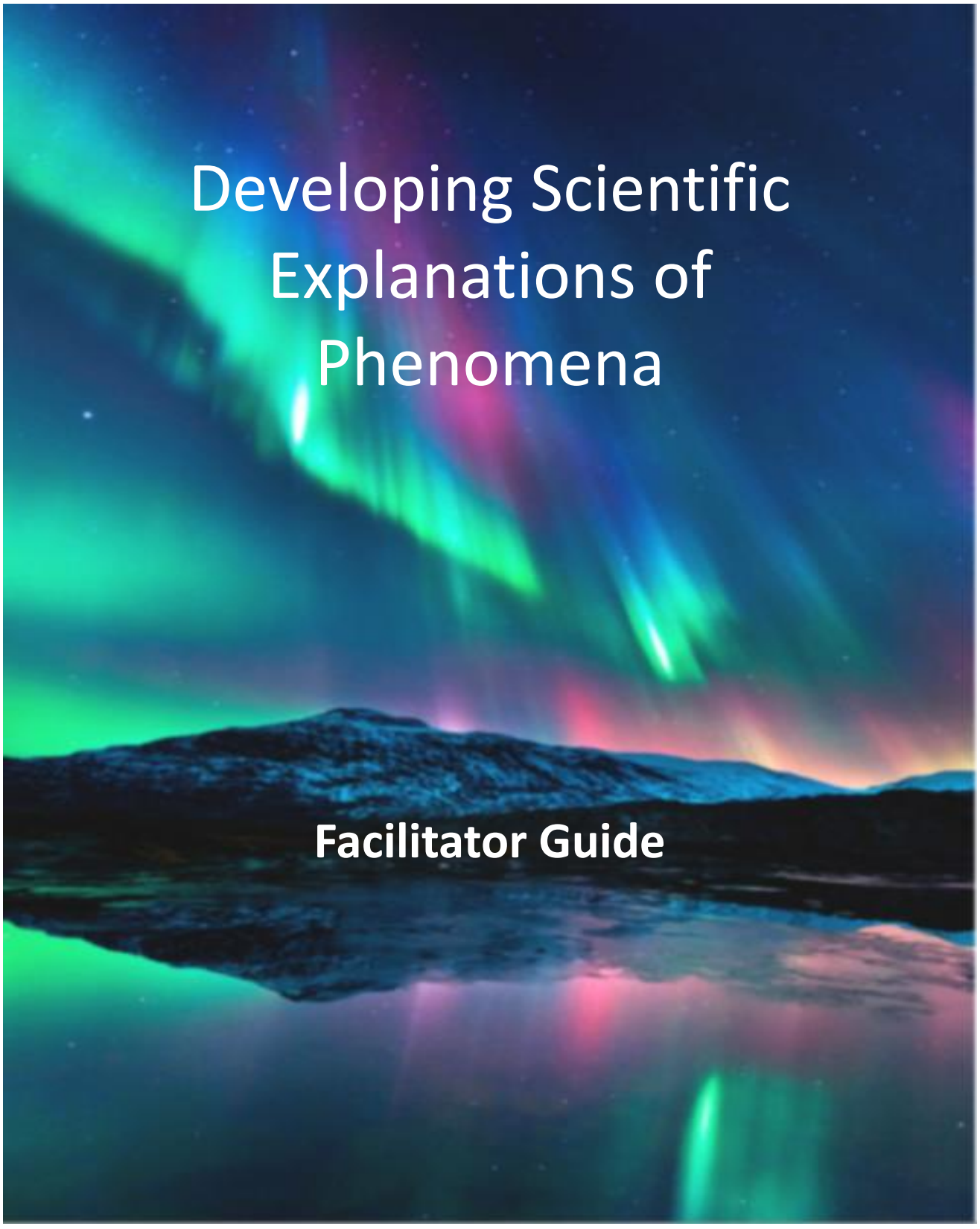

Developing Scientific Explanations of Phenomena

Facilitator Guide

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Overview and Planning

Workshop Description

This workshop focuses on developing scientific explanations of phenomena. It is designed to help participants build knowledgeand understanding of what is needed to shift science instruction to three-dimensional instruction, to translate knowledge into effective practice, and to promote analysis andreflection.

Connections to research that support this instructional practiceare highlighted throughout this training. The information to replicate this professional development opportunity is providedso that workshops can be consistent in content and locally accessible throughout the state.

By the end of the day, participants will:

- Provide examples of how scientific phenomena can be usedto drive standards-based instruction.
- Describe how science and engineering practices from the *Framework* help students develop deep conceptual understanding of science content.
- Identify the critical components of a scientific explanation.
- Provide feedback on student work to support students in developing scientific explanations.

Big Ideas for the workshop:

1. Science instruction should integrate standards-based content, science and engineering practices, crosscutting concepts and understanding of the nature of science.
2. Developing conceptual understanding of science concepts requires students to engage in multiple practices as a means for developing their content understanding.
3. Natural phenomena lead to student-generated questions and can be scientifically investigated and explained at the grade level of the students involved.
4. Scientific explanations answer a question about a phenomenon, use evidence to support the claim, anduse reasoning to connect the evidence to scientific principles or models.

Target Audience	• Classroom teachers (grades K-12), science coaches, ordistrict science curriculum coordinators. • Recommended limit is 30 participants.
Prerequisite knowledge	• It is helpful but not required for participants to have familiarity with A Framework for K-12 Science Education. • It is recommended that they have participated in the self-paced online course Focus on the Framework or have previously attended ASTA's 3-D Learning for All workshops.
Timing	• 6 hours of professional development, including 2 10-minute breaks. • Plan for a 45–60-minute lunch break, depending on proximity of lunch options.
Facilitator Roles and Responsibilities	This workshop will require less presentation and lecture; instead, you will have to use demonstration, questioning, and facilitation skills. This guide includes basic questions you should ask the participants, but throughout the workshop, youwill have to add additional probing questions to get the participants to question their assumptions and continue to refine their content knowledge and pedagogical content knowledge and how the practiced strategies can make a difference in student achievement. **Facilitator instructions for activities are also included as presentation notes on the slides.**
Workshop Preparation	Preparation is critical to a successful workshop. Listed beloware some tips that will help you prepare for your session. <u>4+ Weeks Prior to the Session</u> 1. Participate in a Training-of-Trainers session. 2. Identify the date, time, and location for this training. 3. Identify the date, time, and delivery platform for follow-up webinars. 4. Determine how course follow-up questions will be handled.

	5. Gather information about your training site: • Contact person with phone number. • Size of room and space to work in small groups. • Audio Visual equipment • Projection system • Flipchart easels and if paper is available. • Table and chairs: One table for leader (in front), one to two tables for materials, enough tables for the number of participants to sit in groups of about four or five. • Wall space for posting flipchart paper. • Determine plans and payment for refreshments as desired/needed. <u>1 Week Prior to the session:</u> 1. Finalize meeting attendees - Follow-up with key contactsvia e-mail to confirmed list of attendees, location, room arrangement, timeframe, etc. 2. Confirm final details with site, including logistics, requesting projector, computers with internet, room setup, etc. 3. Go through the entire Content Facilitator's Guide. • Use margins to note key points you plan to emphasize. • Walk through all activities. • Prepare any flipcharts. • Organize materials according to when you will needthem. • Make any adjustments that are needed to the activities, room layout, audio-visuals, etc., based onthe number or participants. 4. Gather all the required materials listed in the "Workshop Materials" list. 5. Finalize plans and payment for refreshments as desired/needed. <u>Day of the Session</u> 1. Have sign-in sheet out on table with a pen. 2. Have name tag stickers out on table with markers. 3. Set up training room. 4. Ensure that technology (computer and projector) is on andrunning properly. 5. Have the facilitator guide with you. 6. Make sure all materials are organized for efficient distribution.

	<u>After the Session</u> 1. Submit sign-in sheets as per instructions. 2. Send email to participants to complete an evaluation. <u>One week after the session</u> 1. Email participants with follow-up tips, remind them of the assignment, and provide link to follow-up webinar. <u>After the final webinar</u> 1. Submit sign-in sheets as per instructions. 2. Send email to participants to complete an evaluation. 3. Send email to participants with PD hours certificate.

Notes:

Required Materials

Workshop Materials

Room Equipment:

- Computer with LCD projector
- Internet connection (for viewing videos)
- Screen
- Power strip
- Extension cord
- Floor cover for extension cord (to prevent tripping)
- Remote to advance slides on presentation

Handouts:

- Arizona Science Standard – full document – 1 per every 2-3 participants (Room Copy)
- Helping Students Make Sense of the World book – 1 per participant
- Participant Workbook – 1 per participant
    - Pages 1-3: Color copy of the Framework's 3 Dimensions
    - Page 4: Book Reflection Notes
    - Page 5: Big Ideas / Progression of Big Ideas
    - Page 6: Big Ideas Reflection Notes
    - Page 7: Know/Questions T chart
    - Page 8: Book Reflection Notes
    - Page 9: Q-CER Template
    - Page 10: Writing Scaffolds
    - Page 11: CER Scoring Rubric
    - Page 12: Checklist for productive discussions
    - Page 13-14: 3D Teaching and Learning Organizer (2 copies)
- Sample Gr1 CER – 1 per participant
- Sample Gr 5 CER – 1 per participant

Materials needed for investigations:

- Materials for making sun dials
    - Paper plates, plastic cups, straws, tape or clay, markers
- Flashlights (or participant cell phones with flashlight)
- Rulers or measuring tapes
- Compass (or app on phone)
- Globes (or balls)
- Handouts with sundial pictures
- Articles with information about Earth's rotation
- Simulations or videos – QR codes for easy access

	Other general materials needed: • Name tags • Sign in sheets • Flip chart paper and stand • Painters tape to post flip charts/or sticky back flip charts • Post-it notes for participants • Markers and highlighters, in a variety of colors • Any plates, napkins, utensils for food, if not provided by thecaterer • Bowls for distributing chocolate/candy to group, if provided • List of nearby restaurants, if appropriate

Notes:

Background Resources

Supporting Resources

Content Background Information

- Sun's Shadow
- How sundials work
- How to read a sundial
- Mathematics of Sundials (HS)
- What causes day and night article
- Day to night video
- Elementary demo on how the Sun creates shadows
- Elementary demo on how Earth's movement makes day andnight
- Video demo of shadow moving with explanations
- Video explanation of sundials

Understanding and Selecting Phenomena:

- Qualities of a good anchor phenomenon for a coherent sequenceof science lessons
- Criteria for Evaluating Phenomena
- Using Phenomena in NGSS-Designed lessons and Units
- How Using Mysteries Support Science Learning

Constructing Explanations

- Difference between explanation and Argument
- Framework for Constructing Scientific Explanations

Supporting Student Discourse

- Making Thinking Visible: Talk and Argument
- Establishing Classroom Norms for Discussion
- Talk Move Checklist
- Procedures for Classroom Talk
- A Discourse Primer for Science Teachers

Science Education Research and Resources

- Taking Science to School
- A Framework for K-12 Science Education
- Working with the Big Ideas in Science Education

Background

Understanding light is important to help students understand many fields of science.

Light travels in straight lines. When light reaches an object, it can travel through the object if the object is transparent. It can be reflected from a shiny object or light can be absorbed if the object is opaque. Shadows are produced when light hits an opaque object which prevents the light beams from passing through. When an object blocks the light's path, then darkness appears on the other side. This darkness is called a shadow.

The Sun is a source of light. When sunlight hits an opaque object, it forms a shadow. As the Earth rotates each day (each full rotation takes approximately 24 hours), the Sun appears to change position in the sky. This changes the angles of sunlight, which affects the appearance of shadows. On a sunny day, you can stand a stick in the ground and watch its shadow move and change shape. When the Sun gets low in the sky, the stick's shadow gets longer.

Astronomers understand that the Sun doesn't actually move across the sky. Instead, the cycle of day and night is caused by the Earth rotating on its axis with different sides facing toward or away from the Sun. The Earth rotates on its axis from west towards east, or counter clockwise (when looking down from the North Pole). This has the effect of making the Sun appear to rise in the east and set in the west. Because the shadow is on the opposite side of an object as the Sun, the shadow will move clockwise around the object throughout the day.

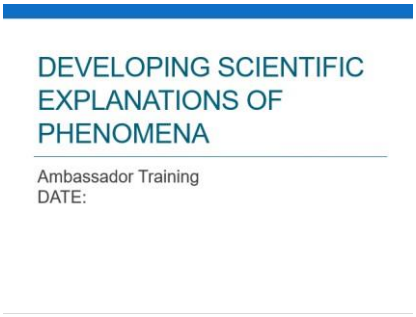
Understanding light is also important in life sciences. Biologists know that light is important for plants to be able to make their own food. Animals are then able to eat these plants for their food.

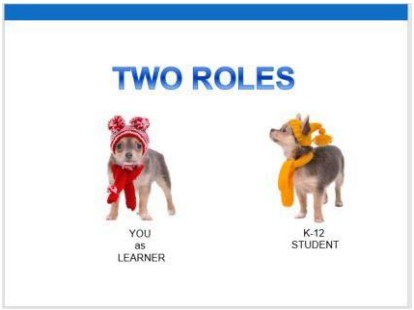
Engineers develop lots of different technologies that use light energy. Some are designed to help us see in the dark (flashlights, car headlights) some use light to help us see other things, like projectors, and some are used to help capture light energy, like photovoltaic tape for solar energy panels. Other technologies are used to reduce the effects of sunlight and save on energy costs, like window films, sunscreens, and shades. Other technologies are designed to protect people from light energy, like sunglasses and sunscreen.

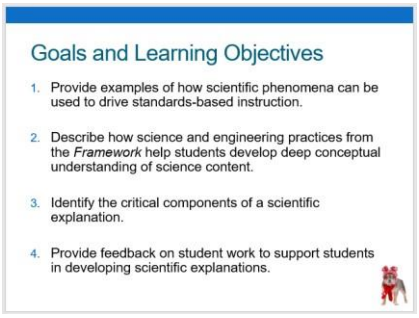
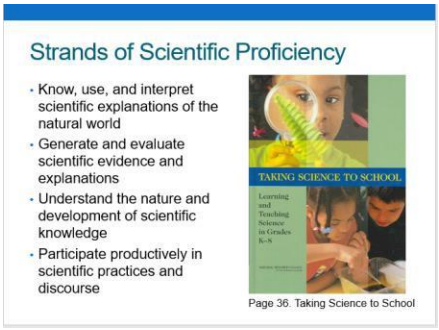
Notes:

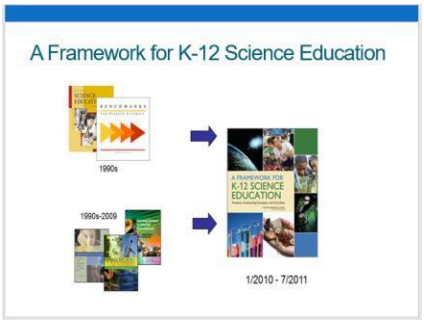
Section 1: Introduction and Background Information (30-35 minutes)	
Activities and suggested time allocations	Materials and Pre-Session Preparations
Welcome and overview (10-15 minutes)	**Slides 1-5** of the presentation
Goals of Science Education (20 minutes)	**Slides 6-12** of the presentation • Participant Guide: Color copy of the Framework's 3 Dimensions – pages 1-3 • Helping Students Make Sense of the World book (pages 6-7) • Participant Guide: Reflection notes – page 4

Notes:

Slide	Slide Title and Facilitation Notes
	**Slide 1: Title Slide** Welcome participants to the session. *Facilitator notes: Add the date of the training.* *Point out that in the copy of the presentation they receive, Ambassador Training will say Science Educator Training and they will need to update the date field.*
	**Slide 2: Welcome and housekeeping** *Facilitator notes: Adjust this slide as needed for the housekeeping of your group.* Briefly introduce participants to the materials and which items are workshop copies and need to remain after the session and which items they will be able to write on and take with them.
	**Slide 3: Welcome and housekeeping** Introduce yourself and have each person in the room introduce themselves. If it is a very large group, do small group or table introductions rather than whole room introductions. You can customize a question such as asking, “What is one positive experience you have had with leading professional development?” for leaders or “What is one thing you hope to get out of today’s session?” for teacher participants.

Slide	Slide Title and Facilitation Notes
	**Slide 4: Three Roles** Today we will be wearing 3 hats: 1. You will be here as yourself, as the facilitator of this professional development. When you see the dog with the Facilitator hat on the slide, we will take time to talk about different facilitator moves you can make while you are presenting the training. 2. You will also be approaching this information as the educator as the learner. When you see the dog with the Educator as Learner hat on the slide, we will take time to talk about the learning that is expected from educators participating in this workshop. 3. During parts of the day, you will be approaching the activities from a K-12 student perspective. When you see the dog with the K-12 Student hat on the slide, we will take time to talk about the classroom strategies to support learning that is expected from K-12 students. As a visual cue, these pups will appear in the lower right corner of the slide when the perspective changes. *Facilitator notes: Point out that the slide deck they receive will not have this slide, since they aren't training trainers and won't be discussing how to lead this training session. The slide in their deck will be the next slide showing two roles.*
	**Slides 4: Two Roles** Today we will be wearing 2 hats: 1. You will here as yourself, an educator as the learner. When you see the dog with the Educator as Learner hat on the slide, we will take time to talk about how you use the information you are learning to support your students or the teachers in your district.

	2. During parts of the day, you will be approaching the activities from a K-12 student perspective. When you see the dog with the K-12 Student hat on the slide, we will take time to talk about the classroom strategies to support learning that is expected from K-12 students. As a visual cue, these pups will appear in the lower right corner of the slide when the perspective changes
	**Slide 5: Goals and Learning Objectives** Present each objective one at a time.
	**Slide 6: Strands of Scientific Literacy** When thinking about the goals of K-12 science education, it is important to consider what outcomes we want students to have. Introduce the 4 strands one at a time: These 4 strands of scientific proficiency lay out broad learning goals for students. They address the knowledge and reasoning skills that students must eventually acquire to be considered fully proficient in science. They are also a means to that end; they are practices that students need to participate in and become fluent with in order to develop scientific proficiency. **Strand 1: Know, use, and interpret scientific explanations of the natural world** This strand includes acquiring information and productively incorporating the information and ideas to understand many phenomena in the natural world. This includes using those ideas to construct and refine explanations, arguments, or models of phenomena.

	Strand 2: Generate and evaluate scientific evidence and explanations This strand includes the knowledge and skills needed to build and refine models based on evidence. This includes designing and analyzing empirical investigations and using empirical evidence to construct and defend arguments. **Strand 3: Understand the nature and development of scientific knowledge** This strand focuses on students understanding science as a way of knowing. Scientific knowledge is a particular kind of knowledge with its own sources, justifications, and uncertainties. Students who understand scientific knowledge recognize that predictions or explanations can be revised based on seeing new evidence or developing a new model. **Strand 4: Participate productively in scientific practices and discourse** This strand includes students understanding the norms of participating in science as well as their motivation and attitudes towards science. To engage productively in science, students need to understand how to participate in scientific debates, adopt a critical stance, and be willing to ask questions. These strands are not independent or separable in the practice of science, nor in the teaching and learning of science. Students develop scientific proficiency when classrooms provide learning opportunities that interweave all four strands together in instruction.
	**Slide 7: Development of the Framework** Show the first two books: In the 90s the National Center for Science Education produced the National Science Education Standards and AAAS developed the Benchmarks for science literacy. Both of these documents focused on WHAT students should learn at specific milestones. Show the next three books: In the early 2000s there were a number of documents created that described what it meant to be science literate. These included what students should learn but focused

	more on HOW students learn science. Show the Framework: The organizations behind these different documents teamed up to create the Framework for K-12 Science Education. This book contains the current research that includes a focus on both: how students learn and what they should learn by certain milestones.

Notes:

Section 2: Engaging with a phenomenon (110-120 minutes, including break)	
Activities and suggested time allocations	Materials and Pre-Session Preparations
Engaging with a phenomenon (40 minutes)	**Slides 13-17** • Video: • https://www.youtube.com/watch?v=3B7KLstUZbI • Chart paper • Markers The purpose of the activity in Slides 15-16 is to establish a baseline understanding about light and shadows so students can later investigate sundials at a deeper level. Materials needed for this investigation: • paper plates • pencils or straws • tape or clay • light sources (flashlight or participants' cell phones) • rulers or tape measures • compass
Selecting and aligning phenomena (20 minutes)	**Slides 18-25** • Video: https://www.youtube.com/watch?v=Dfmur6IkM7U&t=5s • Participant Guide: Big Ideas / Progression of Big Ideas – page 5 • Participant Guide: Big Ideas Reflection notes – page 6 • Arizona Science Standards (complete set, 2 per table)
BREAK (10 minutes)	**Slide 26**

Engaging with a phenomenon, Part 2 (40-50 minutes)	**Slides 27-31** • Helping Students Make Sense of the World book (page 18, Figure 1.1) • Participant Guide: Know/Questions T chart – page 7 • Chart paper • Markers The purpose of the activity in Slide 30 is to gather enough information about how Sun shadows can be used to tell time. Materials needed for this investigation: • paper plates • pencils or straws • tape or clay • light sources (flashlight or participants' cell phones) • rulers or tape measures • compass • globes • pictures of student data (flag pole data) • Day to night video • Elementary demo on how the Sun creates shadows • Elementary demo on how Earth's movement makes day and night • What causes day and night article

Notes:

Section 3: Understanding Explanations (30-40 minutes)	
Activities and suggested time allocations	Materials and Pre-Session Preparations
What is an explanation? (30-40 minutes)	**Slides 32-35** • Helping Students Make Sense of the World book (pages 209-216) • Participant Guide: Book Reflection Notes – page 8
LUNCH (45-60 minutes)	**Slide 36** (Depending on timing, this might move)

Notes:

Section 4: Developing Explanations (180 minutes, including break)	
Activities and suggested time allocations	Materials and Pre-Session Preparations
Writing explanations (50 minutes)	**Slides 37-43** • Participant Guide: Q-CER Template – page 9 • Participant Guide: Writing Scaffolds – page 10 • Participant Guide: CER Scoring Rubric – page 11
BREAK (10 minutes)	

Structures to support student explanations (45 minutes)	**Slides 44-48**
	• Participant Guide: Checklist for productive discussions – page 12
	• For slide 47 use
	  ○ Sample Gr1 CER and/or
	  ○ Sample Gr 5 CER

Reflection and Connections (10-15 minutes)	**Slides 49-52** • Participant Guide: – 3D Teaching and Learning Organizer – page 13
3-D Planning Time (45-60 minutes)	**Slides 53-54** • Participant Guide: – 3D Teaching and Learning Organizer – page 14

Notes: