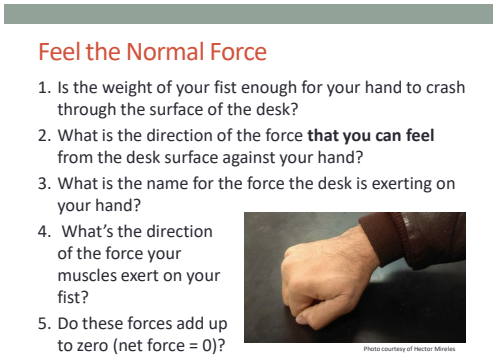
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 58.** Contact and Noncontact Forces (4 min) a. Introduce the objects on the slide and what they represent. 1. A spring launching a ball upward 2. A ball falling to the ground 3. A girl pulling a wagon 4. The Moon orbiting Earth 5. A pendulum hanging by a string 6. A man trying unsuccessfully to push a heavy crate 7. A magnet attracting nails b. Ask participants to think about each scenario and decide whether the object can move with or without physical contact. c. Discuss the questions on the slide. d. **Emphasize:** "Scientists use the phrase *action at a distance* when an object can move without physical contact with a force. Kind of like the force and Darth Vader!"

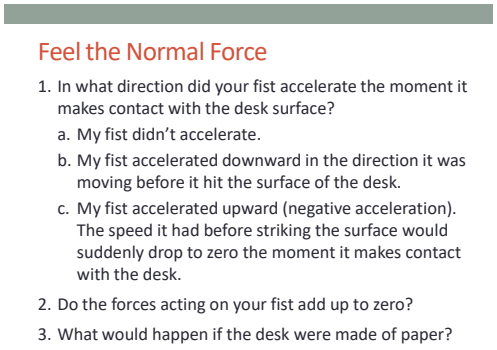
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Describe the Forces  Courtesy of Hector Mireles	**Display Slide 59.** Describe the Forces (1 min) a. "The boy in this slide is pushing a shopping cart filled with soccer balls. What forces are involved in this scenario?" b. Elicit participants' ideas and record them on chart paper.
		Describe the Forces • In what direction is the boy's force pushing/pulling on the cart? • In what direction is the force of gravity pushing/pulling on the cart? • In what direction is force of the ground pushing/pulling on the cart? • Does each of these "force possessors" (the boy, gravity, the ground) have to touch the cart to push or pull it?  Courtesy of Hector Mireles	**Display Slide 60.** Describe the Forces (3 min) a. Discuss the questions on the slide as a group. **Ideal responses:** • The boy is pushing the cart to the right. • Gravity is pulling downward on the cart. • The ground is pushing upward on the cart. • The boy and the ground have to touch the cart to exert a force, but gravity doesn't.

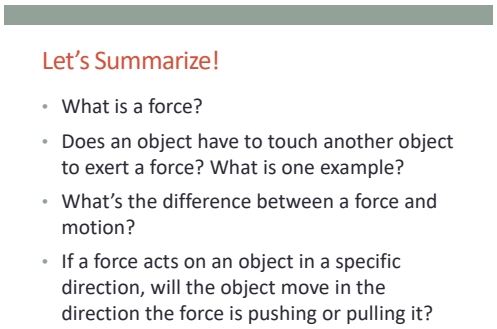
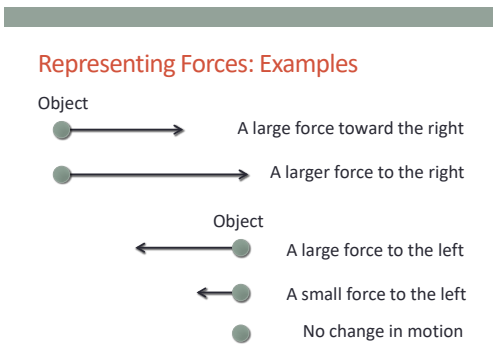
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 61.** Weight (The Force of Gravity) (5 min) **Note:** This activity can be scaled back if time is running short. a. "In our next investigation, we'll explore how weight or the force of gravity acts on various objects." b. Distribute handout 5.8 (Weight [The Force of Gravity]) and go over the instructions. c. "Make sure to draw the *exact* direction of the weight or gravity acting on the objects. Focus on only one object at a time." d. **Individuals:** Have participants complete the handout. e. **Whole group:** Briefly discuss the answers to the questions for each object. **Key science ideas:** • Weight always pulls an object downward regardless of the object's motion. • Weight always acts on objects, even if other forces are acting on them at the same time. • Weight is proportional to the mass of the object. The bigger the mass, the bigger the weight. **Ideal responses:** A. **Ball:** Gravity is pulling the ball downward. No other forces are acting on the ball. B. **Filing cabinet:** Gravity is pulling the cabinet downward. No other forces are acting on the cabinet. C. **Filing cabinet:** Gravity is pulling the cabinet downward. The floor is pushing up on the cabinet.

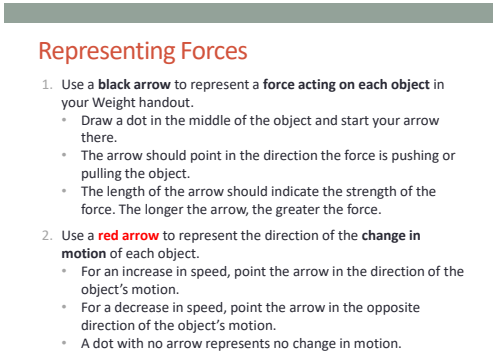
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			D. **Filing cabinet:** Gravity is pulling the cabinet downward. The floor is pushing up on the cabinet, and the man is pushing it to the right. E. **Bananas:** Gravity is pulling the bananas downward. The scale tray is pushing up on the bananas. F. **Baseball:** Gravity is pulling down on the ball as it flies upward. G. **Soccer ball:** Gravity is pulling down on the ball. The ground is pushing up on it, and the grass is slowing it down. H. **Feather:** Gravity pulls the feather downward toward the ground. The feather acts like a parachute as the air slows its descent a little bit. I. **NASA satellite:** There is no weight or gravity in outer space, but the nearby planets pull the satellite toward them. J. **Feather:** Gravity is pulling the feather downward even as the air from the fan is blowing it to the left.
			**Display Slide 62.** Identify the Key Science Ideas (5 min) a. "What key science ideas are the diagrams on the slide illustrating? What do they tell us about normal force, weight, and acceleration?" **Hint:** The illustrations are like an answer key. b. **Pairs:** Have participants discuss the questions with an elbow partner and then record their ideas in their science notebooks. c. **Whole group:** Invite participants to share their answers. Record the key science ideas on chart paper.

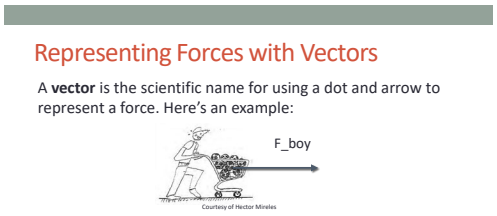
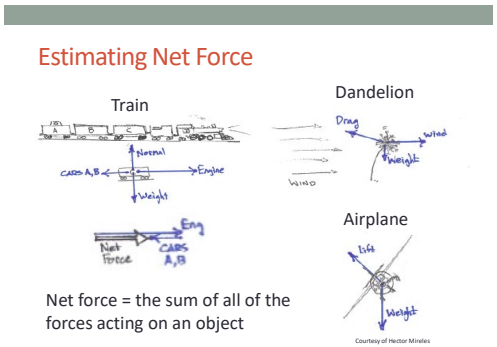
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 63.** Normal Force: Force from a Surface (5 min) a. Walk participants through the key science ideas on the slide and ask them how closely these ideas match the ideas they came up with in the previous activity. b. Emphasize the following points during the discussion and encourage participants to ask questions: • Since two objects can't occupy the same space, a normal force is exerted to keep that from happening. • Gravity is the only force acting on a free-falling apple, so the net force is downward (The apple accelerates downward.) • Gravity exerts a downward force on an apple resting on a table, but a normal force is exerting an upward force on the apple at the same time. These forces are equal and opposite, so the net force is zero. • A heavy object (such as a file cabinet) has a large normal force (longer arrows) compared to the normal force acting on an apple.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 64.** Feel the Normal Force (Less than 1 min) a. Read the instructions on the slide. b. Ask participants to carry out the experiment and pay close attention to what happens at the point of contact with the surface of the desk. c. Then quickly advance to the next slide.
			**Display Slide 65.** Feel the Normal Force (4 min) a. Ask participants what they felt when their knuckles made contact with the surface of the desk. **Ideal answer:** I could feel a downward force from my arm muscles because of the weight of my hand. b. Discuss the questions on the slide. **Ideal responses:** 1. No. The surface stops my knuckles. 2. I can feel an upward force from the desk against my hand. 3. The normal force. 4. Downward toward the surface of the desk. 5. No. The normal force is greater than the force from my muscles. **Note:** Participants may think that the forces add

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			up to zero because the surface of the table stops their hands. To address this misconception advance to the next slide.
			**Display Slide 66.** Feel the Normal Force (2 min) a. Briefly discuss the questions on the slide. **Ideal responses:** 1. My hand accelerated upward (negative acceleration). The speed it had before striking the desk sudden dropped to zero the moment it made contact with the desk. 2. No. The normal force was greater than the force my muscles exerted, so the net force was directed upward. Acceleration was upward, so my hand slowed down very quickly and accelerated in the opposite direction of the initial motion (a = F/m). 3. If the desk were made of paper, my fist would accelerate straight through it, since the normal force would be insufficient to stop it.

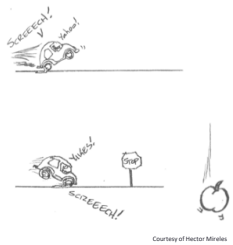
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 67.** Let's Summarize! (4 min) a. Discuss the questions on the slide. **Ideal responses:** • A *force* is a push or pull that involves an interaction between two objects and causes a change in an object's motion. This is one of our learning goals. • Forces can act on an object without the object touching another object. Example: gravity. • A *force* is a push or pull on an object that causes a change in the object's motion. A force must act on an object for it to start moving, but once an object is in motion, other forces can act on it while it's moving. These forces can change the object's speed and/or direction. So force and motion are different factors. • The movement of an object depends on the size and direction of the various forces acting on it. Example: If two forces are acting on an object in opposite directions with the equal force, no acceleration occurs.
			**Display Slide 68.** Representing Forces: Examples (Less than 1 min) a. Walk participants through the examples on the slide.

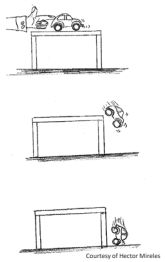
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 69.** Representing Forces (7 min) a. "Let's practice using arrows to represent forces acting on different objects." b. Have participants locate handout 5.8 (Weight [The Force of Gravity]). c. "For each object on the handout, use a black arrow to represent a force that's acting on it. First, draw a dot exactly in the center of the object and start your arrow there. The arrow should point in the direction the force is pushing or pulling the object, and the length of the arrow should indicate the strength of the force. The longer the arrow, the greater the force." d. Give participants a few minutes to draw their arrows. e. "Now I'd like you to use a red arrow to represent the direction of the change in motion that each object experiences. If the speed of the object increases, the arrow should point in the direction of the object's motion. If the speed decreases, the arrow should point in the opposite direction of the object's motion. If there is no change in motion, draw a dot but no arrow." f. Give participants a few minutes to draw their arrows. g. **Whole group:** Invite one or two participants to share their representations with the group.

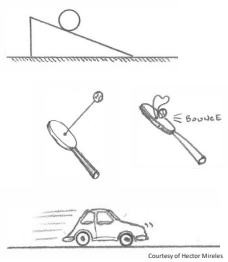
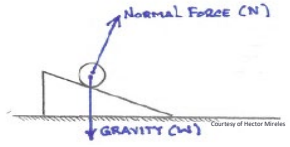
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 70.** Representing Forces with Vectors (1 min) a. Read the definition and rules on the slide. b. Walk participants through the example, highlighting how each rule has been applied.
			**Display Slide 71.** Estimating Net Force (7 min) a. "Next, we'll explore how to estimate the net force acting on different objects." b. Distribute handout 5.9 (Net Forces: Train, Airplane, and Dandelion) and review the instructions. c. Highlight the following points: • Vectors are scaled. A longer vector = a greater force. • Two or more vectors can add up to zero or something other than zero (e.g., vectors of the same length pointing in opposite directions). • The sum of all of the forces acting on an object is called the *net force.* d. Walk participants through the example on the slide showing the forces acting on car C. Note that the force the train engine exerts and the force cars A and B exert don't cancel each other out. The vector below the train shows that the net

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			force (the sum of the forces from cars A and B and the engine) is pointing right (black arrow). Contrast this with the normal force and weight for car C, which do cancel each other out. e. **Individuals:** Have participants complete the handout independently. f. **Whole group:** Invite one or two participants to share their net-force estimates and reasoning. You might want to display one of the completed handouts on a document reader during this discussion.

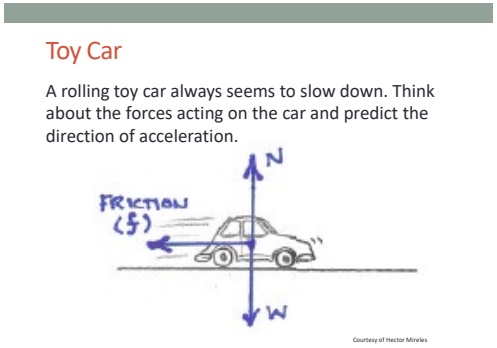
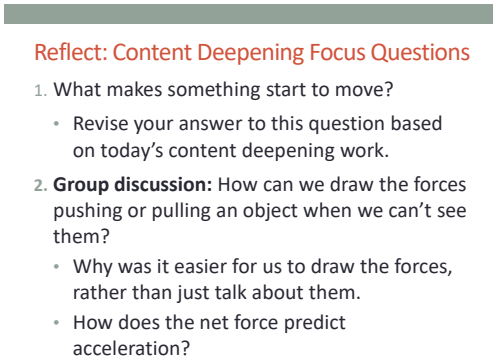
		Representing a Change in Motion
		• A change in an object's motion = acceleration (represented by the symbol **a**).
		• Newton's laws: *Acceleration occurs in the same direction as the net force.*
		  • If the net force is zero, there is no change in motion.
		  • A large net force yields a large acceleration.
			Display Slide 72. Representing a Change in Motion (Less than 1 min)
			a. Read through the information on the slide.

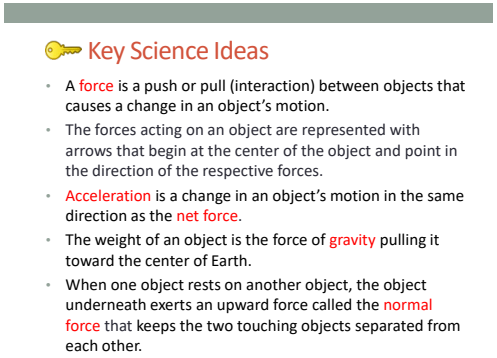
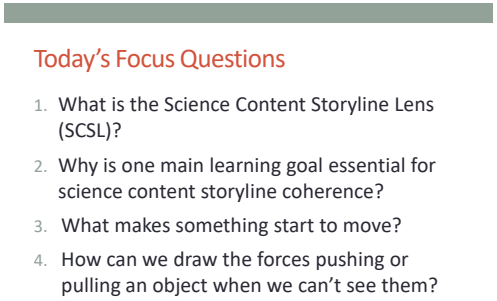
		Apple-and-Car Scenario • A change in motion = acceleration (**a**) • Acceleration occurs in the same direction as the net force. • If the net force is zero, there is no change in motion. • A large net force yields a large acceleration.  	**Display Slide 73.** Apple-and-Car Scenario (5 min) a. Distribute handout 5.10 (Net Force and Acceleration: Apple-and-Car Scenario) and read through the directions. b. Make sure participants understand the scenario: In the first diagram, the car accelerates. Then it slams on the breaks in the second diagram when an apple falls in the middle of the road (a little

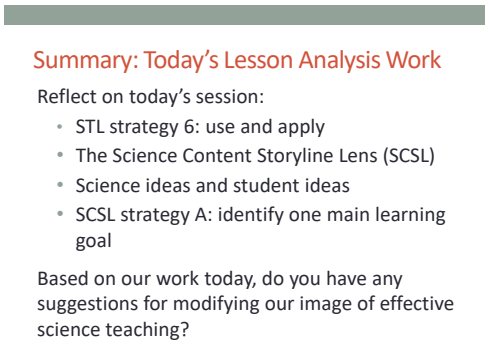
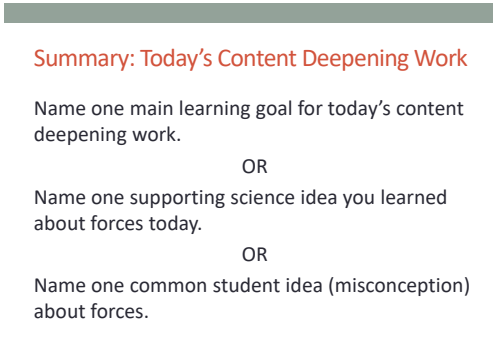
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			Newtonian humor). c. **Individuals:** Have participants predict the direction of the net force in each scenario by identifying the forces acting on the car. Then have them predict the direction of acceleration (change in motion) in each scenario. d. **Whole group:** Discuss participants' predictions and reasoning. Make sure to correct any mistakes or confusion.
		Falling-Car Challenge 	**Display Slide 74.** Falling-Car Challenge (4 min) a. "Our next challenge is to figure out the net force acting on a falling car and determine the change in motion or acceleration." b. Distribute handout 5.11 (Net Force and Acceleration: Falling-Car Challenge) and review the instructions. c. **Individuals:** Have participants complete the handout. d. **Whole group:** Briefly discuss participants' solutions.
		Shopping-Cart Challenge **Scenario:** A son pulls on a shopping cart by dragging his feet. But his father pulls much harder, and the cart moves to the left. 	**Display Slide 75.** Shopping-Cart Challenge (4 min) a. "Now let's consider another scenario and see if we can figure out the net force and acceleration. In this scenario, a father and son are engaged in a tug-of-war with a shopping cart." b. Distribute handout 5.12 (Net Force and Acceleration: Shopping-Cart Challenge) and review the instructions. Emphasize that

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			participants should only consider the forces acting on the cart. c. **Individuals:** Have participants complete the handout. d. **Whole group:** Briefly discuss the forces acting on the cart.
		Forces and Acceleration • Ball • Paddle Ball (Stretched) • Paddle Ball (Impacting Paddle) • Rolling Toy Car 	**Display Slide 76.** Forces and Acceleration (Less than 1 min) a. "In the Forces lessons, students will investigate these objects, all of which have different dynamics at different times." b. "To wrap up our content deepening work today, we'll use everything we've learned so far about forces and motion to make predictions about each of these objects."
		Ball on an Incline Predict the acceleration of the ball and justify your answer by adding together the forces acting on the ball (net force). 	**Display Slide 77.** Ball on an Incline (1 min) a. Ask participants to predict the acceleration of the ball and justify their answers by adding together the forces acting on the ball (net force). b. Highlight the downward pull of gravity (weight) on the ball and the upward push of the surface of the ramp against the ball (normal force). c. "We'll revisit this setup on day 8 of the PD program."

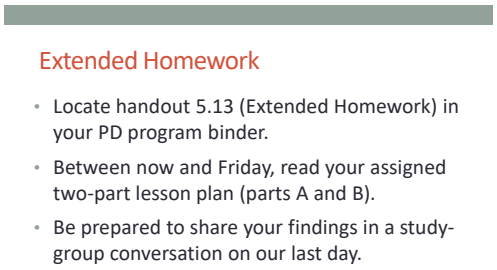
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Paddleball • What's the net force acting on the ball when the string is fully stretched (left) and when it makes contact with the paddle (right)? • What's the direction of the net force? What's the direction of acceleration?  Courtesy of Hector Mireles	**Display Slide 78.** Paddleball (5 min) a. "The motion of a paddleball is complex. Think about the forces acting on it." b. "A stretched elastic band exerts great tension (T) on the ball back toward the paddle, and a very small weight (W) or force of gravity is pulling the ball toward the ground." c. Ask participants, • What's the net force acting on the ball when the elastic is fully stretched? • What's the direction of the net force? • What's the direction of acceleration? d. "When the ball crashes against the paddle, the rubber in the ball compresses and creates a large force moving away from the paddle. Weight or gravity is still exerting a force, but it's very small." e. Ask participants, • What's the net force acting on the ball when it makes contact with the paddle? • What's the direction of the net force? • How about the direction of acceleration?

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 79.** Toy Car (4 min) a. "Have you ever noticed that a rolling toy car always seems to slow down? Let's consider the forces acting on the car." b. "Weight or gravity is pulling down on it, normal force is pushing up on it, and friction, which we'll discuss in our next content deepening session, is acting in the opposite direction of the car's motion." c. "In this diagram, the car is moving to the right, but do any of the forces point to the right?" d. Discuss the following questions: • What is the direction of acceleration? • What would happen if the force of friction were stronger in this diagram? • What would happen to the net force in that scenario?
			**Display Slide 80.** Reflect: Content Deepening Focus Questions (4 min) a. Revisit the content deepening focus questions on the slide. b. **Individuals:** Ask participants to revise their answers for the first question based on today's content deepening work. c. **Whole group:** Discuss the following questions related to the second focus question: • Why was it easier to draw the forces acting on an object than it was to talk about them? • How does the net force predict acceleration?

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 81.** Key Science Ideas (Less than 1 min) a. Review the key science ideas on the slide.
3:10–3:30 20 min **Wrap-Up: Summary, Homework, and Reflections** Slides 82–88	**Purpose** • Summarize and reflect on key ideas from today's learning, including the Science Content Storyline Lens, STeLLA strategy A, and the Forces science content. **What Participants Do** • Review today's focus questions. • Share key ideas from today's lesson analysis (SCSL strategy A) and content deepening work. • Copy down the homework assignment for day 6. • Discuss expectations for the extended homework assignment		**Display Slide 82.** Today's Focus Questions (Less than 1 min) a. Review the focus questions addressed during today's session.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	(Forces lesson plan review). • Write reflections on today's learning. **Posters and Charts** • Effective Science Teaching chart **Handouts in PD Binder** • 5.13 Extended Homework • 5.14 Daily Reflections—Day 5 **Supplies** • Science notebooks		**Display Slide 83.** Summary: Today's Lesson Analysis Work (3 min) a. **Individual think time (1 min):** Ask participants to reflect on the work they accomplished during today's lesson analysis and think about the question on the slide. b. **Whole-group share-out (2 min):** Invite participants to share their ideas for modifying the image of effective science teaching based on today's work. Revise the chart as needed.
			**Display Slide 84.** Summary: Today's Content Deepening Work (3 min) a. **Individual think time (1 min):** Present the options on the slide and give participants 1 minute to come up with a statement that summarizes today's content deepening work in one of these areas. Emphasize that they should *not* refer to the science idea that a force is a push or pull on an object. b. **Whole-group round-robin (2 min):** Go quickly around the room and have each participant share one summarizing statement. **Push for complete sentences!**

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Lesson Analysis Homework 1. Read in the STeLLA strategies booklet: • SCSL strategy B: Set the purpose with a focus question or goal statement • SCSL strategy C: Select activities that are matched to the learning goal • SCSL strategy I: Summarize key science ideas • STL strategy 7: Engage students in making connections by synthesizing and summarizing key science ideas 2. Fill in the appropriate columns on your SCSL Z-fold summary charts.	**Display Slide 85.** Lesson Analysis Homework (2 min) a. Review the homework assignment on the slide and have participants write it in their notebooks. b. Make sure participants are clear about the reading and writing tasks.
		Content Deepening Homework Read sections 4–7 and section 9 in the content background document. Be prepared to discuss these questions next time: • Does the reading clarify the ideas about forces that were discussed today? • What new questions do you have?	**Display Slide 86.** Content Deepening Homework (2 min) a. Go over the content deepening homework assignment and have participants write it in their notebooks. b. Make sure participants are clear about this reading assignment.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 87.** Extended Homework (3 min) a. Go over the information on the slide. b. Have participants review the Extended Homework assignment sheet (handout 5.13), which provides further details about the assignment. c. Remind participants that like the extended homework on the Variation in Traits lessons that they were assigned during week 1, they're responsible for reading parts A and B of their assigned lesson plan. d. Assign a two-part lesson plan to each participant. e. Ask if there are any questions about the assignment. f. **Emphasize:** The group share-out on the last day of the PD program (day 8) should focus on the assignment-sheet questions (section 2). Participants won't have time to share all the details of each lesson plan.
			**Display Slide 88.** Reflections on Today's Session (7 min) a. Allow **at least 5 minutes** for participants to think about today's session and write their reflections and feedback on the Daily Reflections sheet (handout 5.14 in PD program binder).