Introduction

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

The purpose of Tool 3 is to introduce and deepen teachers’ 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 BSCS 5E instructional model offers an approach that surfaces and challenges students’ current conceptions or misconceptions and provides activities and time for reflection to facilitate the reconstruction of ideas and abilities. The Tool 3 process asks teachers to analyze two classroom scenarios: one involves instruction that is aligned with the 5Es and the other is not. Teachers gain a deeper understanding of the 5E model and how it incorporates three-dimensional learning. Using the 5E instructional model and the Unit Blueprint from Tool 1, teachers develop a storyline that focuses on anchor phenomena. They use Tool 3 to develop guiding questions for each phase of the 5Es. Teachers also develop a conceptual flow of the science content in Tool 3 that aligns with the 5E model, all of which lay the groundwork for the design of three-dimensional learning sequences in Tool 4.

Goals and Outcomes:

- Develop understanding of the BSCS 5E Instructional Model to support planning for instruction and assessment aligned with the NGSS
- Develop a coherent storyline based on phenomena and conceptual flow aligned with the NGSS

Prerequisite: Participants should have experience using Tools 1 and 2 Lite.

Time and Purpose

Part 1 Introduction (Slides 1-4) [10 min]
Purpose: Provide an opportunity for participants to connect to one another and to the content of the day.

Part 2 Science Teaching and Learning (Slides 5-10) [70 min]
Purpose: Explore ideas about science teaching and learning.
Summary: Participants read and analyze two teacher scenarios.

Part 3 BSCS 5E Instructional Model (Slides 11-15) [50 min]
Purpose: Introduce 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.

Part 4 Tool 3 Process (Slide 16-21) [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 develop an understanding of anchor phenomena during a concept attainment activity. They use sentence strips to identify the anchor phenomena and concepts from the lessons in the Teacher B scenario. They review a Tool 3 Template Example aligned with the Teacher B scenario to deepen their understanding of coherence in storyline and conceptual flow.

Part 5 Developing a Storyline and Conceptual Flow (Slide 22-24) [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 their sequences from their Tool 1 Unit Blueprint

Total Time = 360 min (6 hours)

Materials:
- Tool 3 Electronic Template (each team will need to revise the number of rows as needed)
- yellow and pink highlighters (one of each color/participant)
- Phenomena concept attainment cards (one set, printed on 11x17)
- blank sentence strips
- markers
- yellow sticky-notes

Handouts
- HO 1 Teacher Scenario A
- HO 2 Teacher Scenario B
- HO 3 BSCS 5E Instructional Model – Summary
- HO 4 NSTA Article by Rodger Bybee
- HO 5 Coherent Instructional Sequences Based on Anchor Phenomena
- HO 6 Tool 3 Template Example
- HO 7 Guide to Developing a Conceptual Flow and Phenomena-based Storyline
- HO 8 How People Learn excerpt (this HO will be used only if the Introduction session was not done with participants.

Resources (Optional for this session)
- R 2 Next Generation Science Standards For States, By States Volume 1: The Standards (2013) by NGSS Lead States
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  Thinking Beyond a Lesson
Slide 8  NGSS Instructional Design
Slide 9  Research-Based Instructional Model
Slide 10  BSCS 5E Instructional Model
Slide 11  Summary of BSCS 5E Instructional Model
Slide 12  Selected Reading (article by Rodger Bybee)
Slide 13  Revisit the Scenarios
Slide 14  Science Teaching and Learning
Slide 15  Science Teaching and Learning
Slide 16  Concept Attainment
Slide 17  Phenomena and Concepts
Slide 18  Ms. Rivera’s Phenomena and Conceptual Flow
Slide 19  Tool 3 Example
Slide 20  Coherence means...
Slide 21  Coherence and Storyline
Slide 22  Your Turn
Slide 23  Sharing
Slide 24  Reflection

PD Leader Resources (NOT used by participants)

- 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 HO 1 – 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 one set of Phenomena Concept Attainment cards
- 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.
Note: After the session, be sure to collect the Teacher B Scenario Charts for use with Tool 4. Remind participants to keep their marked-up versions of the Ms. Rivera lessons.
### Part 1: Introduction (Slides 1-4) 10 minutes

<table>
<thead>
<tr>
<th>Slide and Time</th>
<th>Facilitation Notes</th>
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</thead>
</table>
| **Slide 1 (1 min)** | 1. **Display Slide 1 (Five Tools & Processes for NGSS)**  
Set the stage for the session by linking to the group’s work with Tools 1 and 2. They’ve done some planning for what students will learn, but haven’t 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 instruction and while in the classroom. |
| **Slide 2 (6 min)** | 2. **Display Slide 2 (Planning for Teaching and Learning)**  
Provide the quick-write prompts and give time for each participant to record a response.  
Invite participants to share their ideas with an elbow partner.  
As partners are sharing listen for words and phrases that provide insights into what participants believe about teaching and learning.  
If time permits, provide an opportunity for a whole group conversation. |
| **Slide 3 (1 min)** | 3. **Display Slide 3 (Five Tools and Processes Graphic)**  
Briefly reorient participants to the Five Tools and Processes. Introduce Tool 3 as the focus of the session today. |
### Slide and Time | Facilitation Notes
---|---
**Goals and Outcomes**<br>- Deepen understanding of the BSCS SE Instructional Model to support planning for instruction and assessment aligned with the NGSS<br>- Develop a coherent storyline about phenomena and a conceptual flow aligned with the NGSS

**Slide 4 (2 min)**

4. **Display Slide 4 (Goals and Outcomes)**<br>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 5-10)  70 minutes

**PD Leader Note:** You need to form small groups for the next activity. Count off with everyone from one to seven to form “expert groups” (seven different groups). Each “expert group” should have 3-4 participants, assuming your whole group is more than 20 participants total. Each group will read, highlight, and chart one of the lessons in 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
---|---
**Science Teaching and Learning**<br>- Read the Classroom Scenarios<br>- Individually highlight your assigned lesson (using a color-highlighter)<br>- Assign an independent highlighter to each group, and spread them around the room<br>- As a group, chart what you highlighted for your assigned lesson<br>- Gallery Walk - share with others in a box (interacts in 4 corners)<br>- Individual reflection - think and write down ideas in a table

**Slide 5 (30 min)**

5. **Display Slide 5 (Science Teaching and Learning: Teacher A)**<br>Share with participants that they’ll be reading two scenarios based on MS-LS2 that highlight different approaches to science instruction. Distribute **HO1 (Teacher Scenario A)**.<br>Provide instructions for individuals to read the background information, scan the series of 7 lessons, and mark up the text for their assigned lesson as they read and for each table to create a chart.<br>Once each “lesson” group has charted, provide instructions for a Gallery Walk to look for similarities and differences in how different groups represented the Teacher Scenario A.<br>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.
**Slide 6 (35 min)**

**Facilitation Notes**

6. **Display Slide 6 (Science Teaching and Learning: Teacher B)**

   Share with participants that now they’ll read the Teacher Scenario B and follow the same process. Distribute **HO2 (Teacher Scenario B)**.

   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 B. You may want to facilitate the gallery walk, depending on the size of your group.

   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.

   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.

   **Transition**: Note that the purpose of the two scenarios was for us to have a common experience to help us explore our thinking about instruction that is aligned with the goals and vision of the NGSS. Link to ideas generated by the groups as they consider how they would describe each classroom. If they mention student-centered, integrated or coherent instruction, highlight this comment and use these types of statements to transition to a discussion about NGSS aligned instruction.

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**Slide 7 (2 min)**

**Facilitation Notes**

7. **Display Slide 7 (Thinking beyond a Lesson)**

   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. 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.
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<th>Slide and Time</th>
<th>Facilitation Notes</th>
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<tbody>
<tr>
<td>The slide provides the NRC’s definition of <strong>integrated instructional units</strong> 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 <em>America’s Lab Report: Investigations in High School Science</em> (NRC, 2006).</td>
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**NGSS Instructional Design**
1. Instructional materials are designed with clear performance expectations in mind.
2. Learning experiences are thoughtfully sequenced into the flow of classroom science instruction.
3. Learning experiences are designed to integrate learning of science concepts (DCI and CCC) with learning about the SEP.
4. Students have opportunities for ongoing reflection, discussion, discourse, & argumentation.

8. Display **Slide 8 (Principles of Instructional Design)**
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).

The *BSCS 5E Instructional Model* serves as an understandable and manageable application of an integrated instructional sequence.

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<th>Slide 8 (1 min)</th>
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**Research-Based Instructional Model**
- NRC’s How People Learn
- BSCS 5E Instructional Model
- NRC’s Curriculum Framework

9. Display **Slide 9 (Research-Based Instructional Model)**
Share with participants that the BSCS 5E Instructional model supports the vision of the Framework and it’s grounded in the research on how people learn.

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<th>Slide 9 (1 min)</th>
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**BSCS 5E Instructional Model**
- A specific example of the general architecture for an integrated instructional sequence.

10. Display **Slide 10 (BSCS 5E Instructional Model)**
The BSCS 5E Instructional Model provides a specific example of the general architecture for an integrated instructional sequence. Use an integrated instructional sequence as the basis for a curriculum unit.

While lessons serve as daily activities, design the sequence of lessons using a variety of learning experiences that contribute to the learning outcomes described using the three dimensions of the NGSS.

*Transition:* Note that we want to learn more about the BSCS 5E Instructional Model can help us translate the NGSS into the
### Part 3  BSCS 5E Instructional Model (Slides 11-15)  50 minutes

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<tr>
<th>Slide and Time</th>
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<tr>
<td><strong>Slide 11 (5 min)</strong></td>
<td>Share with participants that we have incorporated the three dimensions into this summary description of the BSCS 5E Instructional Model. 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.</td>
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<td><strong>Slide 12 (20 min)</strong></td>
<td>Provide instructions for the reading and distribute HO4 (NSTA Article by Rodger Bybee). Remind participants that the room will be silent for reading. Offer time for participants to discuss the reading in their small group. Capture key ideas from the whole group. Focus energy on the characteristics of the 5E Instructional Model including descriptors of the phases and overall purpose of the Model.</td>
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<td><strong>Slide 13 (15 min)</strong></td>
<td>Display the first question. Everyone should agree that Teacher B is using the 5Es in her lessons focused on MS-LS2. Next, groups will make sense of the 5Es as they apply their thinking to their charts developed from the reading by labeling each E on a sticky-note with a marker or sharpie. They should find many examples of actions consistent with each phase, but potentially a few inconsistencies. Most groups will easily identify Lesson 1 as the Engage and Lessons 6 and 7 as the Elaborate and the Evaluate. Suggest the options below if groups are struggling to identify the middle lessons (2 – 5):</td>
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<td>• Explore Explore Explain Explain</td>
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<td>Slide and Time</td>
<td>Facilitation Notes</td>
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<td>14. Display <strong>Slide 14 (Science Teaching and Learning)</strong></td>
<td>Ask participants to think back to the discussion about How People Learn and How Students Learn Science in their Introduction to the Five Tools session. Discuss the question on the slide. <strong>PD Leader Note:</strong> If you did not include the Introduction session, have participants read HO8: How People Learn.</td>
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<td>Slide 14 (5 min)</td>
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<td>15. Display <strong>Slide 15 (Science Teaching and Learning)</strong>. Ask one participant to read the quote to the whole group. Discuss the question the slide. Help participants to make connections between the BSCS 5E Instructional Model and how it may help teachers achieve the vision of science education set forth in the Framework.</td>
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<td>Slide 15 (5 min)</td>
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<td><strong>Part 4 Tool 3 Process (Slides 16-21) 95 minutes</strong></td>
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<td>Slide and Time</td>
<td>Facilitation Notes</td>
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<tr>
<td>16. Display <strong>Slide 16 (Concept Attainment)</strong></td>
<td><strong>Facilitator note:</strong> The purpose of this activity is to help participants distinguish phenomena and concepts. The strategy, concept attainment, represents a different approach to develop this understanding. In this strategy, the participants don’t know the question, but the answers will be revealed. The question that the PD leader has in their mind is: Does this statement represent a phenomenon (yes or no)? The goal is for participants to generate a list of criteria that describe the “yes” statements. To prepare, read through the statements to become familiar with them and star the answers to the “easy ones” so that you are able to choose statements through the process that will help your participants move forward in their understanding. In other words,</td>
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<td>Slide 16 (30 min)</td>
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you won’t necessarily use the statements in numbered order. Do NOT use all the statements. Prepare a table near the wall you’ll use. Print the 11X17 phenomena statements so that participants can easily read the statement and you can read the “answer” printed on the back. Lay them out on a table with tape already attached and so that you can read the answers on the back. Prepare your wall with a big YES and NO, each on a separate large sticky note or 8 ½ X 11 paper.

Describe what is going to happen and why. One way to set up this activity is to let participants know that we’ve been using a number of ideas during the early part of the session and we want to tease out an operational definition of some of these ideas. Let them know that this is something of a unique experience similar to a “Carnac the Magnificent” skit from the Johnny Carson Show (Google Johnny Carson Carnac) and describe the premise of his Carnac skit or better yet ask a participant to do it.

Tell participants that the goal is to try and figure out the criteria by that makes a statement a “yes” and (just like Carnac) to determine the question. Begin by asking participants to remain silent while you hold up each of the first four statements. Read each statement and place them on the wall under yes or no.

After the first 4 statements, ask for thumbs up, down, or sideways to reflect how confident they are that they’ll be able to predict yes or no for the next card. Continue to select cards from the pile, read each, ask them to use their thumbs to describe their confidence level, and place it on the wall. By card 8 or 9, most participant should feel more confident.

Ask participants to turn and talk about the criteria they are using to predict. Listen to their conversations. As long as you are hearing criterion consistent with phenomena, gather some ideas from the group and chart them. You might have them talk with a neighbor after another few cards if you do not hear the intended criteria.

By about card 10, have them give thumbs up if they can predict yes or no and explain which place it goes and why. This means that a thumbs up will represent a yes statement, thumbs down a no statement, and thumbs sideways if they aren’t sure. Offer additional opportunities for participants to turn and talk and then share their ideas. Add to the criteria chart as appropriate.

Continue until most (all) participants are able to identify the question and the most helpful criteria for determining a yes statement. Star those statements on the charted list.
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<th>Slide and Time</th>
<th>Facilitation Notes</th>
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<td><strong>Slide 17 (5 min)</strong></td>
<td>17. Display <em>Slide 17 (Phenomena and Concepts)</em>. Distribute <em>HO5 (Coherent Instructional Sequences Based on Anchor Phenomena)</em> and have participants read, then discuss with an elbow partner. Group discussion about what is similar between their rules and the ideas on the handout. Discuss the questions on the slide with participants. If participants are still struggling, brainstorm other examples of anchor phenomena (especially those they might use in their own sequences) to help participants clarify their understanding.</td>
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| **Slide 18 (45 min)** | 18. Display *Slide 18 (Ms. Rivera’s Phenomena and Conceptual Flow)*.  
**Transition:** We’ll use Ms. Rivera’s instructional sequence to practice the kinds of thinking we’ll need to do to develop our own phenomena/problem focused conceptual flows based on our Tool 1 and 2 work.  
Follow the directions on the slide to form two or three bigger “home groups” comprised of 1-2 participants from *each* lesson “expert group.”  
New groups work together to identify the phenomenon and concepts in Ms. Rivera’s sequence – participants should record these and post them in order to compare their storyline to the other larger group’s storyline.  
Debrief the experience with participants after. What was challenging, what “aha” moments did they experience, etc. |
| **Slide 19 (10 min)** | 19. Display *Slide 19 (Tool 3 Example)* and distribute *HO6 (Tool 3 Template Example)*  
Give participants a few minutes to compare their storyline to Ms. Rivera’s – where are they similar, where do they differ.  
Ask participants to look at the conceptual flow – point out that on the tool, the concepts are written as statements that use text from the DCIs and CCCs while the SEPs have their own column.  
Give participants a few minutes to read over the conceptual flow – ask them to share examples of ideas and phrases that come directly from language in the NGSS.  
**Facilitator note:** Given that the goal of this analysis is to develop the habits on mind for this work, you may want to conclude with a meta moment asking participants about what kind of thinking they had to do that they’d want to remember when they are...
### Slide and Time

<table>
<thead>
<tr>
<th>Slide and Time</th>
<th>Facilitation Notes</th>
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<tr>
<td>developing their own storylines of phenomena and conceptual flow.</td>
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<tr>
<th>Slide 20 (5 min)</th>
<th>Coherence means . . .</th>
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<tbody>
<tr>
<td>Coherence is when instruction is organized in a deliberate fashion to promote student learning. At the end of an instructional sequence, students become more sophisticated in using DCIs, SEPs and ECGs to make sense of phenomena and to design solutions. A coherent learning sequence is designed to build toward a bundle of NGSS performance expectations which serve as the learning goals.</td>
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<thead>
<tr>
<th>Slide 21 (optional slide)</th>
<th>Coherence and Storyline</th>
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<tr>
<td>A storyline is situated in a context that drives student engagement and motivation about a phenomenon or problem. In a coherent storyline, students engage in making sense of phenomena or designing solutions to problems.</td>
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<th>Part 5</th>
<th>Developing a Storyline and Conceptual Flow (Slide 22-24) (135 min)</th>
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<th>Slide and Time</th>
<th>Facilitation Notes</th>
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<tr>
<td>20. Display Slide 20 (Coherence means...) and Slide 21 (Coherence and Storyline)</td>
<td>Allow participants to read the text on each slide silently. Give them a moment to think to themselves about how the Tool 3 process helps provide support to help them accomplish instructional coherence. Do a quick turn &amp; talk and ask for any lingering questions.</td>
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| 21. Display Slide 21 (Coherence and Storyline) | Use this slide if you think it would be helpful for participants. |

<table>
<thead>
<tr>
<th>Slide 22 (120 min)</th>
<th>Your Turn</th>
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<tbody>
<tr>
<td>• Read the Guide to Developing a Conceptual Flow and Phenomena-based Storyline</td>
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<td>• Review the three dimensions and SEPs from the instructional sequence you worked with in Tool 2 to develop your EoLS.</td>
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<tr>
<td>• Follow the steps in the Guide and work with your group to develop a coherent SE sequence</td>
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<td>• Transfer your work to the electronic Tool 3 Template.</td>
<td>Give participants a few minutes to read through the Guide and answer any initial question they have. They should have about 2 hours to develop their storyline and conceptual flow for one sequence from their Tool 1 Unit Blueprint – this should be the same sequence they developed their EoLS for in Tool 2. Participants should work make their thinking and their work public so encourage them to use chart paper and sentence strips. Save some time at the end for groups to transfer their work into the electronic Tool 3 Template.</td>
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<td>Slide and Time</td>
<td>Facilitation Notes</td>
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<td>Share with participants that the process is iterative, they may work on storyline, then conceptual flow and then go back and revise parts of their storyline, etc. as they work. This will continue in Tool 4 – they may continue to revised and refine their Tool 3 during the Tool 4 process as well.</td>
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### Sharing
- Share your storyline and conceptual flow with another team!

#### Slide 23 (10 min)

### Reflection
- Talk with a new partner
  - What do you think will be your greatest challenges in planning lessons using the BSCS 5E Instructional Model?
  - What are the similarities and differences between using the BSCS 5E instructional Model to guide classroom practice and what you are doing now?

#### Slide 24 (5 min)

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<tr>
<th>23. Display <strong>Slide 23 (Sharing)</strong></th>
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<tr>
<td>Partner up teams with each other and have one group share their storyline and conceptual flow with another group, then switch. NOTE: If teams are struggling, you may prefer to have one group that has been successful share their Tool 3 with the entire room.</td>
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<tr>
<th>24. Display <strong>Slide 24 (Reflection).</strong></th>
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<tbody>
<tr>
<td>Summarize the conversation of the group as one possible closing. If you have more time, use a more formal closing.</td>
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<tr>
<td>Be sure to collect the Scenario B charts developed by table groups. This information will be used in the session focused on Tool 4.</td>
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