Five Tools and Processes for Translating the NGSS into Instruction and Classroom Assessment

Tool 3: Using the 5E Instructional Model to Develop a Conceptual Flow

Introduction

Tool 1 focused on using information from an NGSS page to develop a Unit Blueprint and Tool 2 involved developing evidence of learning specifications to inform the planning of classroom assessments. Tool 3 introduces an instructional model that is grounded in research and will be used in Tool 4 to design integrated instructional sequences.

The purpose of Tool 3 is to introduce and deepen participants' understanding of the BSCS 5E Instructional Model, a research-based approach to designing instructional sequences within a unit. Consistent with a constructivist view of learning, the 5E model offers an approach that surfaces and challenges students' current conceptions and provides activities and time for reflection to facilitate the iterative revision of students' ideas and abilities. The Tool 3 process asks participants to analyze two classroom scenarios: one involving instruction that is designed based on the 5Es and the NGSS, and another that represents "good" teaching, but that is based on other goals and priorities. Through the descriptions of two classrooms, participants gain a deeper understanding of the 5E model and how it supports three-dimensional, phenomena focused learning. Using the 5E instructional model and the Tool 1 Unit Blueprint, participants develop a storyline that focuses on phenomena and a conceptual flow of the science content. This work lays the groundwork for designing three-dimensional learning, phenomena-focused sequences in Tool 4.

Goals and Outcomes:

- Develop an understanding of the BSCS 5E Instructional Model to support planning for NGSS-aligned instruction and assessment
- Develop an NGSS-aligned coherent storyline about phenomena and conceptual flow.

Prerequisite: Participants should have experience using Tools 1 and 2

Total Time: **385 minutes not including breaks (6 hours and 25 minutes or a one-day workshop)**

Part 1 **Introduction** (Slides 1-4) [10 min]

Purpose: Provide an opportunity for participants to connect with one another and to the content of the day.

Summary: Participants consider factors that guide their decisions about science teaching and learning and orient to the Five Tools and the goals of the session.

Part 2 **Science Teaching and Learning** (Slides 5-12) [95 min]

Purpose: Explore ideas about science teaching and learning and introduce the research-based 5E Instructional Model

Summary: Participants read and analyze two teacher scenarios. They read a synthesis of *How People Learn* and *How Students Learn* and are introduced to the 5E Instructional Model.

Part 3 BSCS 5E Instructional Model (Slides 13-20) [50 min]

Purpose: Explore the BSCS 5E Instructional Model

Summary: Participants learn about the BSCS 5E Instructional Model and revisit the Teacher B scenario to identify the "E" for each lesson. They revisit the research findings and consider how the 5E model leads to a coherent storyline.

Part 4 Tool 3 Process (Slide 21-25) [95 min]

Purpose: Learn how to develop a storyline about a phenomenon and a conceptual flow aligned with the three dimensions of the NGSS.

Summary: Participants use a card sort activity to develop a set of criteria for identifying anchor phenomena. Participants use sentence strips to identify the anchor phenomena and concepts from Teacher B's lessons. Participants review the Tool 3 Template Example aligned with the Teacher B scenario to deepen their understanding of coherence within a storyline and conceptual flow.

Part 5 Developing a Storyline and Conceptual Flow (Slide 26-28) [135 min]

Purpose: Use Tool 3 to develop a storyline and conceptual flow for a 5E sequence.

Summary: Participants review the Guide for Developing a Storyline and Conceptual Flow about a Phenomenon and apply the Tool 3 process to one of the sequences from the Tool 1 Unit Blueprint.

Total Time = 385 min (6 hours 25 min) not including breaks

Materials:

- Tool 3 Electronic Template (each team will need to revise the number of rows)
- yellow and pink highlighters (one of each color/participant)
- Phenomena card decks (one deck printed on card stock/pair of participants). The master for the card deck is found at the end of this facilitator guide.
- blank sentence strips (14)
- blue painter tape (for posting sentence strips)
- markers
- yellow sticky-notes (1 pad per table)

Handouts

HO 1	Teacher Scenario A
HO 2	Teacher Scenario B
HO 3	Synthesis of Research from *How People Learn: Brain, Mind, Experience, and the Classroom* and *How Students Learn: Science in the Classroom*
HO 4	BSCS 5E Instructional Model – Summary
HO 5	NSTA Article by Rodger Bybee

HO 6 Criteria for Evaluating Useful Phenomena and Problems

HO 7 Tool 3 Template Example

HO 8 Guide to Developing a Conceptual Flow and Phenomena-based Storyline

Resources (Optional for this session)

Text Resources

R 1 *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (2012) by National Research Council

R 2 *Next Generation Science Standards For States, By States Volume 1: The Standards* (2013) by NGSS Lead States

R 3 *Next Generation Science Standards For States, By States Volume 2: The Appendices* (2013) by NGSS Lead States

Slides

Slide 1 Five Tools & Processes for NGSS
Slide 2 Planning for Teaching and Learning
Slide 3 Five Tools and Processes Graphic
Slide 4 Goals and Outcomes
Slide 5 Science Teaching and Learning (Teacher A)
Slide 6 Science Teaching and Learning (Teacher B)
Slide 7 Ms. Rivera
Slide 8 How People Learn
Slide 9 Thinking Beyond a Lesson (optional)
Slide 10 NGSS Instructional Design (optional)
Slide 11 Research-Based Instructional Model
Slide 12 BSCS 5E Instructional Model
Slide 13 Summary of BSCS 5E Instructional Model
Slide 14 Selected Reading (article by Rodger Bybee) (optional)
Slide 15 Revisit Ms. Rivera's Lessons
Slide 16 Science Teaching and Learning
Slide 17 Connecting to Ms. Rivera
Slide 18 Coherence means…
Slide 19 Coherence and Storyline
Slide 20 Science Teaching and Learning
Slide 21 Phenomena Card Sort
Slide 22 Phenomena and Concepts
Slide 23 Ms. Rivera's Phenomena and Conceptual Flow
Slide 24 Tool 3 Example
Slide 25 Tool 3 Example
Slide 26 Your Turn
Slide 27 Sharing
Slide 28 Reflection

PD Leader Resources (*NOT used by participants*)

- *How People Learn: Brain, Mind, Experience, and School: Expanded Edition*

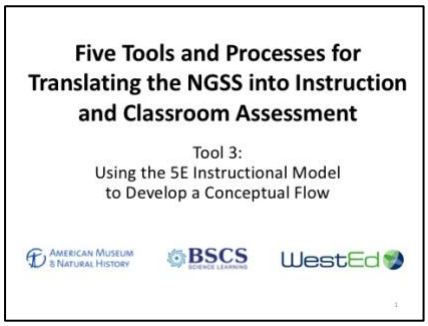
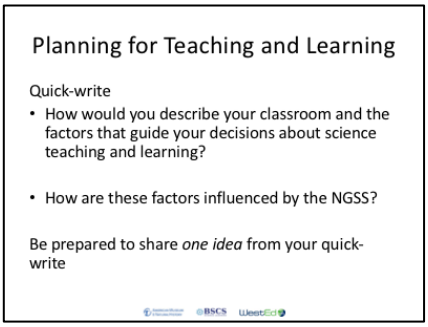
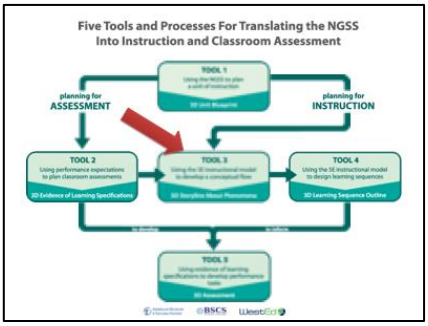
(2000), The National Academies Press, Washington, D.C.

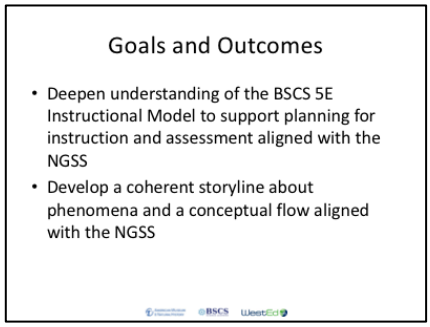
- *How Students Learn Science in the Classroom* (2005), The National Academies Press, Washington, D.C.
- *The BSCS 5E Instructional Model: Origins and Effectiveness* (pp. 113-184) in BSCS | Measuring Our Success: The First 50 Years of BSCS *http://www.bscs.org/estore/bscs-measuring-our-success-first-50-years*
- Tool 4 HO1 – The BSCS 5E Instructional Model

Advance Preparation:

- Communicate with participants prior to the session. Suggest that they bring a computer to complete the electronic Tool 3 Template.
- Print and copy handouts and make set of Phenomena Card Sort cards for each pair. The master for the Phenomena Card deck can be found at the end of this facilitator guide.
- Ensure adequate space for reading, charting, and other work in groups of 3-4. Remember to have yellow and pink highlighters (one of each color/participant) for reading the Teacher Scenarios.
- Decide where you will display the charts for Teacher Scenario A and Teacher Scenario B. There will be seven charts for each scenario. The Teacher B Scenario (Ms. Rivera) charts will be used again in Tool 4.
- In preparation for the report out of Ms. Rivera's lessons in slide 6, we encourage you to annotate the Ms. Rivera's Teacher B scenario. Use Tool 3 HO4: The 5E Instructional Model and Tool 4 HO1: 5E Teacher/Student to note key features of each lesson's E are evident. Use your notes to highlight key ideas shared by participants that exemplify the E of that lesson.
- After the session, be sure to save the Teacher B Scenario Charts for use in the Tool 4 session.

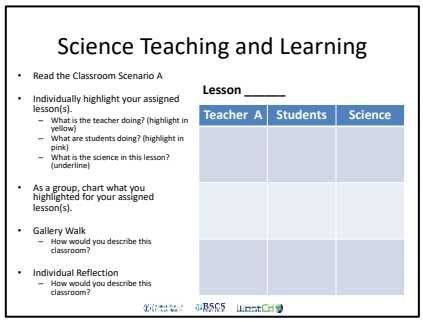
Part 1 Introduction (Slides 1-4) 10 minutes

Slide and Time	Facilitation Notes
 Slide 1 (1 minute)	**Display Slide 1 Five Tools and Processes for NGSS** a. Welcome participants to the session. Lead an opening for the group if appropriate. b. Set the stage for the session by linking to the group's work with Tools 1 and 2. Mark that participants have done some planning for what students will learn, but they have not really planned for how students will learn. **Transition**: *We want to give you a chance to think individually and then together about what informs your decisions when you plan for and carry out instruction.*
 Slide 2 (6 minutes)	**Display Slide 2 Planning for Teaching and Learning** a. Provide the quick-write prompts and give time for each participant to record a response. b. Invite participants to share their ideas with an elbow partner. c. As partners share, listen for words and phrases that provide insights into what participants believe about teaching and learning. d. If time permits, provide an opportunity for a whole group conversation.
 Slide 3 (1 minute)	**Display Slide 3 Five Tools and Processes Graphic** a. Briefly reorient participants to the Five Tools and Processes. Introduce Tool 3 as the focus of the session today. Possible narrative: *Tool 1 focused on using information from an NGSS standards page to develop a Unit Blueprint and Tool 2 involved developing evidence of learning specifications to inform classroom assessment. In today's session, we'll be learning about Tool 3, which introduces an instructional model that is grounded in the research on learning. The product of our work from Tool 3 will be used in Tool 4 to design integrated three-dimensional, phenomena focused instructional sequences.*

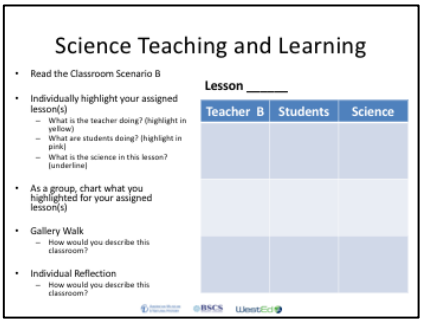
Slide and Time	Facilitation Notes
 Slide 4 (2 minutes)	**Display Slide 4 Goals and Outcomes** **a.** Share the goal for the day and connect to ideas shared by participants in response to the quick-write prompt.

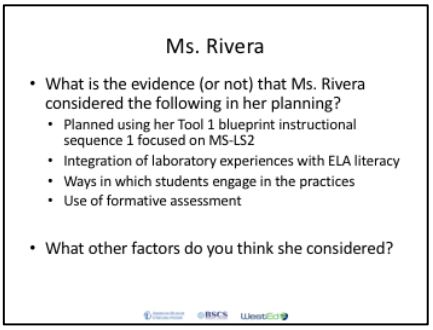
Part 2 Science Teaching and Learning (Slides 5-12) 95 minutes

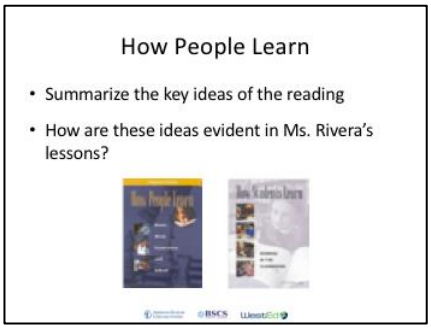
PD leader note: *You need to form small expert groups for the next activity. If you have 28 or fewer participants, you will have one home group. Count everyone off from one to seven to form seven expert groups. If you have more than 28 participants, you will have two home groups. Each expert group within the home group should have 3-4 participants. Each expert group will read, highlight, and chart one of the lessons from Teacher Scenario A and the same number lesson in Teacher Scenario B. These expert groups will be used to form home groups in Part 4. Participants will also work in these expert groups during the Tool 4 session.*

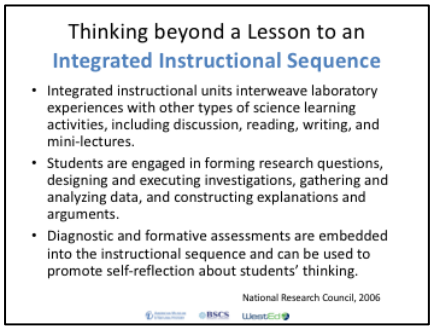
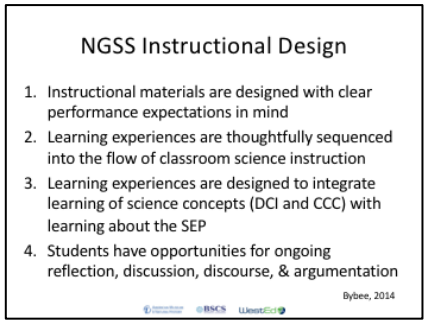
Slide and Time	Facilitation Notes
 Slide 5 (30 minutes)	**Display Slide 5 Science Teaching and Learning: Teacher A** a. Share with participants that they'll be reading two scenarios that highlight different approaches to science instruction. Distribute **HO1: Teacher Scenario A**. b. Provide instructions for individuals to read and mark the text for their assigned lesson: i. Highlight in yellow what the teacher is doing ii. Highlight in pink what the students are doing' iii. Underline the science in the lesson Invite participants to keep the room silent for those that need quiet for reading. If individuals finish before others in their group, they should skim the other lessons in the sequence. c. As each expert group finishes reading and marking the text, invite them to construct a 3-column chart for their lesson, as shown in the slide. Individuals should share what they have highlighted and represent the group

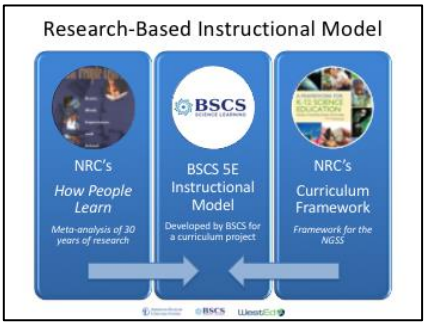
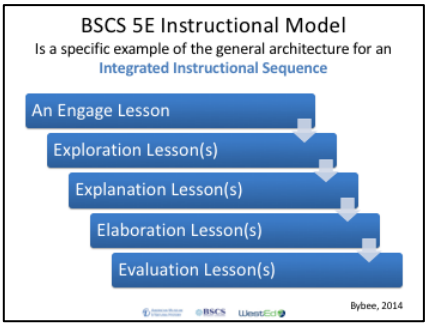
Slide and Time	Facilitation Notes
	members' ideas on the chart. They should note their lesson number in the upper left-hand corner of the chart. d. If any group finishes early, invite them to read the lesson before and after their assigned lesson and all lessons if possible. **PD leader note**: The third column is intentionally vague, as we want participants to surface their ideas about what it means to engage in classroom "science." The goal is surface participants' current thinking about what constitutes "science" and to eventually challenge participants' ideas to include as part of the "science" not only the disciplinary core ideas, but also the practices of science and crosscutting concepts. In doing so, you can use the chart to frame a discussion about who is responsible for engaging in the science (students and/teacher). Also note that Teacher B is a "good" teacher who is implementing the strategies learned through the district offered professional learning experiences. e. Once each group has charted, ask participants to hang their chart paper on the wall so that the group can see the lessons in order. **PD leader note:** If you have two home groups, you will have two sets of charts for Teacher Scenario A. Have each post their lesson charts on a different wall and provide instructions for a Gallery Walk to look for similarities and differences in how each group though about Teacher Scenario A. Depending on the size of the group, you may want to facilitate the Gallery Walk. If you have one home group (and one set of charts) invite the whole group to stand at the charts and lead a whole group discussion as follows: f. Have one member from each expert group summarize their lesson, beginning with lesson 1. The summary should include information from all three columns. They should plan on a very brief, 1-2 minute summary. g. Invite participants to think silently about their response to the individual reflection question. Note that they will share their responses after examining Teacher Scenario B.

Slide and Time	Facilitation Notes
 Slide 6 (35 minutes)	**Display Slide 6 Science Teaching and Learning: Teacher B** a. Share with participants that they'll now follow the same process for Teacher Scenario B. Distribute **HO2: Teacher Scenario B**. b. Note that each expert group will read the same lesson as they did for Teacher Scenario A. Invite individuals to silently read and mark the text. If individuals finish before others in their group, they should skim the other lessons in the sequence. c. As each expert group finishes reading and marking the text, invite them to construct a 3-column chart for their lesson, as shown in the slide. Individuals should share what they have highlighted and represent the group members' ideas on the chart. They should note their lesson number in the upper left-hand corner of the chart. d. Once each group has charted, ask participants to hang their chart paper on the wall so that the group can see the lessons in order. e. If any group finishes early, invite them to read the lesson before and after their assigned lesson and all lessons if possible. f. Invite the whole group to stand at the charts and have one member from each expert group summarize their lesson, beginning with lesson 1. The summary should include information from all three columns. Again, the summary should be brief. **PD leader note:** As participants summarize each lesson, ask clarifying questions and paraphrase to highlight ideas, words, and phrases that are consistent with the E for that lesson. Refer to the annotations for each lesson made in the Advance Preparations. a. Invite participants to think silently about their response to the individual reflection question. Invite elbow partners to discuss their ideas about Mr. Coles and Ms. Rivera. Then invite pairs to share their ideas with the whole group. **PD leader note**: Expect to hear table groups talk about how each scenario represents a different approach to instruction. The intent is not to say that Teacher A is a "bad" teacher and Teacher B is a "good" teacher. i. Scenario A is a more teacher-centered approach to

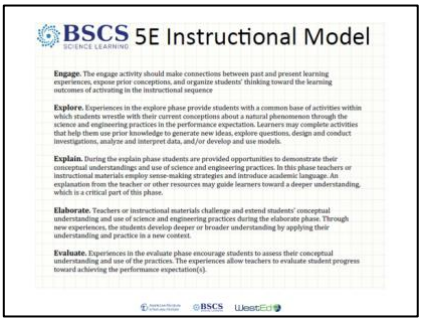
Slide and Time	Facilitation Notes
	learning and teaching science. Mr. Coles does most of the meaning-making during his lessons. ii. Scenario B represents a more student-centered approach to learning and teaching science. Ms. Rivera provides more opportunities for her students to make meaning from their experiences. iii. It is important to draw out the idea that Mr. Coles is a good teacher and his students are likely learning science ideas. Mr. Coles would score high using Danielson's *Framework for Teaching*. However, Ms. Rivera's approach to instruction is more consistent with inquiry-based teaching and constructivist learning. **Transition**: *Note that the purpose of the two scenarios was for us to have a common experience to explore our thinking about instruction that is aligned with the goals and vision of the NGSS. Use ideas generated by the groups (e.g., student-centered, integrated or coherent instruction) to transition to a discussion about NGSS-aligned instruction.*
 Slide 7 (5 minutes)	**Display Slide 7 Ms. Rivera** Possible narrative**:** *In the two scenarios, we explored what Mr. Coles and Ms. Rivera and their students did over the course of a unit of instruction as well as the science in each lesson. Now, we want to zoom in to think about Ms. Rivera's actions and the rationales for her decisions.* a. Ask participants to individually consider the slide on the prompt. b. Have participants share their ideas with the whole group. **PD leader note**: Possible responses might include: i. Big ideas from Instructional Sequence 1 are evident in this instructional sequence. Students learned information about the types of patterns of interactions (MS-LS2.A) and human population impact on Earth's system (MS-ESS3.C). In addition, students used their understanding about the Yellowstone food web to explain the effects of wolf introduction in the Adirondacks (MS-LS2-2). ii. Students analyzed and interpreted data to construct explanations and arguments and crosscutting concepts seem to be present including cause-effect and patterns.

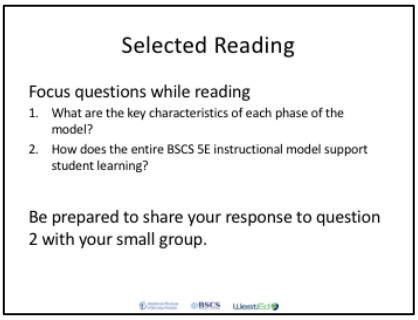
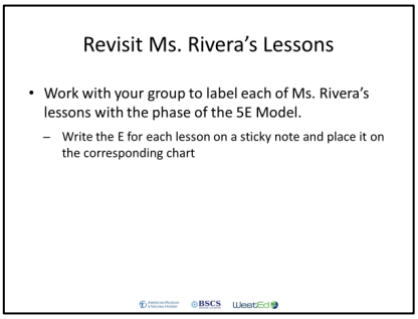
Slide and Time	Facilitation Notes
	Transition: *We have begun to consider Ms. Rivera's decisions in planning effective lessons based on the Framework and the NGSS. We will now look at key research about how students learn to see if Ms. Rivera's lessons incorporate the findings.*
 Slide 8 (20 minutes)	**Display Slide 8 How People Learn** **PD leader note:** Determine how you will refer back to the reading from How People Learning and How Students Learn Science in the Classroom if participants completed this reading in a previous session. You may choose to skip this slide and refer back to the reading later in the session (see slide 16). a. Distribute **HO3: Synthesis of Research from *How People Learn: Brain, Mind, Experience, and the Classroom* and *How Students Learn: Science in the Classroom***. b. Ask participants to read the synthesis and summarize their ideas in their journals. Remind participants that some individuals might need silence when reading. c. Ask participants to discuss their ideas with an elbow partner and consider how these ideas might be evident in Ms. Rivera's lessons. **PD leader note**: Possible participant responses might include: i. Ms. Rivera surfaced students' ideas about a topic or problem before constructing or learning new knowledge. ii. Ms. Rivera provided guiding questions to provide purpose for each lesson and consider the extent to which they've made progress towards answering those questions. iii. Students placed their ideas within a broader conceptual framework to understand how their ideas fit together to explain something in the world. **Transition:** *Recall that the purpose of Tool 3 is to develop a storyline that focuses on anchor phenomena and a conceptual flow of science content. We will now consider how a research-based instructional model can support the design of instructional sequences with a coherent conceptual flow.*

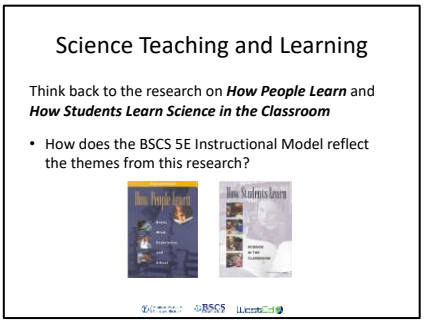
Slide and Time	Facilitation Notes
 Slide 9 (2 minutes) (optional)	**Display Slide 9 Thinking beyond a Lesson (hidden)** **PD leader note**: Slides 9 and 10 may be used if participants need additional support for identifying characteristics of 3-D learning that are aligned with 3-D learning. Below are key points that can be highlighted: i. The NGSS requires that we expand conceptions about instruction from "the lesson" to an integrated instructional sequence in order to translate these new standards to classroom instruction. ii. Based on a synthesis of research findings about the role of laboratory experiences, the NRC found these types of experiences, when integrated with other instruction, produce more effective learning sequences for students and enhance student achievement of learning goals. iii. The slide provides the NRC's definition of *integrated instructional units* which have two key features: • First, laboratory and other experiences are carefully designed or selected on the basis of what students should learn. • Second, the experiences are explicitly linked to and integrated with other 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).**
 Slide 10 (1 minute) (optional)	**Display Slide 10 NGSS Instructional Design (hidden)** a. The three dimensions of the NGSS compliment the NRC's conclusion for integrated instructional sequences. b. The slide provides four principles of instructional design that contribute to attaining learning goals as stated in the NGSS according to Rodger Bybee (2014). c. The BSCS 5E Instructional Model serves as an understandable and manageable application of an integrated instructional sequence.

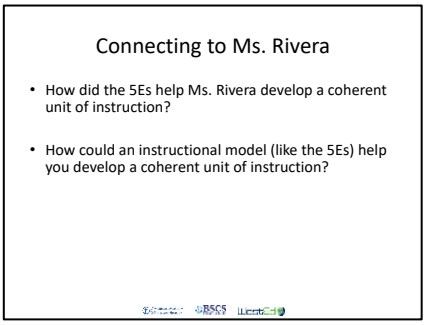
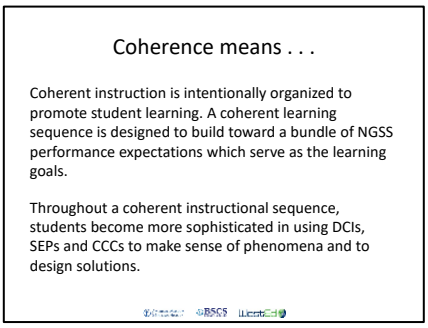
Slide and Time	Facilitation Notes
 Slide 11 (2 minutes)	**Display Slide 11 Research-Based Instructional Model** a. Share with participants that the BSCS 5E Instructional model supports the vision of the National Research Council (NRC)'s *Framework for K-12 Science Education*, which informed the development of the NGSS, and is grounded in research on how people learn. b. Mark that the 5E model offers an approach that surfaces and challenges students' current conceptions and provides activities and time for reflection to facilitate the iterative revision of students' ideas and abilities. c. Note there are other instructional models that could be used to develop a conceptual flow. One of the developers of the Five Tools was BSCS Science Learning so we use the BSCS 5E Instructional Model throughout the Five Tools.
 Slide 12 (3 minutes)	**Display Slide 12 BSCS 5E Instructional Model** a. Share that the BSCS 5E Instructional Model provides a specific example of the general architecture for an *integrated instructional sequence*: i. While lessons serve as daily activities, designing integrated instructional sequences involves identifying learning experiences that contribute to the learning outcomes described using the three dimensions of the NGSS. ii. These integrated instructional sequences serve as the basis of a curriculum unit. **Transition**: *We want to learn more about the BSCS 5E Instructional Model to help us translate the NGSS and create learning experiences that are student-centered, coherent, and incorporate all three dimensions of the NGSS (disciplinary core ideas, science and engineering practices, and crosscutting concepts).*

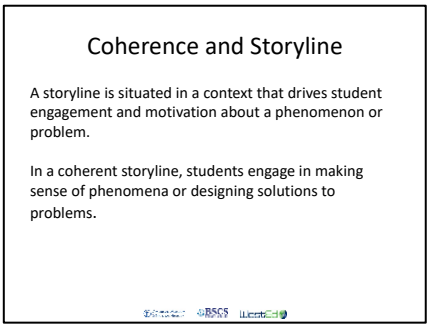
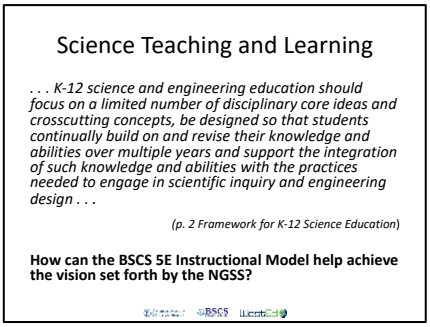
Part 3 BSCS 5E Instructional Model (Slides 13-20) 50 minutes

Slide and Time	Facilitation Notes
 Slide 13 (10 minutes)	**Display Slide 13 5E Instructional Model** a. Distribute **HO4: BSCS 5E Instructional Model – Summary**. Share with participants that we have incorporated the three dimensions into this summary description of the BSCS 5E Instructional Model. **PD leader note:** BSCS recently rebranded as BSCS Science Learning as indicated by the logo on the handout. b. Ask participants to individually read the 5E Instructional Model Summary, encouraging them to mark the text as they read, noting key features of each 5E phase. c. After participants have read the summary, ask participants to summarize the key features of each 5E phase with an elbow partner. **PD leader note**: Participants often identify the introduction of academic vocabulary as a key feature of the *Explain* phase. It's important to clarify that during the *Explain* phase, students are using evidence to support their ideas. Once these ideas are developed, teachers may introduce academic vocabulary to provide a common language to reference student-generated ideas. d. Note the references to the DCIs, SEPs, and CCCs in the descriptions of certain phases of the model. While the DCIs and SEPs are in the foreground in the *Explore* and *Explain* phases, the CCCs are in the foreground of the *Elaborate* phase. e. Ask participants to consider whether Mr. Coles and/or Ms. Rivera's class showed evidence of aligning their instruction with the 5E model. f. Take a whole-group thumbs up/down poll and invite participants to share their rationales. There should be consensus that Ms. Rivera's class showed evidence of using the 5Es.

Slide and Time	Facilitation Notes
 Slide 14 (25 minutes) (optional)	**Display Slide 14 Selected Reading (hidden)** **PD leader note**: This slide can be used to guide the reading of this article, which further explains the development of the 5E Instructional Model. Alternatively, ask participants to read the article on their own time. a. Distribute **HO5: NSTA Article by Rodger Bybee**. Remind participants that the room will need to be silent for reading. b. Provide instructions for the reading and offer time for participants to discuss the reading in small groups. c. Capture key ideas from the whole group on chart paper. Focus energy on recording the purposes and key features of the 5E Instructional Model and each phase.
 Slide 15 (25 minutes)	**Display Slide 15 Revisit Ms. Rivera's Lessons** a. Ask each group to determine which E corresponded to each of Ms. Rivera's lessons, using their handouts to support their decision. Mark that they should find many examples of actions consistent with each phase, but potentially a few inconsistencies. Note that it may be helpful to consider the purpose of each lesson. b. Once the group has come to consensus, they should label the E on a yellow sticky-note with a marker or sharpie and place the sticky-note on each poster. c. When all groups have placed their sticky notes on the charts, gather the whole group around the charts to discuss their determinations. Begin with the lessons with the greatest consensus, ending with those with least consensus. **PD leader note:** i. Most groups will easily identify Lesson 1 as the *Engage* and Lessons 6 & 7 as the *Elaborate* and the *Evaluate* lessons. ii. If groups are struggling to identify the middle lessons (2 – 5), suggest the options below. a. Explore, Explore, Explain, Explain b. **Explore, Explain, Explore, Explain (correct answer)** c. Explore, Explore, Explore, Explain d. Explore, Explain, Explain, Explain **PD leader note**: Remind your participants to use evidence

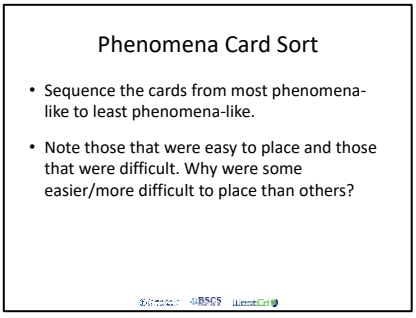
Slide and Time	Facilitation Notes
	from the scenario and the 5E handout. It will be helpful for you to use your annotated scenario and notes to facilitate the discussion. Additional guidance for differentiating between the phases is provided below: i. There are two cycles of *Explore-Explain* lessons, each building upon a particular set of ideas that taken together deepen their understanding of the Yellowstone ecosystem. Note that within an instructional sequence we generally do not advocate for more than two Explore-Explain cycles. ii. In the *Explore* lessons, students engage in a *common learning experience* using data to develop their ideas about relationships between organisms and factors in the ecosystem. iii. In the *Explain* lessons, students connect their claims with evidence to deepen their understanding of the Yellowstone ecosystem. Students apply academic language to ideas they have developed. Note that the word "explain" may appear on charts that are not Explain lessons. iv. In the *Elaborate* lesson, students *apply their understanding* about the Yellowstone ecosystem to make predictions and explain interactions within *another context*. v. If participants are unable to come to consensus, move the conversation forward by sharing the intended E for that lesson and asking for evidence that would support that intention.
 Slide 16 (5 minutes)	**Display Slide 16 Science Teaching and Learning** a. Ask participants to think back to their discussion about *How People Learn* and *How Students Learn Science* (**HO3**). b. Invite table groups to discuss the question on the slide. **PD leader note**: To scaffold the task, you might ask participants to consider how the 5Es align with the three key findings from the reading. Ideas to highlight in the discussion include: i. Students *engage with prior knowledge* during the *Engage* phase. ii. As students *Explore* and *Explain* their ideas about a phenomenon, students are *organizing their ideas into*

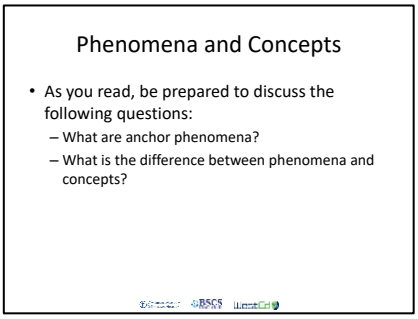
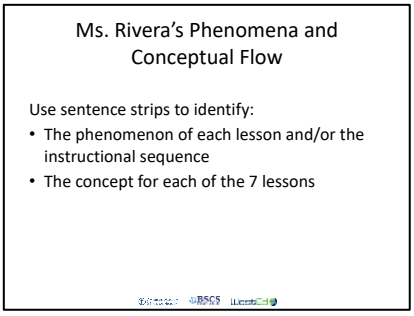
Slide and Time	Facilitation Notes
	a conceptual framework and using it to revise their understanding of the phenomenon. iii. Students *monitor their own thinking* as they consider how well their ideas fit the evidence (all phases); consider how they could apply their ideas to explain another context (*Elaborate*), which might warrant further revision or development of their ideas; and assess their conceptual understanding (*Evaluate*).
 Slide 17 (8 minutes)	**Display Slide 17 Connecting to Ms. Rivera** a. Ask participants to respond to the questions individually in their journals. Then invite table groups to discuss their responses. b. Ask each table to share one takeaway from the second question with the whole-group. Example responses to highlight in the discussion include: i. Integrated instructional sequences start with eliciting and making connection between past and present knowledge and experiences. ii. Students use their existing ideas to make sense of data and use evidence to support the validity of their ideas. iii. Students further test and revise their ideas in other phenomena contexts. iv. Students assess their conceptual understanding and use their conclusions to inform additional actions to solidify their understanding.
 Slide 18 (2 minutes)	**Display Slide 18 Coherence means…** a. Invite participants to read the text on the slide silently. b. Give them a moment to think to themselves about how the Tool 3 process helps provide support to help them accomplish instructional coherence. c. Do a quick turn and talk, then ask for any lingering questions.

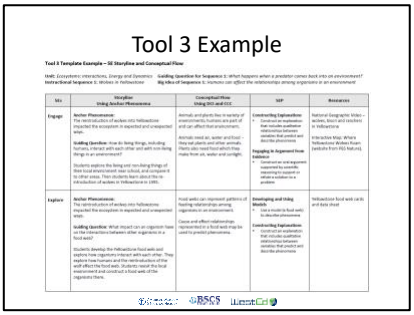
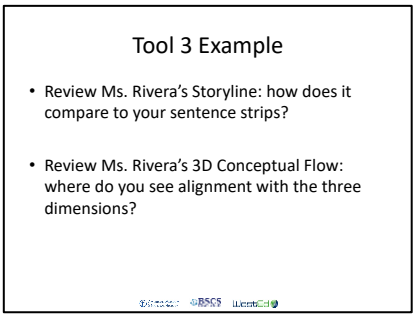
Slide and Time	Facilitation Notes
 Slide 19 (5 minutes) (optional)	**Display Slide 19 Coherence and Storyline (hidden)** **PD leader note:** Use slides 19 – 20 if you feel participants need additional support with ideas around coherence and storyline. a. Invite participants to read the text on the slide silently. b. Ask participants to share their ideas about coherence and storyline after reading the text.
 Slide 20 (5 minutes) (optional)	**Display Slide 20 Science Teaching and Learning (hidden)** a. Ask participants to read the quote or one participant to read the quote to the whole group. b. Discuss the question the slide. **PD leader note**: Help participants make connections between the BSCS 5E Instructional Model and how it may help participants achieve the vision of science education set forth in the Framework. Participants should notice that the 5E instructional model involves students beginning with their initial ideas and engaging in common learning experiences to iteratively revise their ideas using evidence.

Part 4 Tool 3 Process (Slides 21-25) 95 minutes

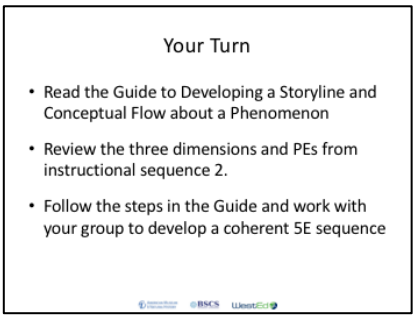
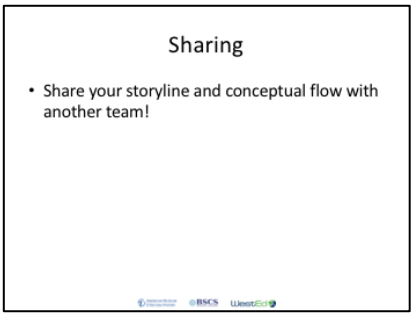
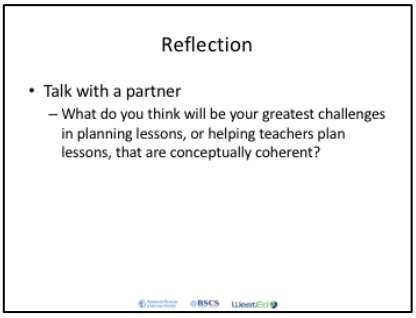
Transition: *In a coherent storyline, students engage in making sense of phenomena or designing solutions to problems. To build consensus around phenomena, we'll begin with a common experience and then consider the phenomena present in Ms. Rivera's storyline.*

Slide and Time	Facilitation Notes
 Slide 21 (30 minutes)	**Display Slide 21 Phenomena Card Sort** a. Ask participants to clear space on their tables so that they can create three groups of cards. b. Pass out one set of phenomena cards to each pair. c. Invite participants to sort their cards into three groups: i. The group on the right will include cards that they think are definitely phenomena, while the group on the left will include cards that are definitely not phenomena. ii. In the space in-between the two groups, participants should place cards for which they are unsure. They can treat this space as a continuum and place cards nearer to one category or the other. d. As participants sort their cards, encourage participants to articulate the rules of thumb they are applying to sort their cards. e. After each group has finished, groups to share examples of cards that they felt were definitely phenomena and those that definitely were not. After each example, ask the whole group for consensus and the rules of thumb they used to place those cards. Chart the rules for identifying phenomena suggested by groups. Do not chart rules for identification of not phenomena. f. Ask groups to share their responses to the second question and how their rules help (or not) them place the cards. Ask how some cards could be reworded to be more clearly placed in the phenomena group. **PD leader note**: The goal of this exercise is not for participants to have the right answers; rather, we want participants to develop a set of criteria for deciding what constitutes a productive phenomenon to frame student learning. The *Phenomena Card Sort Guide* at the end of this facilitator guide has example justifications as well as suggestions for revising statements to make them more "phenomenon-like."

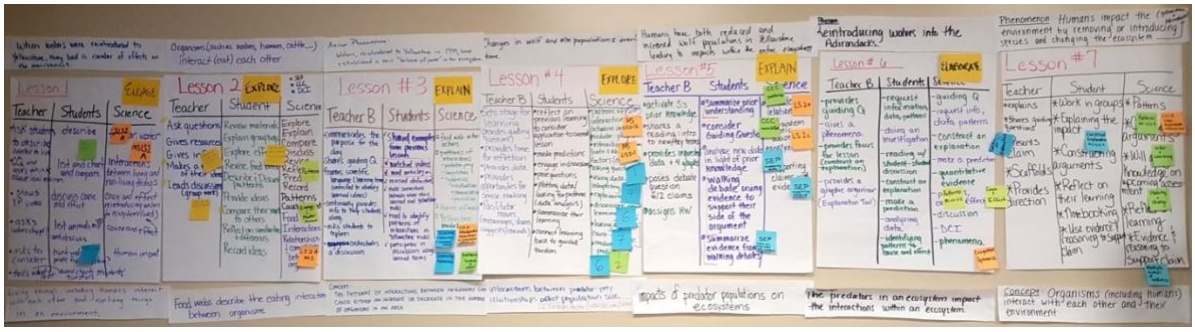
Slide and Time	Facilitation Notes
 Slide 22 (5 minutes)	**Display Slide 22 Phenomena and Concepts** a. Distribute **HO6: Coherent Instructional Sequences Based on Anchor Phenomena** and allow participants time to read and mark the text. b. Have participants discuss the questions on the slide with an elbow partner. c. As a whole group, discuss the similarities between their rules and the ideas on the handout. **PD leader note**: Emphasize key points about anchor phenomena: i. They involve something to be explained (e.g., observations or data). ii. They prompt students to wonder about how/why something is happening. Although questions might be posed about how/why a phenomenon is occurring, questions alone are not considered phenomena because they do not describe what is to be explained. These statements can often be rephrased to become phenomena. Concepts are scientific facts or complete sentences that show relationships. These concepts are often part of a scientific explanation of a phenomenon. Single words or phrases are topics and not phenomena. d. To help distinguish between anchor and investigative phenomena, invite participants to find the three cards with statements about zebra mussels (cards 2, 5, and 10). Ask participants to determine which cards might serve as anchor phenomena (card 2) and which might serve as investigative phenomena (cards 5 and 10). Encourage them to support their ideas by citing the handout.
	**Display Slide 23 Ms. Rivera's Phenomena and Conceptual Flow** a. Each expert group should identify the phenomenon and concepts for their assigned lesson in Ms. Rivera's sequence. Participants should record these on separate sentence strips. b. Have groups post the phenomenon strips above the lesson chart paper. Concept sentence strips should go

Slide and Time	Facilitation Notes
Slide 23 (45 minutes)	underneath the chart paper. **PD leader note:** See the image at the end of this facilitator guide for a completed example. Note that this image also shows the three colors of sticky notes which will be added I Tool 4. c. Debrief the experience with participants by asking questions, such as, "What was challenging?" and "What "aha" moments did they experience?"
 Slide 24 (x minutes)	**Display Slide 24 Tool 3 Example** a. Distribute **HO7: Tool 3 Template Example**. Provide time for participants to orient themselves to the structure of the Tool 3 template example. b. Explain the different headings in the Tool 3 template and how each row represents one 5E phase. **Transition:** Share that this is the Tool 3 Template that Ms. Rivera used to develop the conceptual flow for Instructional Sequence 1 of her Tool 1 Blueprint.
 Slide 25 (10 minutes)	**Display Slide 25 Tool 3 Example** a. Give participants a few minutes to compare their storyline to Ms. Rivera's (e.g., "Where were they similar? Where did they differ?). b. Ask participants to look at the conceptual flow. Point out that the concepts are written as statements using text from the DCIs and CCCs, while the SEPs have their own column. c. Ask participants to share examples of ideas and phrases that come directly from language in the NGSS. **PD leader note:** At this point, participants should move to the groups they were in when they developed their EoLS in Tool 2. This may be an opportune time to provide a break in conjunction with the reorganization of groups.

Part 5 Developing a Storyline and Conceptual Flow (Slide 26-28) (135 min)

Slide and Time	Facilitation Notes
 Slide 26 (120 minutes)	**Display Slide 26 Your Turn** a. Distribute **HO8: Guide to Developing a Conceptual Flow and Phenomena-based Storyline.** Give participants a few minutes to read through the Guide and answer any initial questions. b. Mark that you will provide 2 hours for participants to develop a storyline and conceptual flow for one instructional sequence from their Tool 1 Unit Blueprint – this should be the same sequence they developed their EoLS for in Tool 2. c. Note that groups are not planning specific lessons or activities at this point. They will do this work with Tool 4. d. Mark that participants will make their thinking and their work public, so they should work using chart paper and sentence strips. e. Share with participants that the process is iterative – they may go back and forth between working on their storyline and conceptual flow. As they proceed to Tool 4, it will likely lead to continued revision and refinement of their Tool 3 work.
 Slide 27 (10 minutes)	**Display Slide 27 Sharing** a. Pair teams with each other and have one group share their storyline and conceptual flow with another group, then switch. **PD leader note**: If teams are struggling, you may have one group that has been successful share their Tool 3 with the entire room.
 Slide 28 (5 minutes)	**Display Slide 28 Reflection** a. Invite participants stand with someone with whom they have not worked with today and discuss the prompt. b. Ask groups to share their conversation as one possible closing. If you have more time, use a more formal closing. **PD leader note:** Be sure to keep the Scenario B charts and sentence strips as they will be used in the Tool 4 session.

Example of Teacher Scenario B (Ms. Rivera) Charts



This image shows an example of Ms. Rivera's seven lessons charts with the concept sentence strips above the charts and the phenomenon sentence strips below.

Note that this image also shows the presence of the three dimensions with orange (DCI), blue (SEP) and green (CCC) sticky notes. These sticky notes are added to the charts in Tool 4.

Phenomena Card Sort Guide

The information below provides guidance for deciding whether a statement is a phenomenon or what revisions could be made to make it more phenomenon-like.

Card Information	Rationale
1. Ecosystems	**Not a phenomenon.** This is a topic that does not describe anything for students to explain.
2. The introduction of zebra mussels to the Hudson River greatly impacted the health of the ecosystem.	**Phenomenon.** These observed changes in the Hudson River prompt students to consider the role of zebra mussels in these changes. This is an example of an anchor phenomenon that could anchor a unit of instruction.
3. Ecosystems can be disrupted by natural events and by human-made events.	**Not a phenomenon.** This statement is a concept that describes the categories by which ecosystems can be disturbed. There is nothing to be explained.
4. The reintroduction of wolves to Yellowstone in 1995resulted in both expected and unexpected consequences.	**Phenomenon.** These observed changes in the wolf and elk population prompt students to consider why these changes occurred.
5. The zebra mussel population in the Hudson River grew exponentially over 5 years, but the size of individual mussels decreased.	**Phenomenon.** These observed changes in zebra mussels prompt students to consider why these changes occurred. This is an example of an investigative phenomenon that could guide an activity or series of activities.
6. Holly's parents wonder how to deal with the insects that are damaging their crops.	**Problem.** This statement about observed changes prompts students to wonder about the relationships between the insects, crop, damage and possible solutions. The problem could be improved by adding specific details about the insects, crops, or crop damage.
7. How does the amount of snowfall in Yellowstone affect the elk and wolf populations?	**Not a phenomenon.** Questions alone are not considered phenomena because they do not describe what is to be explained. This statement could be rephrased to become phenomena.
8. Organisms interact with their environment and other organisms.	**Not a phenomenon.** This statement is a concept that describes the relationships between living and non-living parts of an ecosystem. There is nothing to be explained.

Card Information	Rationale
9. There are fewer carnivores than herbivores and fewer herbivores than producers in a food web.	**Phenomenon.** Observations to be explained include the relative numbers of producers, herbivores, and carnivores. Students might wonder why this pattern exists – why aren't the same number of each type of organism? Is the number of producers always larger than the number of herbivores? The phenomenon could be improved by providing specific examples within a specific ecosystem, which might lead students to investigate what patterns of interaction exist and how these patterns could explain the observed distribution of organisms.
10. When scientists introduced quagga mussels to the Hudson River ecosystem the size of zebra mussel population decreased.	**Phenomenon.** These observed changes in mussel populations prompt students to consider why these changes occurred. This is an example of an investigative phenomenon that could guide an activity or series of activities.

Ecosystems

Card #1

The introduction of zebra mussels to the Hudson River greatly impacted the health of the ecosystem.

Card #2

Ecosystems can be disrupted by natural events and by human-made events.

Card #3

The reintroduction of wolves to Yellowstone in 1995 resulted in both expected and unexpected consequences.

Card #4

The zebra mussel population in the Hudson River grew exponentially over 5 years, but the size of individual mussels decreased.

Card #5

Holly's parents wonder how to deal with the insects that are damaging their crops.

Card #6

How does the amount of snowfall in Yellowstone affect the elk and wolf populations?

Card #7

Organisms interact with their environments and other organisms.

Card #8

There are fewer carnivores than herbivores and fewer herbivores than producers in a food web.

Card #9

When scientists introduced quagga mussels to the Hudson River Ecosystem the size of zebra mussel population decreased.

Card #10

Phenomena/ Problems

Phenomena/ Problems

Phenomena/ Problems

Phenomena/ Problems

Phenomena/ Problems

Phenomena/ Problems

Phenomena/ Problems

Phenomena/ Problems

Phenomena/ Problems

Phenomena/ Problems