Advancing Tools and Processes for Next Generation Science

Model A: Three-Dimensional Phenomena Driven Instruction

Purpose: Administrators will gain a greater understanding of phenomena-focused three-dimensional teaching and learning to increase their ability to support teachers' enactment of the NGSS.

Audience: Superintendents, assistant superintendents, principals, science supervisors, instructional specialists, and instructional coaches who need a deeper understanding of what phenomena-focused three-dimensional teaching and learning is and what it looks like in a classroom setting.

Components of the model: A brief NGSS introductory immersive experience, parts of Tools 3 and 4, and analysis of Mr. Coles' and Ms. Rivera's classroom scenarios.

Time: One full-day session (recommended) or two half-day sessions.

Introduction

Model A offers an opportunity to help formal leaders develop a deeper understanding of phenomena-focused three-dimensional teaching and learning. It is designed for administrators who have little knowledge of the NGSS or this approach to science teaching and learning and who are interested in learning more because they will be supporting teachers who are expected to implement a phenomena-focused three-dimensional classroom. A school or district should consider this model if they want to ensure that formal leaders have a common, working understanding of phenomena-focused three-dimensional teaching and learning. Neither prerequisite knowledge about phenomena-focused three-dimensional teaching and learning, nor experience with the Five Tools and Processes is needed for participants in this model.

Goals of Model A:

- Increase understanding of phenomena-focused three-dimensional teaching and learning.
- Develop understanding of the opportunities and challenges implementing phenomena-focused three-dimensional teaching and learning presents.
- Promote awareness of how phenomena-focused three-dimensional teaching and learning of science connects to mathematics and ELA student learning.

Prerequisite: NONE

Participant Outcomes after Completing Model A:

Participants should be able to

- articulate how phenomena-focused three-dimensional teaching and learning is different from previous science instruction,
- describe the opportunities and challenges that implementing phenomena-focused three-dimensional teaching and learning presents, and
- recognize and articulate evidence of phenomena-focused three-dimensional teaching and learning in an instructional experience.

Total Time: 6.5 -7 hours

Two half-day sessions (recommended) with possible work time in between, or one full-day session

Part 1 Introduction and Effective Science Teaching and Learning (Slides 1 – 6) (30 minutes)

Purpose: Set the stage for the focus of session and begin to build community
Summary: Participants have an opportunity to connect to each other and to the content of the day through a grounding activity. Professional Development (PD) Leaders review the goals and agenda. Initial group norms are agreed upon. Participants consider what high quality teaching and learning look like in light of the NGSS.

Part 2 **Immersive Experience: Zebra Mussels** (Slides 7 – 14) (70 minutes)
Purpose: Provide participants with an immersive phenomena-focused three-dimensional learning experience to create a common vision of effective phenomena-focused three-dimensional learning.
Summary: Participants will explore the effects of invasive zebra mussels on the Hudson River ecosystem. Participants will use the Identify and Interpret strategy to analyze the relationship between zebra mussels and phytoplankton and develop a scientific explanation as learners. They will debrief the common experience and revise their Effective Teaching and Learning charts.

Part 3 **Effective Science Teaching and Learning** (Slides 15 – 28) (140 minutes)
Purpose: Provide participants with an opportunity to compare two classroom planning and instructional practices to create a common vision of effective phenomena-focused three-dimensional learning.
Summary: Participants will jigsaw Mr. Coles' and Ms. Rivera's instructional units and describe differences between them. Participants will consider the role of phenomena and the three dimensions in creating a coherent instructional sequence and how they support student learning. Participants will revise their Effective Teaching and Learning charts.

Closing (If doing two half-day sessions) (Slide 29) (5 minutes)

Opening (If doing two half-day sessions) (Slides 30-32) (30 minutes)

Part 4 **Considering the NGSS Innovations in Your Context** (Slides 33-41) (140 minutes)
Purpose: Provide participants with an introduction to the shifts and innovations of the NGSS and engage in conversation about what's important for teacher development (How do we create more teachers like Ms. Rivera?).
Summary: Participants will jigsaw readings about the vision of the NGSS and consider how the NGSS differs from old state standards. Participants are introduced to the Five Tools and Processes for Translating the NGSS into Instruction and Classroom Assessment. Participants analyze challenges to implementing the NGSS and supports needed as they create an action plan to translate the NGSS into phenomena-focused three-dimensional instruction and assessment.

Part 5 **Closure** (Slides 42-43) (10 minutes)
Purpose: Revisit the goals for the session and reflect on learning from the session.
Summary: Participants will review the goals for the session and reflect on learning from the session through a closing activity.

Materials

Charts

- Effective Learning and Teaching
- List of Science and Engineering Practices (use BLUE font)
- List of Crosscutting Concepts (use GREEN font)

Handouts

HO1 Zebra mussels and Phytoplankton
HO2 Developing a Scientific Explanation Tool (NOTE: Print 2 copies of this handout; one for use in the session, one for participants to keep a clean copy.)
HO2a Sample Explanation (optional)
HO3 Ecosystems: Interactions, Energy, and Dynamics
HO4 The Three Dimensions
HO5 MSLS2 Common Core State Standards Connections
HO6 Teacher Scenario A (Mr. Coles)
HO7 Teacher Scenario B (Ms. Rivera)
HO8 Coherent Instructional Sequences Based on Anchor Phenomena
HO9 NGSS Innovations
HO10 Sample page from the NGSS (prepared by PD Leader) (NOTE: MS-LS2 is recommended to align with the zebra mussel immersive activity)
HO11 Sample page from previous standards (prepared by PD Leader)
HO12 Five Tools Graphic
HO13 Analysis and Action Plan

Resources (optional for this session)

R1 A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012) by National Research Council
R2 Next Generation Science Standards For States, By States Volume 1: The Standards (2013) by NGSS Lead States
R3 Next Generation Science Standards For States, By States Volume 2: The Appendices (2013) by NGSS Lead States

Materials

- Chart paper (preferably sticky for hanging on walls)
- Tape for hanging chart paper
- Chart markers
- Sticky notes
- Highlighters

Slides

Slide 1 Introduction to the Five Tools and Processes
Slide 2 Introductions
Slide 3 Goals
Slide 4 Agenda
Slide 5 Norms
Slide 6 Effective Teaching and Learning
Slide 7 Set Up
Slide 8 Science Learner
Slide 9 An Unwelcome Newcomer
Slide 10 Data Collection
Slide 11 Zebra Mussels and Phytoplankton
Slide 12 Developing a Scientific Explanation
Slide 13 Effects of Zebra Mussels on the Hudson River Ecosystem
Slide 14 Effects of Zebra Mussels on the Hudson River Ecosystem

Slide 15	Educator
Slide 16	Reflecting on the Experience
Slide 17	Writing a Scientific Explanation
Slide 18	Opportunities for Learners
Slide 19	Effective Teaching and Learning
Slide 20	Science Teaching and Learning
Slide 21	Science Teaching and Learning
Slide 22	Phenomena in Teaching and Learning
Slide 23	Phenomena in Three-Dimensional Teaching and Learning
Slide 24	Phenomena in Three-Dimensional Teaching and Learning
Slide 25	Thinking Beyond a lesson to an Integrated Instructional Sequence
Slide 26	NGSS Instructional Design
Slide 27	Three-Dimensional Teaching and Learning
Slide 28	Effective Teaching and Learning
Slide 29	State of Science Reflection (not used in 1-day session)
Slide 30	Opening (not used in 1-day session)
Slide 31	Review of Last Session (not used in 1-day session)
Slide 32	Effective Teaching and Learning (not used in 1-day session)
Slide 33	Innovations of the NGSS
Slide 34	Innovations of the NGSS
Slide 35	NGSS vs. Our Old State Standards
Slide 36	Meta Moment
Slide 37	How do we build the necessary teacher knowledge to translate the NGSS?
Slide 38	Five Tools and Processes
Slide 39	Analysis and Action Plan
Slide 40	Analysis: Challenges and Supports
Slide 41	Action Plan
Slide 42	Goals
Slide 43	Closing

PD Leader Resources

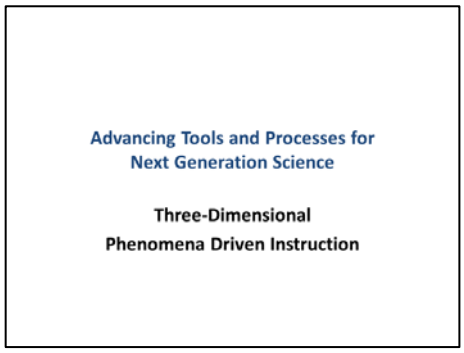
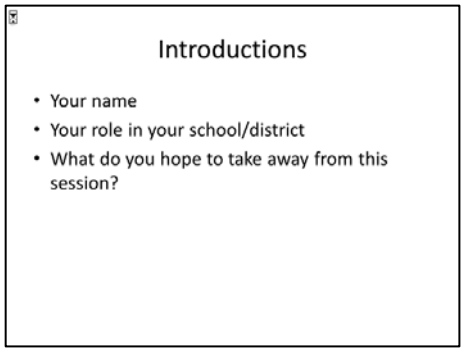
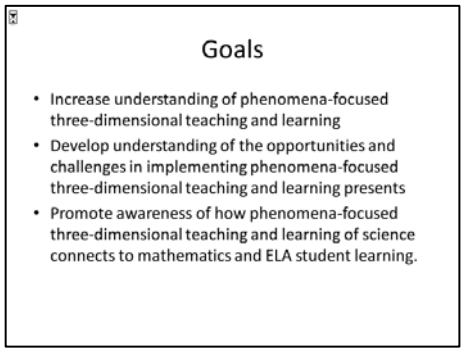
- Zebra Mussel Data Tool Instructions
- Using Phenomena in NGSS-Designed Lessons and Units (This handout provides the PD Leader with additional background information on phenomena. It should not be shared with participants in this session.)
- Ms. Rivera and the Three Dimensions (This handout provides examples of DCIs, SEPs and CCCs in the seven-lesson sequence.)
- I Can Use the Identify and Interpret (I^2) Strategy (Student and Teacher Editions), BSCS 2012 (These handouts provide the PD Leader with additional background information on how to use the Identify and Interpret strategy.)

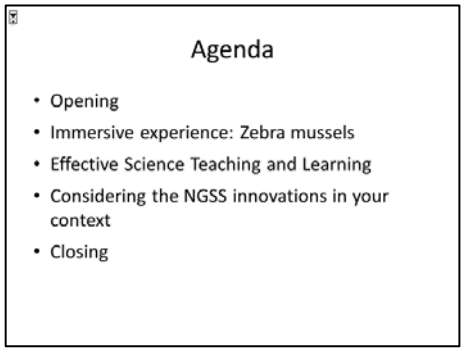
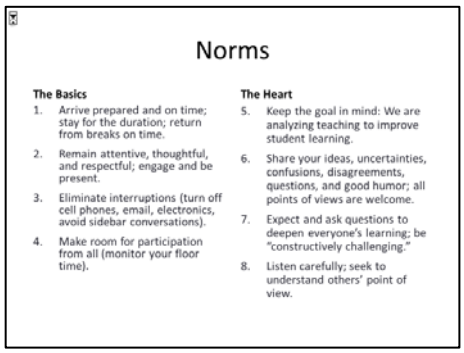
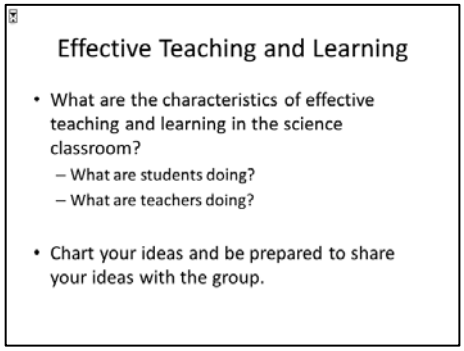
Advance Preparation

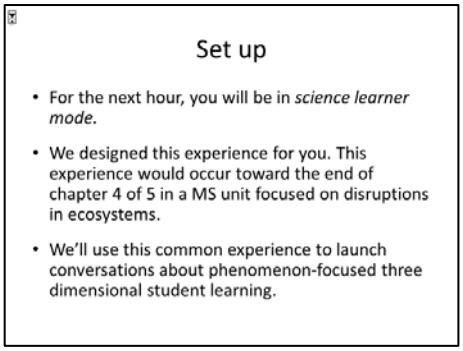
- Make sure the meeting space has plenty of wall space for hanging chart papers in part 3.
- Communicate with participants prior to the session. Decide if you want participants to sit in predetermined groups (based on leadership teams or other criteria)
- Select sample page from the NGSS and related page from previous state standards
- Print handouts (1/participant) and prepare charts (list of SEPs and CCCs)

- Make sure you are comfortable navigating the zebra mussel data tool to demonstrate the tool to participants in the session.
- If desired, link a timer program to the hourglass icon in the upper right of each slide.
- If doing two half-day sessions, unhide the transition slides between Part 3 and Part 4.

Part 1 Introduction (30 minutes)

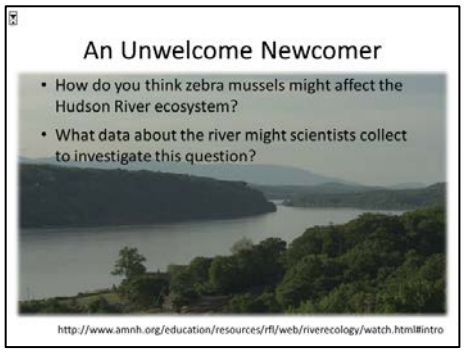
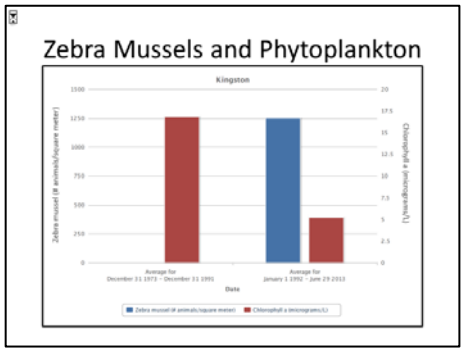
Slide	Facilitation Notes
	**Display Slide 1. Three-Dimensional Phenomena Driven Instruction (0 min)** a. Welcome participants to the session.
	**Display Slide 2. Introductions (optional; 10 min)** a. Introduce yourself. Have other facilitators introduce themselves. Click to show rest of slide. b. Share the prompts with participants. Allow time for participants to silently consider their responses. Ask for a volunteer to begin and continue around the room until everyone has had an opportunity to share. PD Leader Note: If participants already know each other, this slide can be omitted or shortened by using a Turn-and-Talk or table group conversation with a whole group sharing of common ideas shared.
	**Display Slide 3. Goals (1 min)** a. Explain that the purpose of this session is to introduce participants to the NGSS and the Five Tools and Processes. The group will have an opportunity to experience phenomena-focused three-dimensional learning through a common immersive experience, analyze phenomena-focused three-dimensional teaching, and consider their role in supporting the shifts and innovations of the NGSS.

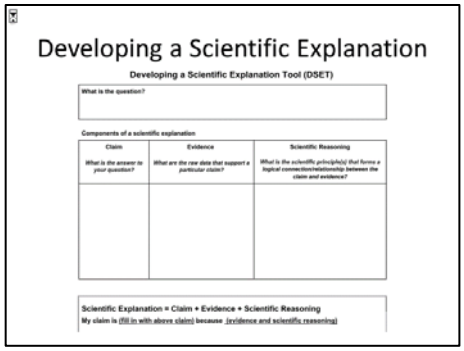
Slide	Facilitation Notes
	**Display Slide 4. Agenda (1 min)** a. Review the agenda with participants, making links between the parts of the session and the session goals.
	**Display Slide 5. Norms (optional)** a. Small groups may need to set their own norms, but this time can be used to establish whole group norms. If your group already has group norms, this slide can be edited, although those norms should be revisited in the context of this session. <u>PD Leader Note:</u> if your group is from the same organization/district, this is an opportune time to make connections between the NGSS and other initiatives. Insert slides as appropriate to frame how the NGSS and its conceptual shifts are important and support the organization/district's larger vision.
	**Display Slide 6. Effective Teaching and Learning (15 min)** a. Share the prompt: What are the characteristics of effective teaching and learning in the science classroom? What are teachers doing? What are students doing? b. Provide 2 minutes for participants to think and write individually. c. Invite them to work with their table group to chart their responses in a T-chart (Point to a T-chart with the teacher and student headers). d. Tell participants that you'll put 5 min on the clock, but that you'll offer more time if needed. e. Invite participants to scan other charts for similarities and differences. Alternatively, if time permits, have groups share key ideas from each side of the T-chart with the whole group. <u>PD Leader Note:</u> These charts will serve as an important formative assessment for PD Leaders. Keep the charts posted as you will refer to them throughout the session.

Slide	Facilitation Notes
	To transition to the next part of the session, highlight that we considered both effective teaching and effective learning. We'll focus on effective learning next, then effective teaching, and finally an action plan to support both in their setting.
	**Display Slide 7. Set up (5 min)** a. Describe the characteristics of being in science learner mode to the participants to help them understand the purpose for the learning experience they are about to have. ● Be a learner. As an adult, you may already know the science content of this experience, but you may also learn something new. Use a learner lens to consider how middle school students would engage with the content of the activities. ● Stay in learner mode throughout the experience. If you have a thoughts or questions as an educator, capture it on a sticky note. There will be opportunity to discuss these after the experience. ● This experience was designed for you, an adult learner. The activities would take much longer with middle school students. b. Share that this experience comes from the *Disruptions in Ecosystems* unit developed by the American Museum of Natural History and the Lawrence Hall of Science. The activities they will experience will provide a common experience to begin conversations about phenomenon-focused three-dimensional student learning. <u>PD Leader Note:</u> It is important to consider the difference between "student" and "learner" lenses. The activities are not experienced in "student" lens as you are working with adult learners. Rather, participants will engage in the experience with a "learner" lens. This provides an opportunity to engage in the experience as an adult considering the perspective of a middle school student.

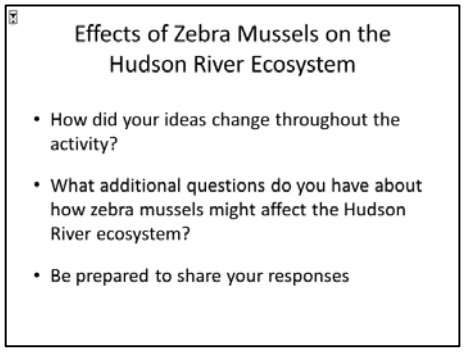
Slide	Facilitation Notes
	**Display Slide 8. Science Learner (0 min)** a. Remind participants they will be in science learner mode for the next hour.

Part 2 Immersive Experience: Zebra Mussels (90 minutes)

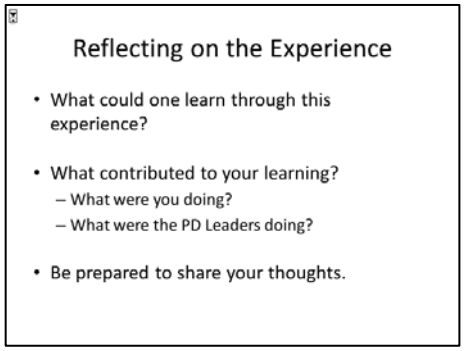
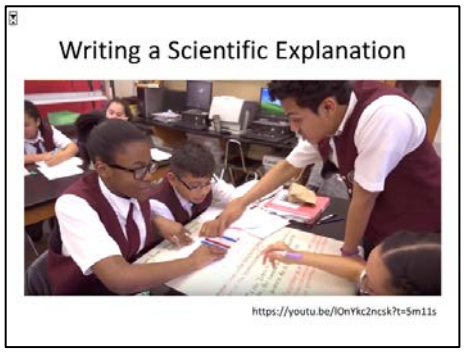
Slide	Facilitation Notes
	**Display Slide 9. An Unwelcome Newcomer (3 min)** a. Share with participants that an important scientific habit of mind is curiosity about the natural world, including examining cause and effects as well as conditions that affect stability and change in systems. Scientists ask questions, analyze and interpret data, and construct explanations as they try to understand the natural world. b. As you introduce the video, encourage participants to note the questions: How do you think zebra mussels might affect the Hudson River ecosystem? What data about the river might scientists collect to investigate this question? c. After showing the video, invite participants to discuss the questions in small groups. Ask several participants to share their group's conversation for each question. Chart participants' ideas about how zebra mussels might affect the Hudson River ecosystem.
	**Display Slide 10. Data Collection (2 min)** a. Highlight that some of the types of data that scientists might want to consider could be collected over time as well as at various locations along the river. b. Share that today we will examine data that scientists collected over time. Use the website to show how the data tool can be used to examine actual data collected at the Kingston sampling site. PD Leader note: Prior to facilitation, refer to the handout (Zebra Mussel Data Tool Instructions) to be familiar with and demonstrate the data tool in the allotted time.
	**Display Slide 11. Zebra Mussels and Phytoplankton (20 min)** a. Pass out Handout 1: Zebra Mussels and Phytoplankton to participants. Share that they will use the Identify and Interpret strategy developed by BSCS to analyze and interpret the data represented in the graph. PD Leader Note: Refer to the I Can Student and teacher handouts for additional information on this strategy. b. Share that you will model the first step of the strategy: *Identify* changes, trends, or differences. In the space to the left of the graph, write "What I See:" followed by a brief description of an observation: "there were no zebra mussels

Slide	Facilitation Notes
	present between December 31, 1973 and December 31, 1991.". Draw an arrow from the statement to the left side of the X axis. Note that you are only writing what you observe at this stage. You will *interpret* your observations in a later step of the strategy. c. Invite participants to write at least two What I See statements. After participants have completed their What I See statements, they should share them with their small group. d. Share that you will model the second step of the strategy: *Interpret* the meaning of the observations identified. Underneath your What I See statement, write "What It Means:" followed by "zebra mussels were introduced to the Kingston site after 1991.". e. Invite participants to add What It Means statements underneath each of their What I See statements, with reasons the observation is important to explain the effects of zebra mussels at this site on the Hudson River. Invite participants to share their What I See and What It Means statements with the whole group. Transition: Share that we can use evidence from data and science principles to develop a scientific explanation about how zebra mussels have affected the Hudson River. Highlight that explanations are at the heart of science – they are the *product* of a scientist's work.
	**Display Slide 12. Developing a Scientific Explanation (30 min)** a. Share that the Developing a Scientific Explanation Tool will help them organize their explanation. Pass out 2 copies per participant of Handout 2: Developing a Scientific Explanation Tool. Mark that they will write on one copy as learners in this session; the other copy is for their future reference/use as educators. b. Review the structure of the tool and the definitions of each part. • Claim—an assertion; statement of fact • Evidence—information that supports an argument; used to prove or disprove an assertion • Reasoning—links claim and evidence and should include science ideas • Explanation—combines the claim, evidence, and reasoning; provides the reasoning to connect the

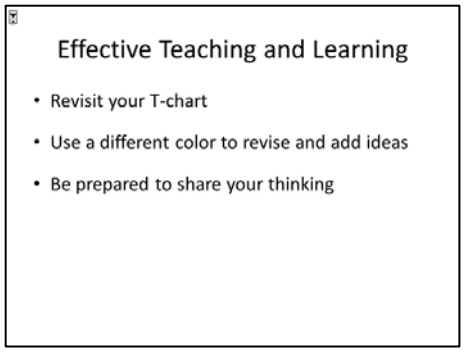
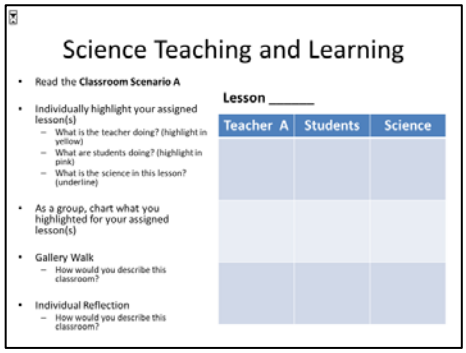
Slide	Facilitation Notes
	claim and evidence; justification c. Note the connection between the Identify and Interpret strategy and Explanation Tool. Mark that the evidence will come from the graph that they just interpreted. This evidence may come from the identify statements and/or the interpret statements. d. Pass out Handout 3: Ecosystems: Interactions, Energy, and Dynamics. As participants read the handout, they should note science ideas that will help explain the changes in the Hudson River ecosystem. These science ideas will be used to populate the Scientific Reasoning column of the explanation tool. e. Emphasize that the explanation combines the claim, evidence and scientific reasoning. Note the sentence stem in the box. Mark that writing in science helps us make sense of natural phenomena by linking science ideas with observations and evidence. f. Invite participants to complete the explanation tool in pairs. Each member of the pair should complete the tool and be prepared to share their explanation. <u>PD Leader Note:</u> If needed, remind participants that they are adult science learners, and this would take much longer with middle school students. A sample explanation tool is provided as Handout 2a. Use this sample with Slide 12 if you sense that participants are reluctant to share their own explanations.
Effects of Zebra Mussels on the Hudson River Ecosystem • Share your explanation with two other participants – Discuss similarities and differences between your explanation and others' explanations • Share your findings with your partner	**Display Slide 13. Effects of Zebra Mussels on the Hudson River Ecosystem (10 min)** a. Have participants stand with two other participants to form groups of three. Invite participants to read their explanation, exactly as written, to the other two members of their group. Once each member has read their explanation, the group should discuss similarities and differences between the three explanations. b. Participants should then return to their partner and share their findings. <u>Transition:</u> Remind participants that our question was, "How do you think zebra mussels might affect the Hudson River ecosystem?". Highlight their charted original ideas about the question.

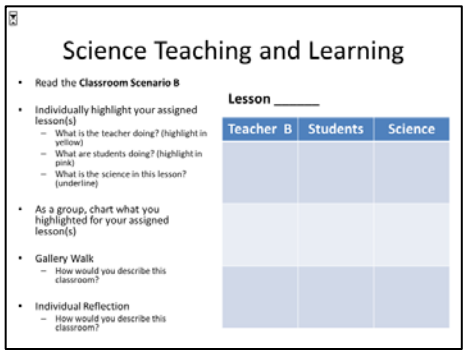
Slide	Facilitation Notes
	**Display Slide 14. Effects of Zebra Mussels on the Hudson River Ecosystem (5 min)** a. Invite participants to respond individually to the two prompts. After participants have had time to write their responses, invite several participants to share their responses with the whole group.

Part 3 Effective Science Teaching and Learning (120 minutes)

Slide	Facilitation Notes
	**Display Slide 15. Educator (0 min)** a. Share with participants that we'll use the common experience to think together about effective science learning from a teacher and administrator perspective.
	**Display Slide 16. Reflecting on the Experience (5 min)** a. Ask participants to read and reflect silently on the prompts. b. Invite participants to share their thinking with an elbow partner. c. Gather ideas from the whole group.
	**Display Slide 17. Writing a Scientific Explanation (5 min)** a. Share that students in science classrooms make sense of natural phenomena and develop explanations or those phenomena. The explanation tool provides a scaffold to teach students the components of a scientific explanation, and to support their writing. The tool also supports students with scientific reasoning, which will support and link back to the claim. b. Share that in this video clip participants will see middle school students' construction scientific explanations about the effects of zebra mussels on the Hudson River ecosystem. They will also see students giving each other feedback and reflecting on their explanations, as well as teachers' thoughts on the implementation of the explanation tool. Play the video clip (5:11 to 8:22) <u>PD Leader Note:</u> The URL on the slide will start the video at 5:11. Play the video from 5:11 to the end at 8:22. c. Invite participants to turn and talk at their tables about what resonated with them in the video clip. Have participants share important ideas from their conversations with the

	whole group. PD Leader Note: To close the discussion, mark connections to Common Core English Language Arts as well as connections to the Effective Teaching and Learning chart from the beginning of the session.
	**Display Slide 18. Opportunities for Learners (10 min)** a. Pass out Handout 4: The Three Dimensions. Orient participants to the handout and the three dimensions of the NGSS, based on your participants' background familiarity with the NGSS. b. Ask participants which practices were highlighted in the common experience to develop an explanation of a natural phenomenon. Gather several ideas from the group. c. Mark that, while other disciplinary core ideas may be part of the common experience, the experience focused on LS2: Ecosystems: Interactions, Energy, and Dynamics. d. Have participants share which crosscutting concept was most in the foreground of the common experience. PD Leader Note: While important to identify each of the individual dimensions in the common experience, the purpose of the discussion is to consider how the three dimensions collectively provide a rich opportunity for students to construct understanding. e. Advance the slide to share the prompts. Invite participants to use the handout to discuss with their table group where in the common experience they observed the interplay between the three dimensions. f. Ask participants to share evidence of three-dimensional learning in the common experience with the whole group. g. Ask participants to share opportunities for learners to connect science learning to Common Core ELA and mathematics standards that they observed during the common experience. Pass out Handout 5: MSLS2 Common Core State Standards Connections and invite participants to share additional connections from the NGSS Connections to Standards pages. PD Leader Note: A potential connections to MS mathematics is found in the interpretation of the zebra mussels graph with CCSS.Math.Content.7.S.P.A.1: *Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of*

	that population. Understand that random sampling tends to produce representative samples and support valid inferences. A potential connection to MS ELA is found the in the completion of the CER with CCSS.ELA-Literacy.WHST.6-8.1: *Write arguments focused on discipline-specific content.*
	**Display Slide 19. Effective Teaching and Learning (5 min)** a. Review the prompts with participants. Encourage participants to revise and add ideas to their chart using a different color marker based on the common experience they engaged in as learners. Emphasize that while the common experience was focused on student learning, they may also have ideas that they will want to add to the effective teaching side of the T-chart. Transition: Highlight that we focused on effective learning through the common experience. We will now turn our focus to effective teaching.
	**Display Slide 20. Science Teaching and Learning: Teacher A (30 min)** PD Leader Note: Form small groups for the next activity. Have the group count off from one to seven to form seven "expert groups". Each group will read, highlight, and chart one of the lessons in Teacher Scenario A, and the same number lesson in Teacher Scenario B. Make sure you have planned for space to display all seven charts for both scenarios. a. Share that we will read two scenarios that highlight different approaches to science instruction. Distribute Handout 6: Teacher Scenario A to each participant and a sheet of chart paper to each table. b. Provide instructions for individuals to mark up the text as they read and to create a chart for their assigned lesson. PD Leader Note: Prior to reading, have participants put away handout 4 so they will not try to put DCIs in the science column. c. Once each group has charted, provide instructions for a Gallery Walk to look for similarities and differences in how different groups thought about Teacher Scenario A. You may want to facilitate the gallery walk, depending on the size of your group. d. Provide a few minutes for table groups to share their findings and then invite them to record their responses to the question for individual reflection. Note that they will not be sharing their ideas now but will later in the session.



Display Slide 21. Science Teaching and Learning: Teacher B (35 min)

a. Share with participants that now they'll read the Teacher Scenario B and follow a similar process. Distribute Handout 7: Teacher Scenario B to each participant and a chart paper to each table.

b. Provide instructions for individuals to mark up the text for their assigned lesson as they read and for each expert group to create a chart for their lesson.

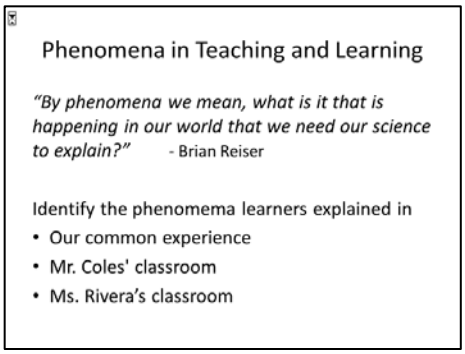
c. Once each group has charted, provide instructions for a Gallery Walk to look for similarities and differences in how different groups thought about the Teacher Scenario B. You may want to facilitate the gallery walk, depending on the size of your group.

d. Provide a few minutes for table groups to share their findings and then invite them to record their responses to the question for individual reflection. Note that they will now share their ideas about both scenario A and B.

e. Expect to hear table groups talk about how each scenario represents a different approach to instruction. Scenario A is a more teacher-centered approach to learning and teaching science. Mr. Coles does most of the meaning-making during his lessons. Scenario B represents a more student-centered approach to learning and teaching science. Ms. Rivera provides more opportunities for her students to make meaning from their experiences. Although Mr. Coles would score high using Danielson's *Framework for Teaching*, Ms. Rivera's approach to instruction is more consistent with inquiry-based teaching and constructivist learning.

f. Highlight participant comments that refer to Ms. Rivera's unit's focus on a single phenomenon (participants may or may not use this term) – Wolves in Yellowstone, while Mr. Coles' unit did not have a single phenomenon focus. Participants may note that Ms. Rivera used the phenomena to introduce science concepts while Mr. Coles used phenomena as examples of science concepts already introduced.

Transition: Sharing that the purpose of the two scenarios was to have a common experience to help us explore our thinking about instruction that is aligned with the goals and vision of the NGSS. We will now dig more deeply into some of the key features of NGSS-aligned instruction. We'll begin by considering the role of phenomena in three-dimensional instruction.

<table>
<tr>
<td> 
</td>
<td>Display Slide 22. Phenomena in Teaching and Learning (5 min)
a. After participants have read the quote, invite participants to turn and talk with a partner to identify the phenomena learners explained in their common experience (invasive zebra mussels disrupting the Hudson River ecosystem), Mr. Coles' classroom (various, but none present throughout the lesson sequence), and Ms. Rivera's classroom (the disruption to the ecosystem caused by the removal and reintroduction of wolves from Yellowstone National Park).</td>
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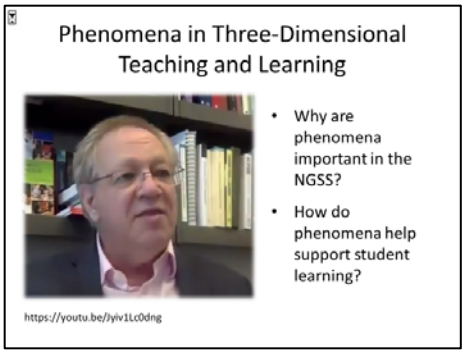
<td> 
</td>
<td>Display Slide 23. Phenomena in Three-Dimensional Teaching and Learning (5 min)
a. As you introduce the video, encourage participants to note the questions: "Why are phenomena important in the NGSS?" and "How do phenomena help support student learning?".
b. After watching the video, invite participants to discuss the questions at their table.</td>
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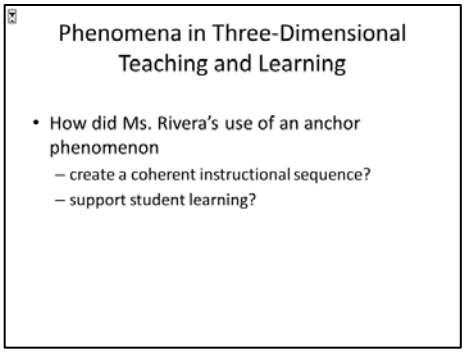
<td> 
</td>
<td>Display Slide 24. Phenomena in Three-dimensional Teaching and Learning (10 min)
a. Distribute Handout 8: Coherent Instructional Sequences Based on Anchor Phenomena. Encourage participants to read and markup the handout individually. When others at in their group have finished reading, they should have a conversation about the prompt.
b. Draw the whole group back together and ask several participants to share one important idea from their group's discussion.
<u>Transition:</u> Phenomenon-focused, three-dimensional teaching and learning requires that we expand conceptions about instruction from "the lesson" to an integrated instructional sequence that also includes lab experiences.</td>
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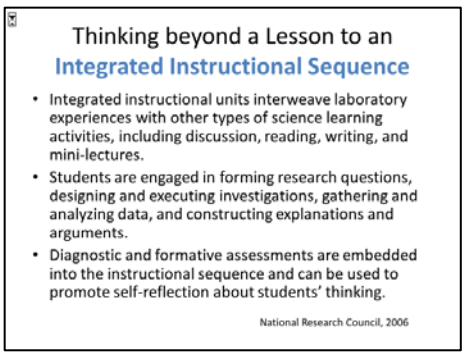
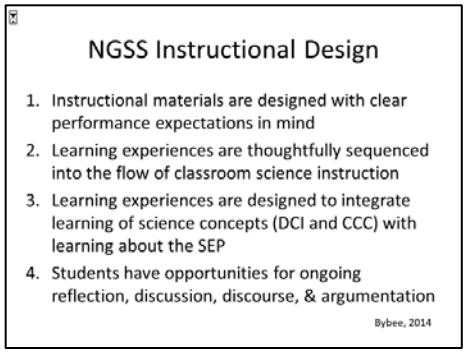
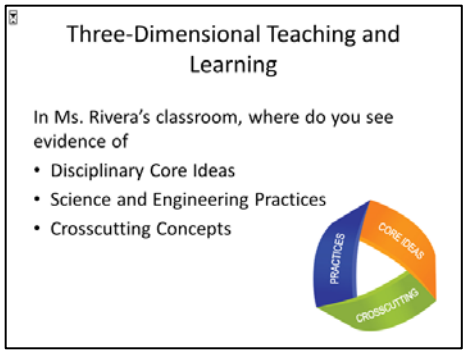
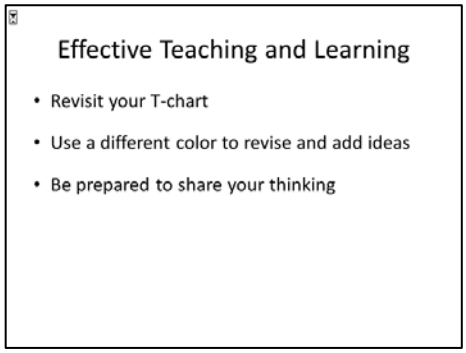
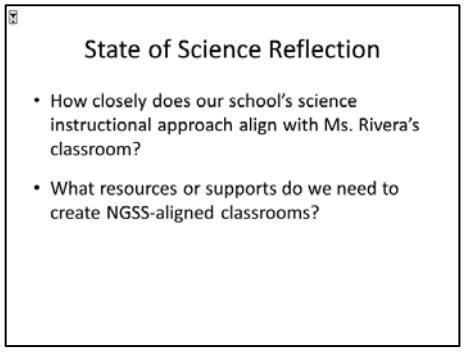
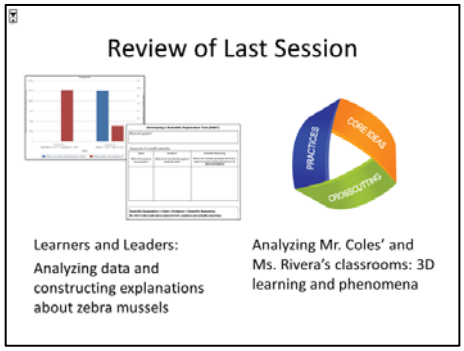
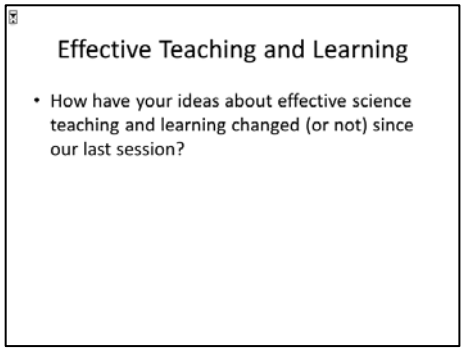
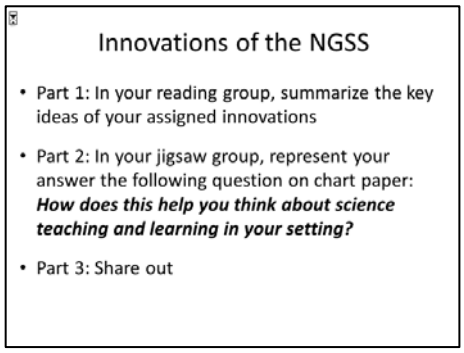
<td> 
</td>
<td>Display Slide 25. Thinking Beyond a Lesson (2 min)
a. Based on a synthesis of research findings about the role of laboratory experiences, the NRC found these types of experiences, when integrated with phenomenon-focused, three-dimensional instruction, produce more effective learning sequences for students and enhance student achievement of learning goals.
b. Share that the slide provides the NRC's definition of integrated instructional units which have two key features:</td>
</tr>
</table>

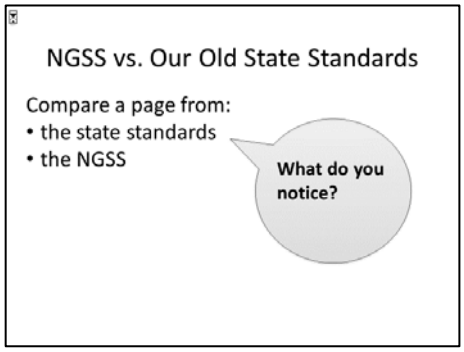
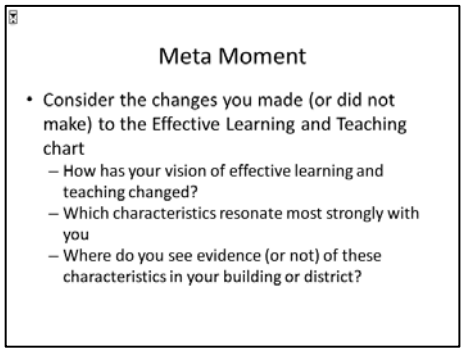
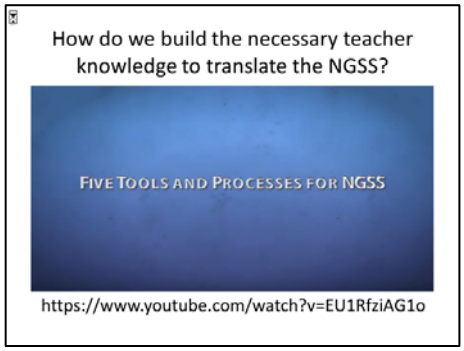
	First, laboratory and other experiences are carefully designed or selected based on what students should learn. Second, the experiences are explicitly linked to and integrated with other phenomenon-focused, three-dimensional learning activities in the unit. PD Leader Note: Information on slide is taken from *America's Lab Report: Investigations in High School Science* (NRC, 2006).
	**Display Slide 26. NGSS Instructional Design (1 min)** a. Share that the three dimensions of the NGSS compliment the NRC's conclusion for integrated instructional sequences. The slide provides four principles of instructional design that contribute to attaining learning goals as stated in the NGSS according to Rodger Bybee (2014). Transition: For the next activity, participants should be in their assigned lesson groups from the classroom scenario activities.
	**Display Slide 27. Three-dimensional Teaching and Learning (17 min)** a. Participants should return to the chart they constructed for their assigned lesson from Ms. Rivera's instructional sequence. Using Handout 4 (The Three Dimensions), each group should identify language on their chart that matches each of the three dimensions. b. In lesson sequence, ask groups to share evidence of DCIs in each lesson. Repeat the process for SEPs and CCCs.
	**Display Slide 28. Effective Teaching and Learning (15 min)** a. Review the prompts with participants. Encourage participants to revise and add ideas to their chart with a new color marker based on their analysis of Mr. Coles' and Ms. Rivera's classrooms, the role of phenomena, and the three dimensions. Emphasize that while this part of the session was focused on effective teaching, they may also have ideas to add to the student learning side of the T-chart. PD Leader Note: If doing two half-day sessions, end the first day's session with the individual reflection on Slide 27. If doing one full-day session, transition to Part 4. Transition: Highlight that we have focused on effective learning through the common experience and effective teaching through the last activities. We will now turn our focus to the vision of the NGSS and how we can support that vision in our own settings.

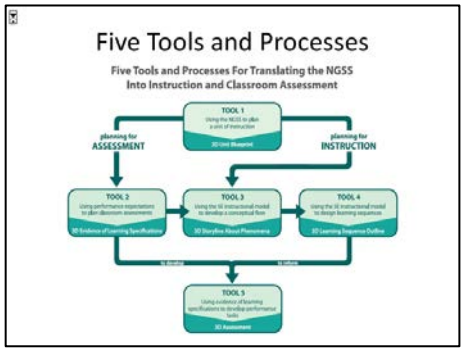
Closing and Opening **Unhide and use these slides if doing two half-day sessions**

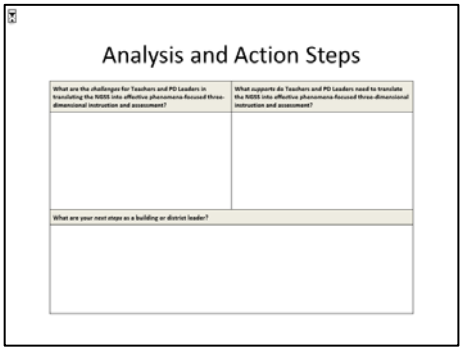
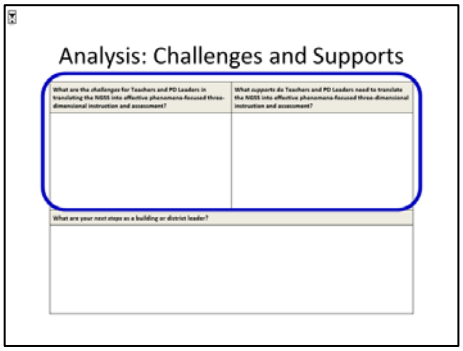
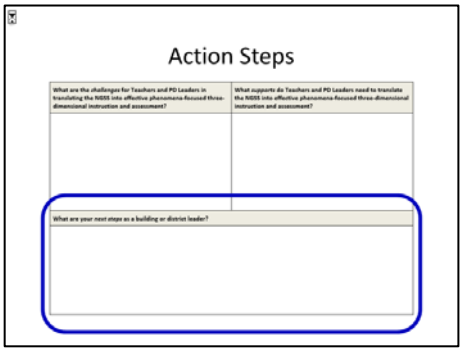
Slide	Facilitation Notes
	**Display Slide 29. State of Science Reflection (5 min)** PD Leader Note: Use this slide as the closing of Day 1 if doing two half-day sessions. a. Invite participants to individually reflect on the prompts. Ask several participants to share their thinking with the whole group.
	**Display Slide 30. Opening (5-10 min)** PD Leader Note: Use this slide as the opening of Day 2 if doing two half-day sessions. a. Provide directions for your selected opening activity.
	**Display Slide 31. Review of Last Session (10 min)** a. In their table groups, invite participants to discuss the activities and the purpose of each activity from the first half-day session. b. Ask several groups to share their ideas with the whole group.
	**Display Slide 32. Effective Teaching and Learning (10 min)** a. Invite participants to take a few minutes to individually write their response to the prompt. b. Have participants share their ideas with their table groups. c. Ask several participants to share a summary of their table's conversation.

Part 4 Introduction to the NGSS (140 minutes)

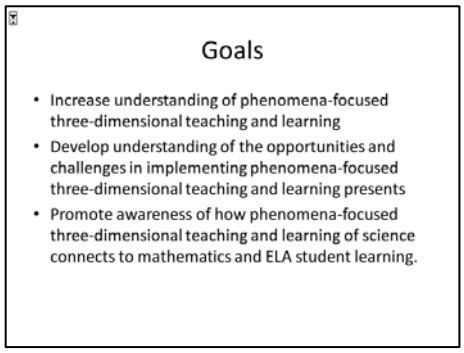
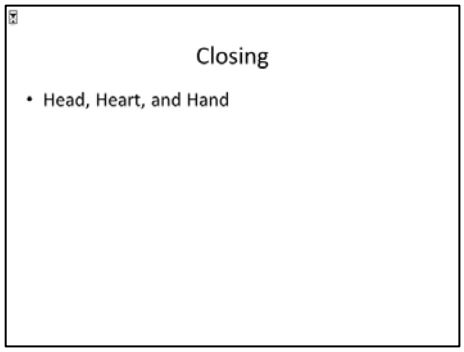
Slide and Time	Facilitation Notes
	**Display Slide 33. Innovations of the NGSS (60 min)** Part 1: a. Divide participants into three expert groups. Distribute HO9, NGSS Innovations. Everyone should read the introduction (first three paragraphs) of the article. Group A should also read Innovation 1, Group B should also read Innovations 2 and 3, and Group C should also read Innovations 4-5. Invite participants to read and mark up the text silently. b. Once everyone in their group has finished reading the text, the group should have a conversation summarizing the key ideas of their assigned innovation. Part 2: c. In groups consisting of at least one person from each expert group, participants should represent their ideas about the posted question. They should share about their innovations but should spend more of their time looking for themes across the innovations, and how it can help them think about science teaching and learning in their own setting. Part 3: d. Invite groups to share their representation with the whole group.
	**Display Slide 34. NGSS Innovations (5 min)** a. Share the video in which Rodger Bybee and Peter McLaren discuss the innovations of the new standards.

Slide and Time	Facilitation Notes
	**Display Slide 35. NGSS vs. Our Old State Standards (20 min)** PD Leader Note: Edit this slide as needed: • If your location is a recent adopter of the NGSS, select an appropriate page from the NGSS (HO10) to compare to a similar grade level and content page (HO11) from the previous state standards of the location where your PD is taking place. • Alternatively, if your location adopted the NGSS several years ago, use this time to consider: 1) How has instruction has changed (or not) since adoption of the NGSS. 2) What shifts still need to occur in instruction for effective phenomena-focused three-dimensional teaching and learning to occur? a. Use this opportunity to allow participants to discover similarities and differences between previous standards and the new NGSS. Distribute HO10 and HO11. Allow participants time to talk in small groups. b. During the whole group share out, be sure to highlight the foundation boxes on the NGSS page, along with the Performance Expectations on the top of the page. Share the SEP (blue) and CCC (green) charts.
	**Display Slide 36. Meta Moment (10 min)** a. Direct participants' attention to the T-charts of effective teaching and learning. Highlight that there have been several opportunities to refine the characteristics of effective teaching and learning throughout the sessions. b. Invite participants to respond to the prompts individually. c. Invite several participants to share their responses.
	**Display Slide 37. How do we build… (6 min)** a. Share the video to introduce participants to the Five Tools.

Slide and Time	Facilitation Notes
	**Display Slide 38. Five Tools and Processes (5 min)** a. Distribute HO12 (Five Tools Graphic). Share that the Five Tools and Processes were designed by the American Museum of Natural History (AMNH), Biological Sciences Curriculum Study (BSCS), and WestEd. Give participants a few minutes to examine the Five Tools graphic. Review the purposes of each tool that were described in the last video: b. The purpose of Tool 1 is to help teachers develop an understanding of the three dimensions of the NGSS and to use these dimensions to develop a blueprint for designing an instructional unit. c. In Tool 2, teachers start to plan the assessment and evidence of learning for their unit by taking performance expectations from the NGSS and developing evidence of learning specifications. d. The purpose of Tool 3 is to introduce and deepen teachers' understanding of the BSCS 5E Instructional Model by developing a storyline anchored in phenomena and conceptual flow that aligns with the 5Es and provides an integrated approach to instruction. e. In Tool 4 teachers use the storyline and conceptual flow based on the 5E model to outline an instructional sequence with key questions for each activity and the ideal student responses. f. The purpose of Tool 5 is to develop a three-dimensional performance task to help teachers evaluate what students have learned as a result of NGSS-aligned instruction. PD Leader Note: At this point, it may be helpful to share that all tools use examples from Disruptions in Ecosystems unit created by the American Museum of Natural History and the Lawrence Hall of Science. The common learner experience came from Chapter 4 of the unit, and the Ms. Rivera classroom scenario came from Chapter 1. The unit and the Five Tools are freely available on the AMNH website.

Slide and Time	Facilitation Notes
	**Display Slide 39. Analysis and Action Steps (1 min)** PD Leader Note: If your group consists of leadership teams attending together, encourage these teams to work together to complete the tool. a. Pass out HO13: Analysis and Action Steps. Give participants a few moments to read the prompts for each section.
	**Display Slide 40. Analysis: Challenges and Supports (15 min)** a. Invite participants to fill out the first two sections of the tool. Encourage specificity in their responses, including site-specific supports. b. After participants have had time to write individually, have participants share their responses with their table group. Alternatively, if the group is small, responses can be shared with the whole group.
	**Display Slide 41. Action Steps (15 min)** a. Invite participants to complete the next steps section of the tool individually. Encourage participants to be as specific as possible in their responses. b. After participants have completed their action plan, have participants share their plan with a partner to get feedback.

Part 5 Reflections and Closure (10 minutes)

Slide and Time	Facilitation Notes
	**Display Slide 42. Goals (1 min)** a. Review the goals for the session with participants.
	**Display Slide 43. Closing (9 min)** PD Leader Note: Select an appropriate closing for your group. The following is a sample closing: a. Introduce the closing activity: Head, Heart, and Hand. Invite participants to respond to the following prompt: "As a result of our work together, I am thinking (point to your head) … I am feeling (point to your heart) …. and I am going to (point to your hand) ..." b. Give participants a moment to consider their response and then ask for a volunteer to start the process. Continue around the room until every participant has had an opportunity to share. PD Leader Note: If you use this closing, PD Leaders are encouraged to share during this closing activity along with participants. Begin and end with a participant and intersperse PD Leader responses throughout. To facilitate this, it is helpful to position PD Leaders throughout the room before.